TURKISH MORTGAGE MARKET:
AN ASSESSMENT OF ITS POTENTIAL AND RISKINESS

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

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ABSTRACT

TURKISH MORTGAGE MARKET:
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This thesis is the first attempt to provide a comprehensive evaluation of the Turkish mortgage market in terms its potential within the European region, the main risks of mortgage termination through default and prepayment decisions of the borrowers, and finally the current mortgage market policies applied by the national policy makers. The present research, firstly, uses a macroeconomic perspective and investigates the development potential or the depth of the Turkish market in comparison with 31 European countries by using a rich panel-data set. Secondly, it follows a microeconomic approach and uses the reduced-form models, which use loan-level data, evaluates the default and prepayment risks simultaneously and assesses the effectiveness of various policy choices that affect Turkish mortgage market. In addition, loan-level data also enables assessing the product and borrower level changes in the market in recent years. Main conclusions of this thesis are; Turkish mortgage market has a significant growth potential which is fueled by the factors such as growing economy, increasing population and urbanization trend, default risk is low in the Turkish mortgage market and default risk related policy

choices are excessively tight and the level of prepayment risk is very high. The results of this thesis is expected to contribute both to the literature on mortgage markets and to the decision making processes of the national policymakers.

Keywords: Housing Policy, Survival Analysis, Default Risk, Prepayment Risk, Basel Capital Accords

ÖZ

TÜRKİYE İPOTEKLİ KONUT FİNANSMANI PİYASASI: POTANSİYELE VE RİSKLİLİĞE İLİŞKİN BİR DEĞERLENDİRME

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Bu tez, Türkiye ipotekli konut finansmanı piyasasının, Avrupa bölgesi çerçevesinde potansiyelinin ortaya konulmasına, ipotekli konut finansmanına ilişkin temerrüt ve erken ödeme gibi sona erme risklerinin incelenmesine ve son olarak da ipotekli konut finansmanı piyasasına ilişkin ulusal otoritelerce belirlenmiş olan güncel politika tercihlerinin kapsamlı bir biçimde değerlendirilmesine yönelik ilk girişimdir. Mevcut çalışma öncelikle makroekonomik bir perspektifle Türkiye ipotekli konut finansmanı piyasasının potansiyelini 31 Avrupa ülkesinin verilerini kapsayan bir model üzerinden incelemektedir. İkinci olarak ise çalışmada mikroekonomik bir yaklaşım sunulmakta, indirgenmiş form modeller vasıtasıyla temerrüt ve erken ödeme riskleri kredi düzeyinde veri baz alınarak eşanlı olarak modellenmekte ve ipotekli konut finansmanı piyasasına ilişkin muhtelif politika tercihlerinin etkinliği değerlendirilmektedir. Ayrıca kredi düzeyindeki veri Türkiye'de ipotekli konut finansmanı piyasasında son yıllarda müşteri ve ürün bazındaki değişimlerin de incelenmesine olanak sağlamıştır. Tez çalışması sonucunda; Türkiye ipotekli konut finansmanı piyasasının ekonomik büyüme, artan nüfus ve kentleşme gibi faktörlerin

de etkisiyle önemli bir büyüme potansiyeline sahip olduğu; Türkiye ipotekli konut finansmanı piyasasında temerrüt olasılığının düşük olduğu ve bu nedenle temerrüt olasılığı ile ilişkili politika tercihlerinin aşırı ihtiyatlı olduğu; erken ödeme riskinin ise oldukça yüksek olduğu sonuçlarına ulaşılmıştır. Tezde ulaşılan bahse konu sonuçların gerek konuya ilişkin yazına gerekse ulusal otoritelerin karar alma süreçlerine katkı sağlayabileceği düşünülmektedir.

Anahtar Kelimeler: Konut Politikası, Sağkalım Analizi, Temerrüt Riski, Erken Ödeme Riski, Basel Sermaye Standartları

To my wife “Esra” and daughter “Nisan Naz”

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I am also deeply grateful to thank my dad, my mom and my sisters Burcu and Gizem Nur and Uslu family who tolerated my absence for many years. I also would like to thank my colleagues and friends, but only the ones who were sincerely happy when I said “I did it”.

Last but not least, I would like to thank my wife, Dr. Esra Uslu Kutlukaya, for the luxury that she provides in my life. She was the only one who had absolute belief that this thesis would come to an end. Without her intellectual and emotional support, completion of this thesis would not have been possible. I could not remember how many cups of Turkish coffees and teas she served to keep me awake for this work to be finished. Besides, she has read and corrected every section I wrote as many times as I have done. I also would like to say “I am sorry” to my daughter. I know that I have stolen many valuable weekends and nights from her for this work. This will not happen again, I hope. “I love you”.

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CHAPTER I

INTRODUCTION

Housing finance system aims to create an intermediation mechanism which facilitates transfer of funds from people with excess funds to the individuals demanding it for home ownership purposes. In recent years, increasing emphasis has been attributed to the development of mortgage markets. Housing policy and more specifically policy with regards to the mortgage markets, is an important policy tool for governments in both economic and social terms and mortgage markets are not only important for developed countries but also important for developing countries such as Turkey.

Supporting housing both as policy and in practice for succeeding fight against poverty becomes an important agenda for several developing countries when it is noted that approximately one-third of the world's urban population lives in slums and the need for approximately 4000 housing units per hour to be completed to meet the demand (Rivzi, 2014). At present, mortgage finance systems is one of the most important tools for policy makers in this process.

In line with the progress in the financial markets, mortgage markets have also shown significant improvement in the last few decades where rapid increase in the product variability and market volume is witnessed. Contrary to its economic and social importance, housing finance sector is generally underperforming in emerging/developing countries. For instance, housing finance systems are mostly underdeveloped in the developing countries; residential lending is small and poorly accessible and lenders remain vulnerable to significant credit, liquidity and interest rate risks. This high level assessment about the mortgage markets of developing countries are also valid for Turkey.

Although housing finance was intermediated mostly by governmental agencies until 1990s, today many banks are offering mortgage products in Turkey. In recent years, following the macroeconomic stability and reduced interest rates, there has been a considerable growth in the amount of loans extended with the housing finance purpose (from 2 billion TRY in 2005 to 130 billion TRY in 2015). However residential mortgage debt to GDP ratio is only around 6% which is lagging behind many developed countries. Briefly, Turkish mortgage market is under-penetrated and assumed to have a significant growth potential. Therefore, the question of whether Turkish mortgage market has a substantial growth potential is one of the main questions that initiated this work.

On the other hand, the global financial crisis had shown another important aspect of housing finance policy. Supporting the development of mortgage markets is crucial. However, managing a sound and stable growth is also essential. Moreover, mortgage markets have started to be used as a countercyclical instrument by the many policymakers in the world. In this respect, closely monitoring and assessing the risks in a mortgage market is also vital.

This study is the first attempt to provide a comprehensive evaluation of the Turkish mortgage market in terms of its potential within the European region, the main risks of mortgage termination through default and prepayment decisions of the borrowers, and finally the current mortgage market policies applied by the national policy makers. The present research, firstly, uses a macroeconomic perspective and investigates the development potential or the depth of the Turkish market in comparison with 31 European countries by using a rich panel-data set. Secondly, the study follows a microeconomic approach and uses the reduced-form mortgage pricing models, which require loan level data and evaluates the default and prepayment risks simultaneously. To the best of our knowledge, this is the first academic study that investigates the depth of Turkish mortgage market in a comparative framework and that uses the reduced-form models to price mortgage market risks using loan level data and evaluates the current set of policy choices.

As a general assessment, the literature on Turkish mortgage market is shallow. No comprehensive information could be obtained regarding the mortgage borrowers in Turkey. Trying to find answers for the questions above, this thesis also provides a inclusive set of analyses about the Turkish residential mortgage market both from the lenders and borrowers side[1].

1.1 Research Questions

Research questions of this thesis can be categorized under two groups; the research questions on the potential of the Turkish mortgage market and the research questions on the riskiness of the Turkish mortgage market.

Regarding the former, the major research question of this thesis is whether there is a significant growth potential of the Turkish mortgage market for the near future. Therefore, growth potential of the Turkish mortgage market, which has been lagging behind several developed and developing countries is investigated thoroughly.

Chapter 3 attempts to answer two basic questions: a) what are the main factors behind the development of mortgage markets? and b) what can be done to boost the growth of Turkish mortgage market? A baseline model is constructed to analyze the present state of the mortgage markets compared to the calculated frontier. Based on the outputs of the baseline model, the potential of the Turkish mortgage market will be analyzed under various scenarios. Moreover, possible government interventions that could help development of this market is discussed in order to present housing finance policies for Turkey.

In addition to answering these questions, the baseline model that is constructed in this thesis could also help decide in which countries the mortgage markets have

[1] It should be mentioned that the focus in this work is residential mortgage market and commercial mortgage market is excluded from this study.

grown more than expected and whether or not this growth would create potential macroeconomic stability problems in the long term.

In order to provide optimum amount of credit to the economy, financial institutions need to create a balance between the capital and provisions they held and risks taken. Underestimation of risks may lead to default of an institution which could even harm the financial stability. On the other hand, overestimating risks may result in creating credit less than the potential, which leads to less than expected profit and growth. For instance, literature on developing economies argue that extreme liquidity in developing countries restricts the growth rates (Freedman and Click (2006:279)). Excessive capital and provision could also create the same effect. Therefore, evaluating the regulatory requirements on the basis of risk is critical.

Excluding the last few years, where Turkish authorities started to use countercyclical macro-prudential tools, financial regulation can simply be described as convergence to the international standards in Turkey. However, taking into account the fact that most of the international standards are calibrated for developed countries, the need for paying more attention to this field becomes obvious. Otherwise, financial stability of the sector could be threatened by the risk accumulation or stressed by too conservative measures.

The international Basel-II capital standard is designed in a way that banks using advanced techniques for modeling their risks are expected to allocate less capital for their risks. Therefore, evaluating the riskiness of mortgage products is important not only for the supervisory agencies but also for the financial institutions. For instance, by measuring the risks better, financial institutions can manage their economic capital and make better pricing.

With respect to the riskiness of the mortgage market, prepayment risk and default risk in the Turkish mortgage market are analyzed in Chapter 4. In this sense, answers are searched for the questions, a) what are the determinants of default risk and prepayment risk in the Turkish mortgage market, b) whether or not current regulations are sufficient for the effective functioning of the market. For the second

question priority will be given to capital adequacy and provisioning regulations. Therefore, this chapter attempts to answer the questions; i) is the current 1% flat provisioning rate appropriate for residential mortgages, ii) is the current 50% risk weight for residential mortgage exposures appropriate under current macroeconomic environment. Therefore, appropriateness of risk weights applied in the Basel-II context and provisioning requirements coming from related Banking Regulation and Supervision Agency of Turkey regulations are scrutinized. Additionally, appropriateness of the current prepayment penalty for mortgage loans is also investigated.

Last but not least, in recent years Turkish mortgage market has shown strong growth. The consumer and product level changes behind of this growth are investigated in more detail in the micro level. According to the best information of the author, no such study has been conducted that comprehensively analyzed the characteristics of mortgage borrowers including their socio-economic status.

1.2 Data

For the analyses in this work, two main sets of data is collected. The first set of data is gathered for the purpose of constructing a cross-country model to support qualitative evaluations regarding the assessments on potential of the mortgage market. In the field of mortgage finance, there is no single data source from which all of the necessary information can be obtained for constructing cross-country models. Some institutions have recently started systematic data collection efforts, including the Bank for International Settlements (BIS) on housing prices and Housing Finance Information Network (HOFINET) on the characteristics of mortgage markets, but these are still limited to a relatively small number of countries. Therefore, for the present study, data has been collected from a wide range of sources, including the European Mortgage Federation (EMF), World Bank, United Nations Development Programme (UNDP), The Organisation for Economic Co-operation and Development (OECD), Eurostat and International Monetary Fund

(IMF) World Economic Outlook reports. A sample of 31 countries has been selected directly from those countries covered by the EMF Hypostat reports, as these reports provide the only comparable data sets for the mortgage market-related indicators. The variables of the mentioned study also included financial, demographic, institutional and economic characteristics of the countries in the sample.

A rich, loan-level data set is obtained from three private commercial banks for the risk analyses. Among these banks two are large scale deposit banks (one is one of the largest banks in Turkey and the other one is a comparatively smaller one) and the third one is a participation bank. The reasoning behind obtaining data from more than one banks is that banks policies and aggressiveness in mortgage lending (i.e. the cut-off value as explained in the sections above) could hamper robustness of the results and therefore heterogeneity among banks could be taken into account by using data from different sources. Given that there is no national/international level standard on banks data collection requirements, the depth and coverage of data that is obtained by different banks vary considerably.

Banks that are contacted for this study are requested to provide all mortgage default and prepayment related data in a pre-specified format (template). In that template, mortgages denominated in currencies other than Turkish lira and variable rate mortgages are excluded. The data collected in this study corresponds to around one-third of the all mortgages originated in Turkey in 2013.

1.3 Methodology

This thesis mainly investigates the potential and riskiness of the Turkish mortgage market. In doing so cross country models regarding the depth of mortgage markets and loan level reduced form models are employed as quantitative models.

The work regarding the potential of Turkish mortgage market depends on three main pillars. These are the analyses on the historical development of the market, analyses

of markets that experienced fast growth in the recent past and a benchmark model to support these analyses.

With respect to history, developments in the housing policy after the establishment of the Republic of Turkey is covered together with the macroeconomic developments in the last decade that could have positive effects on the expansion of the market. In addition to this, mortgage markets of the Malaysia, Chile, Korea and South Africa are investigated in order to better understand the background that helped boosting of their mortgage markets. Lastly, a benchmark model is constructed to analyze the present state of the mortgage markets compared to the frontier. Based on the outputs of the baseline model, the potential of the Turkish mortgage market is analyzed under various scenarios.

There is no theoretical framework for modeling the depth of mortgage markets in a cross country setting. Unlike the earlier studies, which selected a subset of variables based on the economic theory, intuition and conventional wisdom, this study presents an initial attempt to use variable selection methods in order to model cross-country variations in the depth of mortgage markets. Analyses presented in this thesis are based on two dependent variables in order to evaluate the mortgage market development, namely, residential mortgage debt to GDP ratio and mortgage credit to total credit ratio. The residential mortgage debt to GDP ratio is the most widely accepted indicator of the depth of a housing finance market, as it eliminates the country-size effects. Simply, the literature assumes that housing finance system of a country is more developed when the mortgage debt to GDP ratio is high. However, the level of residential mortgage debt to GDP indicator can be evaluated from two different aspects. For most of the developing countries, considering residential mortgage debt to GDP as a proxy for accessibility of housing finance, higher values of mortgage debt to GDP is evaluated as a positive indicator as there is still considerable room in these countries for deepening and penetration (i.e. Roy, 2008). On the other hand, a careful balance is needed to be maintained between deepening of the market and over-indebtedness of households. From the point of view of most of the developed countries, this indicator needs to be closely monitored as significant increases might mean higher risks for the economy (i.e. Girouard *et al.,* 2007).

Additionally, to control for the effect of financial sector development in the selected countries, mortgage credit to total credit ratio is used in this thesis.

For the data analyses, cross sectional regressions, pooled OLS and panel regression methods are applied separately. These are the methods that have been utilized by the major studies in the literature on this subject. When there is a heteroscedasticity problem, White's heteroscedasticity consistent variance-covariance estimators are used.

The variable selection algorithm can be summarized by the following three steps: (1) Variable selection is carried out using R-function *regsubsets* for the cross sectional regressions, pooled OLS analyses and *bestglm* for the panel regression analyses, (2) When the best model obtained does not differ significantly from the other best performing models (i.e. second best, third best model), a cross validation technique is used to determine the final model, (3) Steps (1) and (2) are repeated in order to evaluate the effect of additional variables when there are missing values.

As the final layer of robustness check, all the best performing models that are obtained through the process described above are also compared against the models estimated via robust regression method. Robust regression analysis confirmed the model results presented in this thesis.

The assessment of the riskiness of the Turkish mortgage market is based on descriptive analyses about riskiness and modeling of default and prepayment risks based on loan level data. In the modeling exercise, survival analysis is employed as this method has become the widely accepted methodology for modeling competing prepayment and default risks in the literature.

Before the modeling stage, the dataset is randomly divided into two halves as model building and validation samples. The validation sample helped estimating the out of sample performances of various models.

After constructing several models based on the approach followed by Deng *et al.* (2000, 2005), the resulting models are compared according to their out of sample

rank-ordering performances. In doing so, Receiver Operating Curves is used based on the estimated one year probability of default and probability of prepayment. Later on, risk weights and provisioning rates that are implied by the banks mortgage portfolios (validation samples) are used in order to assess the appropriateness of various regulatory choices. Lastly, a historical analysis on the prepayment related economic loss is calculated and the analysis results are compared with the current set of parameters provided in the Consumer Law.

1.4 Limitations and Further Research

Providing a descriptive mapper regarding mortgage related products and Turkish mortgage market is not one of the aims of this study. Therefore, despite many other studies, this work does not provide lengthy information about mortgage products, calculation of mortgage payments or lenders in the Turkish mortgage market. Only the related aspects of the mentioned issues are briefly covered in this thesis[2].

This thesis has some limitations most of which are due to data related problems. For instance, it was not possible to provide causality relations with the OLS and panel data models that are constructed in order to support the assessment on the potential of the Turkish mortgage market. Additionally, the effect of tax relief on the significance of mortgage interest rate variable and investigating the role of savings rate, LTV ceilings, maturity structure, range of products and outright ownership rate[3] in the development of mortgage markets remains as important factors for future research.

Similarly, the reduced form models for the riskiness of the mortgage market was not able to incorporate some of the variables due to lack of data. Additionally, some of

[2] Readers that are interested in such information are suggested to read more descriptive studies such as Coşkun (2015), Capraz (2013) and Okay (2010).

[3] This data is available in the Hypostat 2013 but excluded from the analyses due to very high number of missing data points.

the variables did not create strong results as indicated by the literature. However, it should be kept in mind that the loan level data set is obtained directly from the banks and there is no other way to improve the quality of this data except for the banks to invest more on this issue and national authorities to force both lenders, borrowers and relevant appraisal companies to provide high quality data.

For the provisioning rate calculation only delinquency status is used as an indicator of impairment. Banks need to design/use additional forward looking measures for their provisioning calculations in addition to the delinquency status variable.

1.5 Expected Contribution

Thesis will make an important contribution to the literature on Turkish mortgage market. In two separate chapters (Chapter 3 and Chapter 4), the literature on potential and riskiness of mortgage markets are investigated. As can be seen from the literature review sections of these chapters, the literature on Turkish mortgage market is shallow. In this respect, this thesis is one of the most comprehensive studies on the Turkish mortgage market with detailed and inclusive qualitative and quantitative analyses.

The analyses in Chapter 3 on the history of the Turkish mortgage market, the analyses on country examples and additional scenario analyses based on the cross country model indicate a huge growth potential for the Turkish mortgage market. More important than this result, current frontier that is calculated for the depth of Turkish mortgage is very low and suggestions on extending this frontier is provided in this thesis. Moreover, the cross-country models presented in Chapter 3 can be accepted as the updated and enriched version of existing research for the European region in terms of the coverage of countries, historical data and empirical analyses.

Currently, information about the characteristics of mortgage borrowers in Turkey is limited. Leaving all other quantitative analyses aside, the descriptive analyses about the borrower and product level characteristics of Turkish mortgage market provides

valuable results. For instance, it is shown that accessibility of the mortgage products is increasing in Turkey as the share of lower age groups and females have been increasing.

As a general assessment, it can be argued that Turkish financial regulation can simply be evaluated as harmonization of local rules with international standards. However, no concrete studies are available on how some crucial parameters in the regulations were calibrated. In this respect, analyses in this thesis could also help policy makers to make more informed decisions on the policy areas affecting Turkish mortgage market. The recent global financial crisis has shown that local mortgage markets are not only important for supporting homeownership and fighting against poverty, but also important as a macro-prudential policy tool which can be used counter-cyclically. Therefore, analyses as the ones provided in this thesis are valuable from the perspective of designing a macro-prudential tool.

1.6 Structure of the Thesis

This thesis is structured as follows. In Chapter 2, background information on mortgage markets is provided together with the risks that is posed by mortgage portfolios. Additionally, Basel standards and international financial reporting standards that are related to the context of this study is briefly covered. In Chapter 3, the development of Turkish mortgage market is analyzed. In doing so, historical development is investigated together with major changes witnessed. Additionally, countries that have experienced fast growth in their mortgage markets are analyzed in order to identify areas for progress. Moreover, a cross country benchmark model is constructed. The idea here is not to calculate a point estimate for the growth of the market but to calculate a benchmark that is implied by current policy variables regarding Turkey.

Chapter 4 is built on the loan level data that is obtained from three different banks. Using this data, first of all, a snapshot of Turkish mortgage market is given. This

includes borrower characteristics and mortgage loan properties. After these analyses, default and prepayment models are built which allows answering some policy questions on the riskiness of Turkish mortgage market including, the appropriateness of risk weights, provisioning rates applied to residential mortgages and the prepayment penalty limits that is introduced by the Consumer Law.

Chapter 5 unifies the main conclusions from Chapter 3 and Chapter 4 and presents recommendations for the policy makers.

CHAPTER II

MORTGAGE MARKETS: HISTORY AND ASSOCIATED RISKS

As a general definition, a mortgage loan, or mortgage, is a loan secured by a real property as collateral. The word *mortgage* comes from two Middle English words: *gage* meant an obligation or commitment, while *mort* referred to death or dying. Hence, it is defined as a "dying commitment", that is, a commitment that is not permanent, but has a finite lifetime (Geltner and Miller, 2001: 383). In case repayments are not fulfilled according to the contract, or if the borrower defaults on his/her obligations, the lender of the mortgage credit has the right to force a foreclosure sale of the collateral property and use the proceeds from that sale to obtain what is owed.

Housing finance system aims to create an intermediation mechanism which facilitates transfer of funds from people with excess funds to the individuals demanding it for home ownership purposes. In recent years, increasing emphasis has been attributed to the development of mortgage markets, especially in emerging economies, in that housing policy is an important policy tool for governments in both economic and social terms. A well-functioning housing finance system creates various positive externalities beyond its formal definition. Arku & Harris (2005, p.895) point out that housing is not simply an indicator but a litmus test of prosperity. Nevertheless, approximately one-third of the world's urban population lives in slums, and formal housing is neither affordable nor adequate for many segments of the population owing to the lack of a well-functioning housing finance system (Warnock and Warnock, 2008, p.239–240).

Housing has been one of the most expensive investment assets; therefore, mortgage lending has been among the most critical decisions for the individuals in their lives.

To buy a house, many people have to save money for years and/or borrow credit that could be paid back over a long time period. UN Habitat (2005, p.1) noted that world needs 4000 housing units per hour needs to be completed to meet demand and Rivzi (2014) highlighted importance of supporting housing both as policy and in practice for succeeding fight against poverty. At present, housing finance systems is one of the most important tools for policy makers in this process. Whereas, in most of the developed countries, policy discussion is related to the interaction between housing markets and countercyclical regulation[4].

Parallel to the developments in financial markets, mortgage markets have also shown significant improvement especially in the developed countries. During this progress, rapid increase in the product variability and market volume is witnessed. Fixed rate and adjustable rate mortgages have been the two main products in the developed country markets but there are also other products such as indexed mortgages and interest-only mortgages. With the boom of securitization markets, the secondary market, several products based on mortgage loan pools have been created such as RMBS, CMBS, CMO, etc.[5]

There have been tremendous changes in rules, practices and instruments prevailing in the financial sector in the last few decades and in this respect housing finance, especially mortgage related products, have shown a notable development. Nevertheless, housing finance systems are mostly underdeveloped in the developing countries. For instance, Eldin, Mohieldin and Nasr (2004:1) argue that housing finance in Middle East and North Africa countries has been limited to state-owned specialized housing banks that created burden on government budgets through heavy reliance on subsidized finance. Although mortgage markets in developed economies

[4] For instance; see Scanlon and Elsinga (2014) for a detailed analysis of policy changes affecting the mortgage markets of the UK and the Netherlands after the Global Financial Crisis.

[5] Residential Mortgage Backed Securities, Commercial Mortgage Backed Securities, Collateralized Mortgage Obligations.

feature a large number of products, housing finance in emerging countries have started to develop only recently (IMF, 2011, p.115).

Today, housing finance systems substantially differ across countries and regions in terms of product diversity, type of lender, degree of government participation and legal enforcement. A closer look into the housing finance systems of the European countries reveal that European housing finance systems have many differences when compared to the US. For instance, in the Europe foreclosure rules usually allows recourse to other income or assets of the borrowers, originate-to-distribute model is less developed and for mortgages originated by banks deposits continue to be the main source of funding (ECB, 2009). However, there is also substantial variation in terms of product diversity (i.e. share of variable rate products), degree of fiscal subsidization (i.e. tax relief) and typical loans terms[6]. While the Western European countries were deregulating and expanding their housing finance systems, the ones in Central and Eastern Europe were in the process of creating them during the last decades.

Housing market is crucial for the effective functioning of an economy. Warnock and Warnock (2008:1) argue that housing sector of a country affects improvement of public health (i.e. reducing the likelihood of outbreak of diseases) and have positive social outputs (i.e. crime reduction and better citizenship). Therefore, housing policy is actually an important policy tool for governments in both economic and social terms. As a result, increasing emphasis is given in developing and transitioning countries on the reform of real estate finance and mortgage markets (Bardhan and Edelstein, 2007:2).

[6] See Wolswijk (2005) for a more detailed analysis of the housing markets of the Euro Area countries. Additionally, IMF (2011, p.117-121) provides a good coverage of the main features of the housing finance systems in several European countries.

Housing finance also serves to the global development goals.[7] According to Figure 1, there is a positive relationship between the depth of the mortgage markets and level of human development.

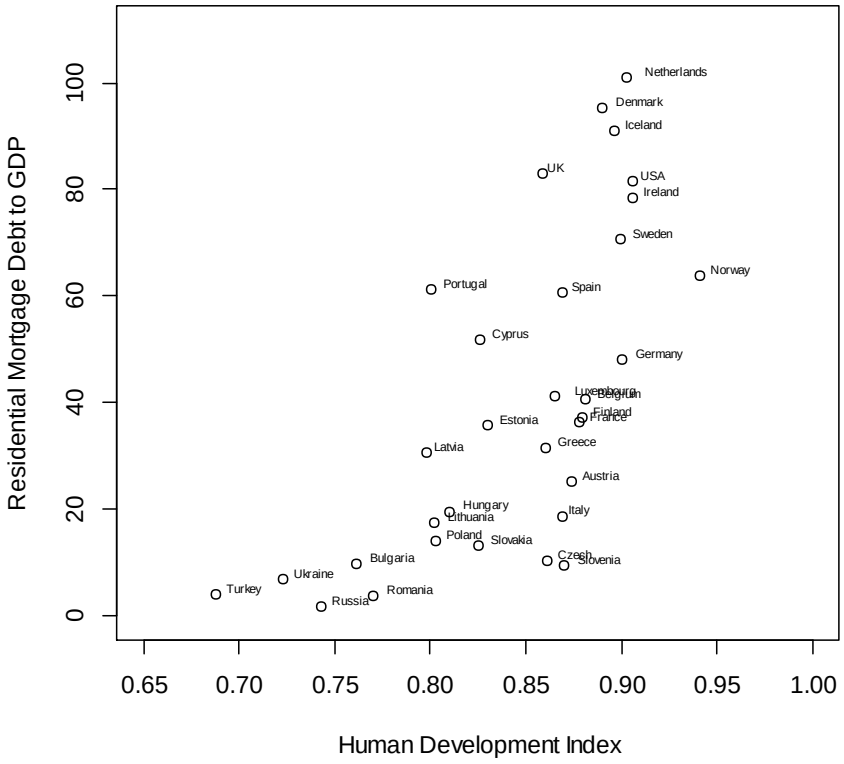


Figure 1: Human Development Index vs. Residential Mortgage Debt to GDP Ratio

As highlighted above, housing finance is associated with the living standards of people (i.e. increasing the quality of housing, infrastructure and urbanization) and has significant positive effects for the economy (i.e. Enhancing savings and promoting financial market development) (Erbaş and Nothaft, 2005:4). The

[7] Target 7D of the UN Millennium Development Goals (MDG) is "By 2020, to have achieved a significant improvement in the lives of at least 100 million slum-dwellers.

importance of housing finance for developing countries is better understood when the average cost of housing to annual income is compared in developed and developing countries. Warnock and Warnock (2008:2) indicate that average house prices are around four times of annual income in developed countries and around eight times in developing countries. Additionally, mortgage finance benefits the whole economy both lower income and higher income (Eldin *et al.*, 2004: 3). According to Worldbank Report (Chiquier and Lea, 2009: xxxiii), favorable macro conditions (falling inflation and mortgage rates), increasing housing demand linked to long-term urbanization and demographic forces, and financial liberalization have been the driving forces behind the expansion of housing finance in emerging economies.

2.1 A Brief History of Housing Finance

Housing finance system was formed in order to meet the housing needs of the people. In some cases it was established by the individuals within a certain society and in some others it was created with the support of the government to react to certain external developments.

Housing finance was originated in the United Kingdom and the first application of mortgage lending dated back to the 18th century with the formation of building societies[8]. Besides, English common law includes a provision coming from the 12th century where land was used as collateral for a loan (Berman, 2005:85). Therefore, in the UK case, establishing a strong legal system for the mortgage market has taken centuries and the UK experience has contributed to the development of other mortgage markets such as the United States market.

[8] The first Building Society was formed in Birmingham in 1774 (Chandrasekar, 2010:9).

On the other hand, the Danish mortgage lending system launched after the great fire of Copenhagen in 1795 after which there was the need for funding to build a large number of new buildings (IMF, 2011: 115).

At present, even after the subprime mortgage crisis experience, United States has the most sophisticated and developed mortgage market. In the US the first institutional development for housing finance was the establishment of building societies in the early to mid-19th century (Office of Policy Development and Research (PDR), 2006:3). In building societies, a small number of people from a region pooled their savings and provided funds to each other for the construction of houses and this process ceased to exist once all members received the loans.

Secondary market is claimed to be important for the development of primary market by allowing transfer of risk from originating institutions to other players via securities market as a result extending more credit to the sector. In the US during 1870s, the first mortgage banks were formed which originated and serviced loans with the funds obtained from selling mortgage-backed bonds (MBBs). This could be considered as the first secondary mortgage market.

Government support for home-ownership dates back to 1913 in the US where deduction of mortgage interest payments from tax was allowed (Erbaş and Nothaft, 2005:10). In response to home mortgage distress in the 1930s (during great depression)[9], in order to provide government guaranteed mortgage insurance, Federal Housing Administration (FHA) was established in 1934. Following this, in 1938, the Federal National Mortgage Association (FNMA) was created to establish a secondary mortgage market by purchasing FHA-insured loans (Wheelock, 2008:140). These developments led to major changes in the US housing system such as; longer maturity mortgages and lower down-payments (Chandrasekar, 2010:4).

[9] Further information regarding housing market distress during great depression can be obtained from Wheelock (2008)

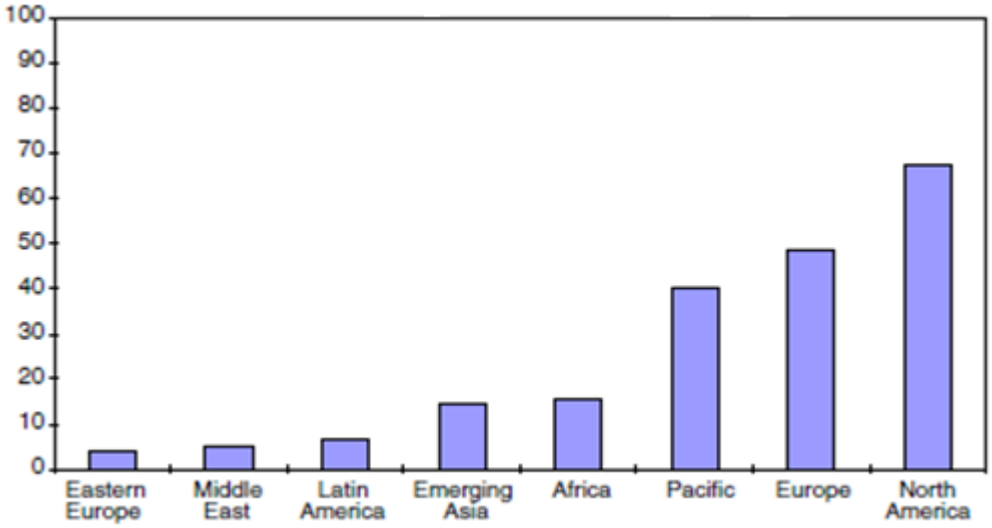
In the US, contractionary monetary policy to control inflation caused a severe recession between 1981 and 1982 and important developments were witnessed in the mortgage market after these years. Financial deregulation and elimination of interest rate ceilings improved the financing options for consumers (Diamond and Lea, 1992:145). Baily *et al.* (2008:11) indicate three main factors as determinants of growing demand for residential housing in the US; a "contagion" in the households of expectations of future price increases, rises in households income and low and downward trending interest rate after 1980's. As a result, there has been a huge growth in the mortgage market after 1980's in the US which finally ended up with the global financial crisis.

2.2 Recent Developments in Mortgage Markets

Currently housing finance systems differ considerably across countries and regions. At present, there are quite a large number of products in the advanced country mortgage markets. On the other hand, according to IMF (2011: 115), housing finance in emerging and newly industrialized countries have started to develop only recently.

Contrary to its economic and social importance, housing finance sector is generally underperforming in the emerging countries. In these countries residential lending is small and poorly accessible and lenders remain vulnerable to significant risks such as credit, liquidity and interest rate risks (Chiquier *et al.*, 2004:1).

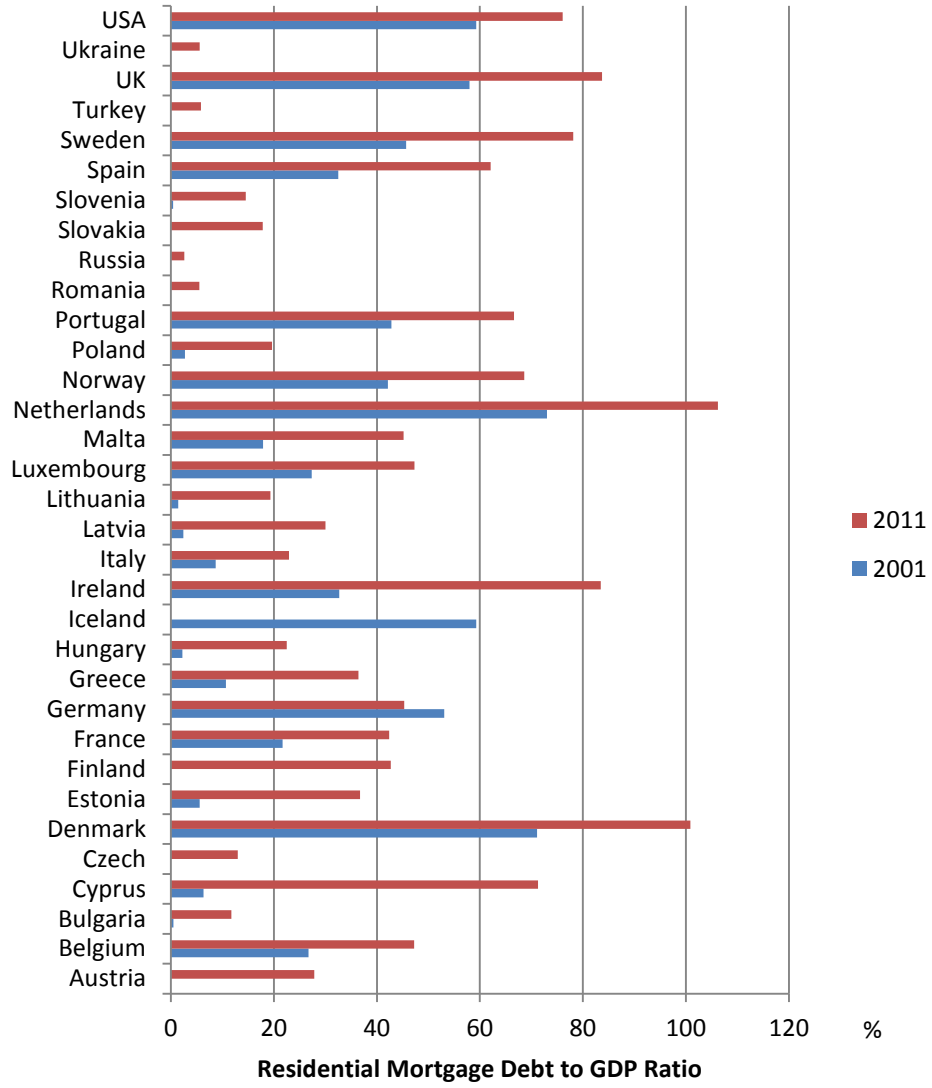
Depth of mortgage markets shows important differences across regions. According to Figure 2, the depth of the mortgage market is at minimum in Eastern Europe and Middle East, i.e. the region surrounding Turkey, and maximum in Europe and North America. Renaud (2005:25) attributes this underdevelopment to former centrally planned system in Eastern Europe and government interventions and reliance on public institutions for housing finance in Middle East.



Source: Warnock and Warnock, 2008:6

Figure 2: Depth of Mortgage Markets in Relation to Regional GDP

Generally, housing finance systems have shown considerable development in the last decade not only in the developed countries but also in the developing countries. Figure 3 clearly shows this development between the years 2001 and 2011.



Data Source: HYPOSTAT, 2012

Figure 3: Residential Mortgage Debt/ GDP (Country Based Ratios)

When mortgage debt to GDP ratio is analyzed at the country level, it is observed that in most of the developed countries this ratio is above 20% level. In Denmark, one of the oldest mortgage markets in the EU, and in Netherlands, this ratio even exceeds 100%. Between 2001 and 2011, both developed and developing countries have shown a significant growth in their mortgage markets. In the new EU countries, household credit to GDP ratio increased from 5% in 2000 to 25% in 2007 (Beck *et*

al., 2010:11). This shows that once the appropriate infrastructures are established, mortgage markets have an important potential to grow at a very rapid pace.

In last few years, Turkey has been experiencing decreasing interest rates and increasing house prices together with higher household income[10]. Moreover as indicated in the Worldbank report (Chiquier and Lea, 2009: xxxiii) long term urbanization and demand fueled by strong desires for better housing conditions are the other factors supporting the growth of the mortgage market in several developing countries such as Turkey, Mexico and Iran. Therefore, residential housing demand is expected to grow further in the near future unless a strong macroeconomic shock affects the whole economy.

Greenspan and Kennedy (2007:120) noted that housing wealth supports consumption and changes in household wealth significantly influence personal consumption. Case *et al.* (2005:26) concluded that there is strong evidence that changes in housing related wealth have important effects on consumption which supports the conclusion that changes in housing prices have a larger and more important impact than changes in stock market prices in influencing household consumption in the US and in other developed countries.

On the other hand, for developing economies like Turkey, the effects of an inefficient mortgage market are similar to the effects of keeping savings under the mattress. For instance, with the use of residential properties as collateral, homeowners have the advantage of obtaining higher volumes of bank loans and having better housing conditions. The banks, on the other side, could significantly reduce their risks and increase their leverage which in turn affects their profitability. Additionally, there is a vast literature on equity extraction from increasing home prices and its effects on consumption in the developed countries. Greenspan and Kennedy (2007:120) showed that free cash generated by home equity extraction is used for financing consumer spending, home improvements and debt repayment in the US. In this

[10] Renaud (2005:23) categorizes Turkey housing finance system as underdeveloped due to suffering from repeated episodes of macroeconomic instability.

respect, supporting the development of mortgage market is also crucial for emerging countries like Turkey. Nevertheless, mortgage lending brings along some important risks; risks for the institutions engaging in mortgage lending in the first round and risks for the financial stability in the second round.

The global financial crisis was a good example reminding the importance of effective functioning of mortgage markets for an economy. The US market, which used to be praised for working perfectly, completely failed during the crisis. In the US, during a period of low interest rates between 2002 and 2004, households with very low payment capacities had the chance of borrowing as a result of the emerging system of banking, the so-called *originate to distribute model*. In that system, banks were mainly considering creating loans only which could be packaged and sold-resold to other-parties through a liquid securitization market. In this period, the main objective of banks turned out to be originating as many credits as possible since the risk generated by lending to low quality customers could be transferred to other institutions or countries.

Thanks to credit rating agencies being extremely generous about their ratings (which helped the market grow for the rating agencies), the products of securitization process were invested by not only other players in the market such as hedge funds and insurance firms, but also by other countries. The lax credit policies combined with the boost of credit rating agencies and one possibility that was seldom taken into account - house prices in the US may drop - led to the beginning of precarious developments in financial markets throughout the world[11].

Global financial crisis of 2008 is an important case showing the importance of tracking the risks in mortgage lending. Nevertheless, Beck *et al.* (2010:27) argues that a deeper mortgage market does not seem to be associated with higher vulnerability of households.

[11] For further information regarding the causes and development of the crisis, see for instance; Diamond and Rajan (2009), Naude (2009) and Iannuzzi and Berardi (2010).

In the last few decades there has been important developments related to risk management and measurement. In this context, Basel Committee on Banking Supervision (Basel Committee - BCBS) has significantly contributed to the development of this field. Basel capital accords (Basel I, Basel-II, Basel-II.5 and Basel-III) have been the milestones in risk measurement, forcing financial institutions to have enough capital against the risks taken. In the following section, some important risks in mortgage lending are discussed first and brief information about Basel standards are provided later.

2.3 Risks in Mortgage Lending

Globally, consumer credit market, and especially the mortgage market has shown a significant growth in the past not only in terms of aggregate figures but also in terms of their share within financial institutions portfolios and earnings. Consumer credit market is also one of the markets where competition is wild. In this respect, financial institutions are required to have automated systems to standardize their credit decisions.

From an economic point of view, increasing the efficiency of credit allocation has the effect of directing resources towards most productive segments, increasing productivity, output and growth. From the financial institution's point of view, better credit decisions can support its competitiveness in the market by increasing profitability.

As the volume of mortgage products increase in the portfolio of a bank, the importance of the risks that these products bring increases. Among the many risks that is formed as a result of mortgage lending, two major risks are the most important ones that should be monitored more closely and measured more sensitively, namely; default and prepayment risk. The models which support automated systems in banks also contributed to the measurement and monitoring of these risks.

McDonald *et al.* (2010) indicated that the 2007-2008 mortgage crisis had shown the importance of accurately assessing and pricing the risks in mortgage lending. Mortgage default is costly to not only the lenders but also to the borrowers. Lenders may encounter loss when the borrower defaults or prepays[12]. For instance, in case of a default, if the proceeding from the foreclosure is less than the value of the financial asset the lender is exposed to a loss. It is well observed that disposal of a real estate by financial institutions at the full market value is very difficult. Capone and Metz (2003) argues that usually, such real estate are sold around 5-10% less compared to similar properties in a region. Similarly, the defaulting individual is also penalized in many ways such as loosing homeownership and down-payments, lower credit rating for future transactions and possibility of losing equity as a result of quick sale (Quercia and Stegman, 1992, Giliberto and Houston, 1989). For these reasons, both the lenders and borrowers try to optimize their lending/borrowing decisions.

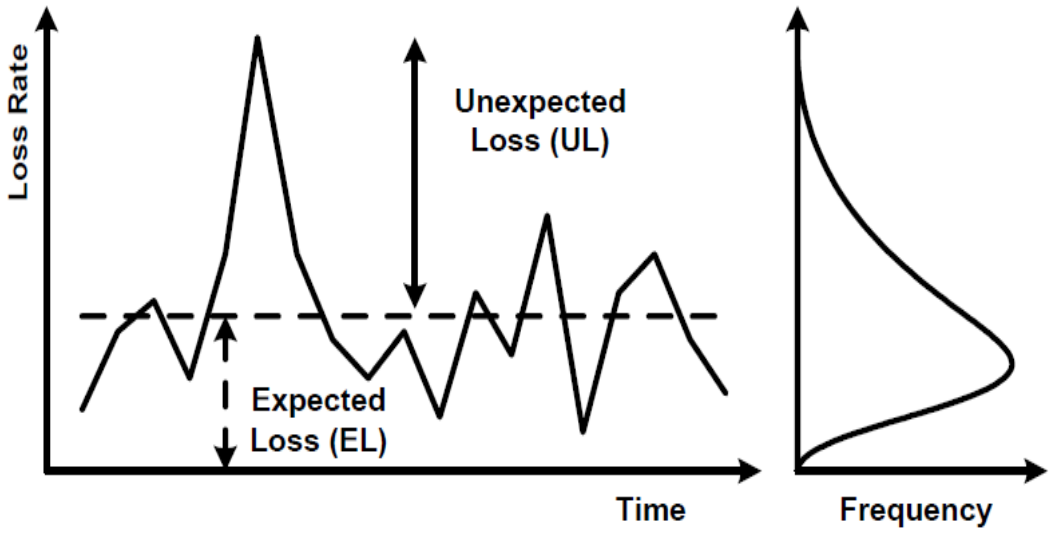
Residential mortgage default is not only a concern for lenders and borrowers but also a concern for regulatory institutions such as central banks and supervision authorities. Past experience has shown that mortgage markets have significant social effects. The origins of global financial crisis has indicated that falling property values might lead to significant amount of mortgage loan default which in turn reduces the incentives to invest in real estate and tightens the availability of loans for these consumers. As a result falling house prices in an economy may have significant effects on financial stability. Therefore, national authorities and international organizations should closely monitor the developments in mortgage markets from the perspective of financial stability. Moreover, regulatory institutions can use default models to predict effects of changing economic conditions and draw up plans to promote homeownership and assist the development of a secondary market (Tam *et al.*, 2010:648). Consequently, findings of this study could shed light on possible policies for supporting homeownership and development of the secondary market.

[12] Delinquencies, defaults and prepayments have important effects on the profitability of the financial institutions.

Major risks in mortgage lending is provided in this section. Accordingly;

Credit Risk: Credit risk can be defined as the possibility that a borrower will fail to meet its obligations in accordance with agreed terms (BCBS, 2000:1). For the case of mortgage lending, this can be considered as the possibility of the lender to go bankrupt and fail to pay the loan back. The main difference in mortgage lending compared to other credit types is that in mortgage lending the collateral (i.e. the house) reduces the potential risks in case of default. Therefore, in Basel capital accords, this type of lending is evaluated as low-risk and hence gets a lower risk weight in capital adequacy ratio calculation compared to other types of exposures.

Expected loss and unexpected loss are two important concepts about measuring and managing credit risk. If we assume a static portfolio for a bank, the losses that are experienced may vary from year to year. Figure 4 provides an illustration and interaction between expected loss and unexpected loss. Basel Committee defines the expected loss as the average level of credit losses that can realistically be expected to occur. Normally, expected losses are a component of pricing.



Source: BCBS (2005i)

Figure 4: Expected Loss and Unexpected Loss

Bank capital has a role of providing buffer to protect debt holders of the bank against extreme losses that might exceed expected levels. Such peaks are illustrated by the spikes above the dashed line in Figure 1. Peak losses do not occur very frequently, but they can be very large when they occur. Losses above expected levels are usually referred to as Unexpected Losses (UL) - institutions know they will encounter these loses, but their timing or severity cannot be known in advance. In other words, unexpected losses are literally unexpected and unavoidable. Risk premium, which is a component of interest rates, is expected to absorb some of the unexpected losses, but it might not cover all unexpected losses. Simply, banks need to set aside enough provisions to compensate for expected losses. Whereas, capital (items that have loss-absorbing function) is needed to cover the risks of such peak losses (BCBS, 2005i:2).

Prepayment Risk[13]: Prepayment risk can be defined as the risk of early repayment of the loan in full. There are two main reasons for prepayment; selling the house or refinancing the mortgage. The motivation behind refinancing is to reduce the interest burden on the loan, whereas prepayment due to selling is mainly a result of the desire for capitalising the house price appreciation (Krainer and Laderman, 2011:5).

Interest Rate Risk: Interest rate risk is the exposure of an institution's financial condition to adverse movements in interest rates (BCBS, 2004:5). As one of the duties of the financial institutions is liquidity transformation, assets of financial institutions have longer maturities compared to liabilities such as deposits. Therefore, being exposed to some level of interest rate risk is natural in banking business. The important characteristic of mortgages for lenders is that when house prices go up lenders benefit very little, on the other hand when the prices go down the lender is at risk for large losses (Van Order, 2007:3).

Sources of interest rate risk can be categorized as repricing risk, yield curve risk, basis risk and optionality risk. Moreover, based on trading intent, this risk could be

[13] This risk can be categorized under interest rate risk.

divided into two as interest rate risk in the banking book and interest rate risk in the trading book.

Liquidity Risk: Liquidity is defined as the capacity of a financial institution, without experiencing extremely high losses, to fund increases in assets and meet its obligations (BCBS, 2008:1). It could arise both from market related conditions (market liquidity risk) and institution specific conditions (funding liquidity risk). As an example, Turkish banking sector is exposed considerable amount of liquidity risk since the average maturity of credits is around two years and average maturity of deposits is less than two months. Therefore, banks should be ready for shocks and be able to meet demand in case of adverse market conditions[14]. During global financial crisis there were several examples of bankruptcies because of not having enough liquidity (i.e. Northern Rock, Bear Stearns, Lehman Brothers). As a result, this risk has become the focus of international standard setters and national authorities in recent years.

FX Risk: Exchange rate risk arises as a result of unexpected changes in exchange rates. It is defined as the possible direct or indirect loss (which includes losses in cash flows, asset and liabilities, net profit and market value) from a change in exchange rate (IMF, 2006:4). This risk not only affects financial institutions but also affects firms and consumers. In early 90's, Emlak bank originated mostly Deutsche Mark denominated housing loans and following 1994 currency crisis, many borrowers defaulted on their loans (Erol and Patel, 2005ii:38). There were also similar cases recently due to Japanese Yen loans. In Turkey, recently several people were defaulted on foreign exchange denominated mortgage credits (especially

[14] At this point, it should also be mentioned that starting from 2006 Turkey was one of the first countries to introduce a liquidity regulation for their banks. A very similar liquidity requirement is accepted by the Basel Committee on Banking Supervision as a global standard after the global financial crisis. Therefore, it can be concluded that liquidity risk is constrained in the Turkish Banking sector.

Japanese Yen and Swiss Francs) as a result of the overvaluation of the currencies[15] in which they borrowed.

Legal Risk: Legal risk is very hard to define since its borders are not clearly determined by the international standard setter. BCBS (2006: footnote 97) vaguely defines legal risk as, "Legal risk includes, but is not limited to, exposure to fines, penalties, or punitive damages resulting from supervisory actions, as well as private settlements".

Legal risk can be crudely defined as legal uncertainty (Mahler, 2007:4). For instance, several consumers used foreign exchange denominated mortgage credit before global financial crisis and during financial crisis the adverse movements in the exchange rate led to several defaults. Individuals sued their banks claiming that the risks inherent in these activities were not clearly explained by the banks. In some of these cases, Turkish Supreme Court of Appeals decided mortgage contract is flawed and this in turn created losses for banks[16].

In mortgage lending there are also other risks such as operational risk, political risk, concentration risk and systemic risk. These risks should be measured and closely monitored both by the supervisory agencies and financial institutions.

2.4 Basel Capital Standards and International Financial Reporting Standards

Basel Committee on Banking Supervision (BCBS) is with no doubt the sole authority in designing capital requirements for financial institutions[17]. Although there is no

[15] Related news can be reached at http://ekonomi.haberturk.com/makro-ekonomi/haber/584257-dovizle-konut-kredisi-200-bin-kisiyi-magdur-etti

[16] http://www.sabah.com.tr/Ekonomi/2011/09/28/dovizzedenin-faturasi-bankaya

[17] For the importance of capital for financial institutions, see Calem and Little (2001:5).

obligation for the non-member countries to comply with Basel rules, the Basel-I and Basel-II frameworks were accepted and implemented by more than 100 countries. Turkey has become a member of the BCBS as of May 2009 and represented in the Committee by the Banking Regulation and Supervision Agency of Turkey. Frameworks formed by the BCBS forms a relation between the regulatory capital of financial institutions and maximum amount of risk that can be taken.

Modigliani and Miller (1958) showed that in a frictionless market without any information asymmetries, the capital structure of a firm is irrelevant to its value. However, due to existence of taxes, asymmetric information, transaction costs and other factors, this does not hold and banks have a very strong preference for debt over equity (Calem *et al.*, 2001:4). Additionally, the recent global financial crisis has once again shown that moral hazard problem in financial markets and the importance of bank capital in creating a global financial system which holds financial institutions far from default and thus taxpayers' money.

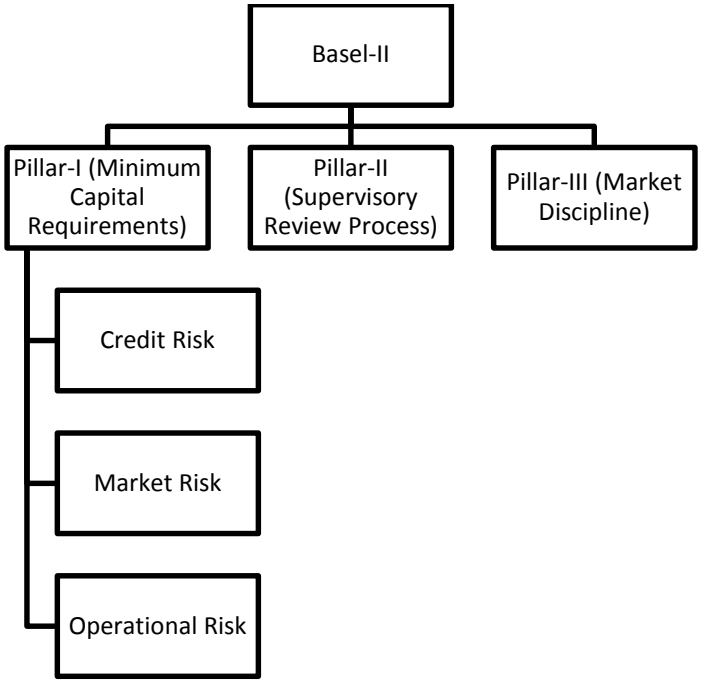
The first capital accord, namely Basel-I, was introduced in 1988. Basel-I was focusing on credit risk only. In 1996, market risk is also included into the coverage of the framework. Considering the problems related to Basel-I framework, the Committee established a work program in 1999 which ended up with the comprehensive Basel-II framework in 2006[18] (BCBS, 2006). Basel-II included operational risk capital charge in addition to credit and market risk capital charges.

With Basel-II, the risk measurement system for credit risk in the first accord was completely changed. In the new framework, a menu based approach was accepted which enables financial institutions to choose most appropriate method for the scope of their activities, from standardized approaches for small financial institutions to advanced methods for financial institutions engaging in complex activities. Additionally, it can be argued that developments in the credit risk modeling literature

[18] Basel-II framework was published in 2004 and comprehensive Basel-II framework was published in 2006.

have affected the Basel II standard in that the new standard became more aligned with bank practices thanks to the advanced approaches.

As shown in Figure 5, Basel-II framework is based on three pillars. These are minimum capital requirements (Pillar-I), supervisory review (Pillar-II) and market discipline (Pillar-III). Financial institutions and regulatory agencies need to evaluate the risks that are not explicitly covered in Pillar-I and allocate sufficient capital under Pillar-II (for the case of mortgage lending this should include all the risks specified above) whereas Pillar-III focuses on public disclosures related to capital requirement calculations and capital.



Source: BCBS (2006)

Figure 5: Structure of Basel II

Due to problems in risk measurement related to securitization and trading portfolios, some revisions were made in the Basel-II framework immediately after the global financial crisis, named Basel II.5. Also in 2010, BCBS announced a reform package to complement Basel-II framework. The whole framework including this new

package is named Basel-III. Basel-III includes additional standards related to minimum liquidity ratios, leverage ratio, definition of capital, capital requirements, etc. The requirements that is introduced by Basel-III has no direct implications for this work. Therefore, throughout this study direct references will be given to Basel-II and relevant Basel-III aspects will be included if necessary.

In Table 1, various capital requirement calculation methods that are covered under Basel-II framework are presented. With Basel-II, the BCBS tried to direct banks towards using modeling approaches by designing the given approaches in a way that the capital requirement reduces as a bank moves towards more advanced approaches, which in turn creates incentives for banks to invest on modeling and make better the risk management processes.

Table 1: Various Capital Requirement Calculation Methods under Pillar 1

<table>
<tr><th>Sophistication of the Bank</th><th>Market Risk</th><th>Credit Risk</th><th>Operational Risk</th></tr>
<tr><td>Simple</td><td></td><td>Simplified Standardized Approach</td><td>Basic Indicator Approach</td></tr>
<tr><td rowspan="2">Medium</td><td rowspan="2">Standardized Approach</td><td rowspan="2">Standardized Approach</td><td>Alternative Standard Approach</td></tr>
<tr><td>Standard Approach</td></tr>
<tr><td rowspan="2">Advanced</td><td rowspan="2">Value at Risk Approach</td><td>Foundation Internal Ratings Based Approach</td><td rowspan="2">Advanced Measurement Approaches</td></tr>
<tr><td>Advanced Internal Ratings Based Approach</td></tr>
</table>

The calculation of bank's capital adequacy ratio is given by the equation below.

$$CAR = \frac{Own\ Funds}{Credit\ Risk\ RWA + Market\ Risk\ RWA + Operational\ Risk\ RWA} \geq 8\% \qquad (1)$$

where; RWA is risk weighted assets[19].

Table 2 provides the risk weights that is applied in bank's capital adequacy calculation under credit risk standardized approach[20]. More specifically, for every claim, banks need to select the appropriate risk weight from the table below (if the bank is using the standardized approach). Basel II introduced the use of external credit assessments in determining the credit risk of various positions. For instance, if a corporate has AAA rating, the risk weight applied is 20%, whereas for a BB-rated corporate this rate is as high as 150%. These risk weights have a significant effect in banks pricing and therefore affect the price of credit (i.e. interest rate).

Table 2: Risk Weights under Credit Risk – Standardized Approach

		External Credit Assessments (Ratings)						
Risk Weights (%)		AAA and AA-	A+ and A-	BBB+ and BBB-	BB+ and BB-	BB- and B-	Below B-	Unrated
Sovereigns		0	20	50	100	100	150	100
Banks	Option 1 (Based on Sovereign Rating)	20	50	100	100	100	150	100
	Option 2 (Based on Bank Rating)	20	50	50	100	100	150	50
Corporates		20	50	100	100	150	150	100
Retail	Mortgages							35
	Other Retail							75

* This is a crude description of the standardized approach. Inside the Basel-II framework there are many other criteria, discretions and etc.

[19] Basel III added some additional ratios beyond the ratio given in this equation such as, minimum 4.5% core tier-1 ratio and minimum 6% tier 1 ratio.

[20] Credit risk internal ratings based approach is covered in the following section in detail.

The main importance of Basel frameworks for the housing market is due to its approach to claims collateralized by residential real estate. In the Basel-I framework while all exposures except for some qualified ones had a risk weight of 100%, mortgages were given 50% risk weight. In other words, Basel-I framework did not differentiate mortgage loans according to their riskiness. Instead, it allowed an advantageous 50% risk weight to be applied to all mortgage loans. Under standardized approach to credit risk of Pillar I of Basel-II, banks are allowed to use as low as 35% risk weight for mortgages which is 30% lower capital requirement compared to Basel-I.

Under internal ratings based approaches, on the other hand, banks are required to model default risks related to mortgage products and assign the risk weight according to the probability of default (PD) and loss given default (LGD) for specific mortgage pools. Banks are required to estimate these parameter.

It should be noted that Basel-II rules were not completely prescriptive, allowing banks to develop models that are appropriate for banks risk profiles and business models (Henderson and Jagtiani, 2010:3). Therefore, Basel-II rules motivated financial institutions to extend more mortgage credit[21].

Advanced methods in Basel-II framework required financial institutions to have a high quality database for credit risk and operational risks which enabled credit and operational risk modeling. In order to satisfy these data requirements financial institutions heavily invested in collecting data in the last 10 years. Without these effects, the analyses presented in this thesis might not be possible. Today, most of the large-size banks in Turkey have significant amount of data for the estimation of probability of default and loss given default, the parameters that are needed to be

[21] For instance; in order to have an 8% capital adequacy ratio, with 1 unit of capital up to 12,5 units of credit could be extended to corporates but up to 25 units of mortgage credit can be extended under Basel-I framework. On the other hand, Basel-II framework allowed up to 35.70 units of mortgage credit to be extended with the same amount of capital.

estimated under internal ratings based method (i.e. advanced method) of Basel-II for credit risk.

On the other hand, the evaluation of credit provisions regarding mortgage products is related to accounting policy. International Accounting Standards 39 and its reflection Turkish Accounting Standards 39 designates the necessary level of provisions that should be set aside by incurred loss model. After the global financial crisis, the G20 led the Basel Committee to propose loan loss provisioning recommendations that are provided below (BCBS, 2009);

i. Loan loss provisioning should be robust. Provisioning should be based on sound methodologies which take into account expected credit losses in the existing portfolios of the banks (over the entire life of the portfolio). The accounting model for provisioning have to permit early identification and recognition of losses by integrating a wide range of available credit information. Expected credit losses should be estimated over the entire life of the loans and the loss experience over the complete economic cycle should be considered.
ii. The new standard should take into account provisions for groups of loans with similar risk characteristics.
iii. When possible, the new standard should be interconnected with the internal risk management and capital adequacy systems of the banks.

In line with these recommendations, IFRS 9 standard focused on this issue and introduced a forward looking approach for the case of impairment. IFRS 9 requires that firms should measure the loss allowance for their financial instruments at an amount equal to 12-month expected credit losses given that the credit risk associated with the financial instrument has not increased since initial recognition (Paragraph 5.5.5). The BCBS published its expectations from the banks regarding the implementation of ECL framework (BCBS, 2015). BCBS noted that the definition of default that is used for accounting should be linked to the definition used for regulatory purposes (as provided in the Basel-II framework). BCBS also highlighted

that in estimating ECL all available information affecting credit risk, including forward looking information and macroeconomic factors need to be used.

In addition to this, IFRS 9 - paragraph 5.5.4, states that for all financial instruments that have significant increases in credit risk since initial recognition, lifetime expected credit losses (LEL) should be recognized. BCBS (2015:27) argued that after the origination, it is hard to fully compensate the increases in credit risk (i.e. by increasing interest rate). Therefore, banks should closely monitor the level of credit risk and the exposure should be subject to LEL requirement. BCBS (2015: 28) also required banks to collect data and quantify the risk in their exposures which will allow banks to judge whether there has been a substantial rise in credit risk. BCBS further argued that due to its backward looking nature delinquency data might not be appropriate at all times in implementing ECL and considers the use of 30 days delinquency status as the only indicator for increased credit risk as a low-quality implementation of an ECL model.

In addition to accounting rules, for the financial institutions, national authorities might set specific rules for provisioning. In Turkey "Regulation on Procedures and Principles for Determination of Qualifications of Loans and Other Receivables by Banks and Provisions to be Set Aside"[22] imposes provisioning requirements related to credits extended by banks. According to this regulation, most of the credit types are evaluated as the same and a constant provisioning rate applies. However, as explained in the previous section, provisions should be able to offset all the expected losses of a financial institution. Therefore, there is possibility of over-or-under provisioning where former limits the lending capacity of an institution and incompatible with accounting standards and latter threats the functioning of the institution and the financial stability. The provisioning rates for mortgage loans are provided in Table 3.

[22] http://www.bddk.org.tr/WebSitesi/english/Legislation/Legislation.aspx

Table 3: Provisioning Rate According to Past Due Status for Mortgage Loans

Types	**Standard**	**Close-monitoring (Special Mention)**	**Substandard**	**Doubtful**	**Loss**
Past Due Days	<30	30-90	90-180	180-360	>360
Minimum Provisioning Rate	%1	%2	%20	%50	%100

Finally, the calculation of expected loss for a given credit is based on the following formula;

$$Expected\ Loss = Probability\ of\ Default\ (PD) * Loss\ Given\ Default(LGD) * Exposure\ at\ Default(EAD) \quad (2)$$

CHAPTER III

POTENTIAL OF THE TURKISH MORTGAGE MARKET

"Cities are built the way they are financed".

(Renaud, 1999)

Along the lines of Renaud's explanation regarding the importance of housing finance, the current landscape of many major cities in Turkey clearly illustrates the lack of a proper mortgage lending system in Turkey. A well-functioning mortgage market in Turkey has not been established until recently due to the very high inflation rates and the hardships from severe financial meltdowns and political instability. Thanks to unplanned urbanization, most Turkish cities expanded frantically. However, under stable, mild and declining inflation rates since the early 2000s there has been some progress in the development of the Turkish mortgage market.

Formally, housing finance systems aim to create an intermediation mechanism which facilitates transfer of funds to the people demanding it for home ownership purposes via financial system. However, a well-functioning housing finance system creates various positive externalities beyond this formal definition. Parallel to the developments in financial markets[23], mortgage markets have shown significant improvement. During this progress, rapid increase in the product variability and market volume is witnessed in many developed countries. However, housing finance systems are mostly underdeveloped in the developing countries. Today housing

[23] See Claessens and Kodres (2014) for a concise discussion on developments in the financial markets before the global financial crisis.

finance systems substantially differ across countries and regions in terms of product diversity, type of lender, degree of government participation (International Monetary Fund (IMF), 2011:115) and legal enforcements. At present, there are large number of products in the advanced country mortgage markets. On the other hand housing finance in emerging and newly industrialized countries has started to develop only recently.

In this chapter, the growth potential of the Turkish mortgage market is investigated. In doing so, historical development is analyzed together with major changes witnessed. Additionally, countries that have experienced fast growth in their mortgage markets are analyzed in order to identify areas for progress. Moreover, a cross country benchmark model is constructed. Finally in the light of these findings, some policy recommendations that might help the development of the Turkish mortgage market is discussed.

The relevant literature on this subject indicates that academic research on the quantitative analysis of the depth of mortgage markets across a broad set of countries is scarce and the existing studies have the major problems of data quality, data coverage or both. The quantitative analysis presented in this Chapter uses a rich data set on 31 developed and developing European countries to investigate the underlying factors behind the growth of mortgage markets during the 2005 - 2012 period. A baseline model is constructed in order to examine the depth of mortgage markets in various countries and the comparative performance of the Turkish market. Using the outputs of the models, the potential future depth of the Turkish mortgage market is estimated under various scenarios.

The quantitative analysis presented has key differences compared to the previous research in this field and might be accepted as an updated and enriched version of the existing studies by Bardhan and Edelstein (2007), Warnock and Warnock (2008), and Badev *et al.* (2014) as it provides a more comprehensive empirical analysis using a robust dataset specifically focusing on the European region. In order to have comparable empirical results with the corresponding studies in the literature, cross sectional regressions, pooled OLS regression analyses, and panel data analyses are

carried out. The findings indicate that statistical significance of variables is highly dependent on both the variables and countries (regional versus global) included in the analyses and the methodology used. Hence, it can be argued that a more accurate analysis for the cross-country variations in the depth of mortgage markets requires the use of an appropriate variable selection methodology, instead of simply grouping different sets of variables separately as done by Badev *et al.* (2014).

Two dependent variables are used in order to evaluate the mortgage market development, namely, residential mortgage debt to GDP ratio and mortgage credit to total credit ratio. The residential mortgage debt to GDP ratio is the most widely accepted indicator of the depth of a housing finance market, as it eliminates the country-size effects. Simply, the literature assumes that housing finance system of a country is more developed when the mortgage debt to GDP ratio is high. Additionally, to control for the effect of financial sector development in the selected countries, mortgage credit to total credit ratio is used.

The level of residential mortgage debt to GDP indicator could be evaluated from two different aspects. For most of the developing countries, considering residential mortgage debt to GDP as a proxy for accessibility of housing finance, higher values of mortgage debt to GDP is evaluated as a positive indicator as there is still considerable room in these countries for deepening and penetration (i.e. Roy (2008)). However, a careful balance needs to be maintained between deepening of the market and over-indebtedness of households. From the point of view of most of the developed countries, this indicator needs to be closely monitored as significant increases might mean higher risks for the economy (i.e. Girouard *et al.* (2007)).

3.1 Research Questions

In the last decade, while evaluating the financial and economic development of the Turkish economy, the potential of the mortgage market is widely stressed; however, no comprehensive study has been carried out until today. The major research question of this chapter is whether there is a significant growth potential of the

Turkish mortgage market for the near future. Therefore, growth potential of the Turkish mortgage market, which has been lagging behind several developed and developing countries will be investigated thoroughly. This chapter attempts to answer two basic questions: 1) what are the main factors behind the development of mortgage markets? and 2) what can be done to boost the growth of Turkish mortgage market? Following Bardhan and Edelstein (2007) and Badev *et al.* (2014), a baseline model is constructed to analyze the present state of the mortgage markets compared to market equilibrium (both emerging and/or developed). Based on the outputs of the baseline model, the potential of the Turkish mortgage market is analyzed under various scenarios. Moreover, possible government interventions that could help development of this market is discussed in order to present housing finance policies for Turkey.

In addition to answering these questions, the baseline model that is constructed in this thesis could also help decide in which countries the mortgage markets have grown more than expected and whether or not this growth would create potential macroeconomic stability problems in the long term[24]. Moreover, these analyses could also help assess the results/conclusions of the major studies in the literature that are dealing with the depth of mortgage market.

3.2 Literature Review

DiPasquale and Wheaton (1992:196) formed the first theoretical framework regarding the real estate market equilibrium by describing how real estate market is impacted by macroeconomic outcomes and financial markets. Dipasquale and Wheaton explained the price formation process using an analytic framework that illustrates the connections between real estate space and real estate assets markets

[24] For instance, in IMF Global Financial Stability Report (2011:111) it is noted that erosion of mortgage underwriting standards and increased household leverage was important underlying factors of the global financial crisis.

(namely the 4 quadrant model). Analysis start with stock of space that is used in determining rent which in turn affects the property prices. Then property prices affect new construction in the property market. For the markets to reach equilibrium, starting and ending stock of space should coincide.

Karley (2003) argued that increasing access to finance plays a key role in reducing poverty among underserved communities. In the same vein, supporting homeownership by increasing access to mortgage finance could allow accumulating wealth and enjoying improved living conditions. The analysis in this chapter is related to the financial sector deepening literature. Beck and De La Torre (2007) argued that use of financial services in many low and middle income countries is restricted to few businesses and households. For economic development and poverty alleviation, theoretical and empirical literature has shown the importance of a well-developed financial system (Beck and De La Torre (2007:2))[25]. Beck and De La Torre (2007), Bardhan and Edelstein (2007), Beck *et al.* (2008), Al Hussainy *et al.* (2011) and Barajas *et al.* (2013) all employed a benchmarking models and compared financial development of a country compared to the model implied benchmark.

Barajas *et al.* (2013) argued that three different sets of policies could be appropriate for different countries depending on the financial possibility frontier/benchmark of a country and countries stance relative to frontier. These are market developing policies that are based on improving macroeconomic stability (to push out the frontier), market enabling policies based on addressing deficiencies in the system including barriers, lack of competition (to help financial system to move toward the frontier) and market harnessing policies via short term macroeconomic management and regulatory oversight (to prevent a financial system from moving beyond the frontier). The market harnessing policies have attracted significant attention in recent years due to its links to countercyclical measures.

[25] See also Beck *et al.* (2000), Honohan (2004).

Development of mortgage market is not only critical for developed countries but also for developing countries due to its backward and forward linkages. Considerable number of studies has examined the mortgage markets in the developed and developing countries. However, academic research on factors affecting the depth of mortgage markets is scarce and the existing studies mostly investigate only single country and/or are rather descriptive in nature.

Diamond and Lea (1992) focused only on developed countries and made descriptive comparisons of the housing finance systems of Denmark, France, Germany, the United Kingdom and the United States. Stephens (2000) analyzed the effect of Economic and Monetary Union on the mortgage finance systems of the European Union members. Chiquier *et al.* (2004) discussed the importance of mortgage-related securities for developing countries. Similarly, several studies have analyzed the development of mortgage markets in specific countries, such as Chile (Pardo, 1999), Mexico (Pickering, 2000), Spain (De Greef and Haas, 2000), Italy (Magri, 2002), UK (Whitehead and Williams, 2011), Turkey (Erol and Patel, 2005i) and Australia (Yates, 2013).

On the other hand, Renaud (2005) made an inclusive comparison, exploring the structural differences between the mortgage finance systems of advanced and developing economies so as to identify the financial innovations that are most needed in emerging markets. Renaud (2005) concluded that the initial state of the mortgage market in a developing country is crucial when deciding on the relevant actions to be taken, and indicated that the importance of macroeconomic stability, property registry systems, interagency coordination, a sound and modern mortgage finance law, reducing unsustainable social housing programs, urbanization and developing a secondary market are all essential elements for sustainable growth in a mortgage finance system.

Roy (2008) analyzed the transition in the Central and Eastern Europe, the Balkans and Russia in order to show how these countries managed to transform the positive economic development to housing finance. On the other hand, Scanlon *et al.* (2008) investigated the recent developments in the 13 developed countries (most of which

is European countries) by taking into account the house prices, debt and affordability and availability and market share of mortgages. Scanlon *et al.* (2008) analyzed the recent developments in thirteen developed economies – mostly in European countries - by taking into account the factors such as house prices, debt, affordability, and availability, and market share of mortgages. Malpezzi (2012) drew lessons based on past experiences under key areas such as property rights and organization of housing markets, infrastructure, housing finance, subsidies and taxes and regulation of housing. With respect to housing finance, he argued that growing housing finance system is highly dependent on the development of financial system and that lending that is provided by financial institutions at subsidized interest rates is problematic, appropriate mortgage instrument design is essential and legal framework for foreclosure should protect the financial interests of lenders, but legal rights of borrowers should also be protected.

With regards to Turkey, Erbaş and Nothaft (2005) investigated the housing market developments in several MENA countries together with Turkey and Mexico, and argued that availability of residential mortgage loans for a wider range of population helps poverty reduction due to growth-enhancing and redistributive effects. Erol and Patel (2005ii) discussed the development of the Turkish mortgage market, evaluated the appropriateness of several mortgage designs in an unstable macroeconomic environment and stressed the importance of supportive government policies for the development of secondary market. Additionally, Turkish Bankers Association (TBB, 2012) covered important issues regarding the development of Turkish mortgage market. It focuses especially on the need for development of secondary market in Turkey by taking into account the funding side of bank's balance sheets.

Similarly, Capraz (2013) analyzed Turkish mortgage system and investigated the effects of macroeconomic variables on mortgage loans. The author concluded that

mortgage interest rates, inflation and fx rates have a negative impact and GDP has a positive effect on the mortgage loans with a one quarter lag[26].

In a more recent study, Yalçıner and Coşkun (2014) analyzed the causal relationships between the volume of housing credit and macroeconomic indicators in Turkey. The authors concluded that the most effective variables on housing credit were occupancy permits, real interest rate, real GDP per person and M2 (monetary aggregate/financial wealth). The authors further noted that development of mortgage market may also be linked to intricate socio-economic developments.

Regarding the developed countries, it is seen that mortgage market has shown significant growth before the global financial crisis and research regarding mortgage market systems was saturated in those periods. On the other hand, the global financial crisis attracted attention back to the mortgage markets and significantly increased the publications in that field. For instance, Chiquier and Lea (2009) compiled a comprehensive handbook focusing on the knowledge and experiences of both the developed and developing countries, covering various topics ranging from mortgage instruments to recent developments in mortgage markets.

Following the global financial crisis of 2008, the IMF addressed the topic of housing finance and financial stability in a comprehensive chapter of the 2011 Global Financial Stability Report (2011, p.136). This report firstly examined the development of various housing finance systems and the actions taken by several countries related to their housing markets, and emphasized the importance of legal institutions and instruments in the effective and efficient functioning of housing finance systems. Additionally, the growth of mortgage debt stock during the pre-crisis period was estimated in a seemingly unrelated regression model to analyze the growth in house prices. The report argued that interest type (fixed versus variable), government participation and house price appreciation have significant effects on the changes in the mortgage debt stock.

[26] This study is the extended the work of Okay (2010).

Additionally, Scharfstein and Sunderam (2011) evaluated the housing finance reform alternatives in the US and argued that the main goal should not be reducing mortgage interest rates but financial stability. Andre (2010) assessed the effects of taxation regarding the housing market, monetary policy and supervision and regulation of the financial institutions on housing booms and concluded that monetary policy has a limited effect on asset price booms, fiscal policy could play a greater role in controlling aggregate demand during booms and regulation and supervision of the financial system was insufficient in many countries during global financial crisis. Barth *et al.* (2009) investigated in detail the formation of the global financial crisis and give policy recommendations for the US financial sector. Keys, Seru and Vig (2012) discussed the link between mortgage securitization and lender screening during the boom and bust of the US housing market and concluded that mortgage origination standards significantly diminished during the boom period. Using household survey data, Institute for the Study of Labor (IZA, 2010) assessed the determinants of access to mortgage finance one at a time for the European Union members.

In the literature, a vast number of studies applied cross country analysis related to housing markets by not directly focusing on the size of the mortgage market. For instance; Hofmann (2003) investigates the relationship between bank lending and property prices in 20 countries using panel data techniques, Adams and Füss (2010) examine the effects of macroeconomic variables on house prices in 15 countries over a period of 30 years using panel cointegration approach.

A 2005 European Central Bank (ECB) working paper pointed out the importance of government instruments on mortgage financing decisions, and concluded that structural fiscal measures may contribute to reducing volatility in the housing and mortgage markets (Wolswijk, 2005)[27]. Additionally, the report investigated the main causes of the real growth in the mortgage debt balance (nominal debt deflated by the national consumer price index) for the EU-15 countries, and found that real growth

[27] These instruments include taxation on imputed rent on houses, deductibility of mortgage interest payments, and capital gains taxes on the revenue earned when selling a house.

in mortgage debt can be explained by such variables as real disposable income, after-tax mortgage interest cost, house prices and financial deregulation, inflation and stock market variables.

To the best of our knowledge, only three papers have carried out a systematic empirical analysis of the depth of mortgage markets across a broad set of countries and attempted to analyze why some countries have larger mortgage markets than others. The first study, carried out by Bardhan and Edelstein (2007), used a data set of 18 OECD countries and constructed a benchmark regression model to evaluate the prospective level of development of the mortgage markets in Russia, India and China between 1991 and 2002. The authors used pooled cross-country regressions and regressed the outstanding mortgage volume as a share of GDP on the economic, financial and demographic determinants in those countries. The estimated coefficient values were then utilized to create a rough benchmark for the selected emerging markets of India, Russia and China. A comparison of the actual and the benchmark model measures then served as the basis for an evaluation of the level of mortgage market development in emerging economies. Assuming that the benchmark represents the expected level at which an emerging market would be evolving in the long run (had it followed the general pattern of the OECD countries), Bardhan and Edelstein (2007) were able to evaluate the nature and relative performance of the housing finance sector. The study concluded that urbanization rate, household size, financial assets-to-GDP ratio and premium of mortgage rate over deposit rate are significant determinants of a country's residential mortgage debt-to-GDP ratio.

A second study by Warnock and Warnock (2008) investigated the differences in the size of the mortgage markets (outstanding mortgage loan balance-to-GDP ratios) of 62 countries for the period 2001–2005. Using a sample that included both developed countries and a wide range of emerging economies, Warnock and Warnock found that, across all countries, when controlling for country size (i.e. average gross national income levels, which is highly significant), countries with stronger legal rights for borrowers and lenders in the form of collateral and bankruptcy laws, deeper credit information systems, and a more stable macroeconomic environment had larger housing finance systems. Empirical findings also indicated that the existence

of sizeable government securities markets does not necessarily guarantee the existence of a developed housing finance system in emerging markets.

The third and most recent study by Badev *et al.* (2014) presented their findings using new data on the depth and penetration of mortgage markets across countries. Authors obtained 938 data points for 118 countries from not only public databases but also through direct contact with housing finance officials during World Bank/IFC country missions for the period 1995-2011, but indicated that their database included more than 10 data points only for 45 countries. Using panel data and cross sectional regressions, Badev *et al.* (2014) investigated the cross country covariates of the housing finance development by focusing on the mortgage debt to GDP ratio (depth dimension) and share of households with a mortgage indicator (access dimension) as dependent variables. Their analysis are based on grouping the extensive set of variables such as banking sector variables, institutional variables, socioeconomic variables, and then investigating the statistical relations only within these groups by including urbanization and inflation into all of the models. Main findings of their paper can be summarized as follows. First, mortgage markets develop only at relatively high levels of GDP per capita and the policies associated with financial system development (such as price stability and the efficiency of contractual and information frameworks) are also associated with mortgage market development. Second, variables such as the development of the insurance sector, the stock market and sources of long-term funding are strongly associated with mortgage market development. However, authors found that government subsidies and support are not strongly associated with mortgage market development. Additionally, authors noted that, monetary stability has been found to be a strong predictor of mortgage market development and, the negative relationship between government ownership and financial deepening is also valid for mortgage market development, but there is no consistent link between competition and mortgage market development.

Although the three papers discussed above provide us with empirical analyses of the depth of mortgage markets across countries, these studies can be criticized as having major problems such as quality of the data, the coverage or methodology. In this

context, this study seeks to investigate the associations with respect to the depth of mortgage market in the Europe between the years 2005 and 2012 in order to better understand cross-country variations in the depth of mortgage markets by using a rich data set and employing a variable selection methodology.

Table 4 provides a comparative summary of existing studies, including the present work. The quantitative analysis might be accepted as an updated version of the studies of Bardhan and Edelstein (2007) and Warnock and Warnock (2008) in that it analyzes the growth of mortgage markets in 31 countries for the period 2005–2012. Historical data coverage of this study is also wider than Badev *et al.* (2014) which uses data for the 2006-2010 period only for the cross sectional analysis. Warnock and Warnock (2008) and Badev *et al.* (2014) cover a higher number of countries using a quite unbalanced data; however, the balance of the data is crucial for the variable selection methodology, which is used in the present study. Although there are some differences with respect to the dependent variables used, mortgage debt to GDP ratio has been widely used in the extant literature. Indeed, existing studies differ greatly in terms of the explanatory variables and empirical analyses employed. Quantitative analysis in this chapter enriches the previous research by employing a more comprehensive analysis.

Firstly, it evaluates the depth of mortgage markets through the use of the largest possible set of explanatory variables, including the share of secondary market issuances in overall mortgage debt and the capital-to-asset ratios of financial institutions. Second, this work employs various R-software tools that use cross validation techniques so as to select the best subsets of the explanatory variables to predict the growth of mortgage markets. In order to model mortgage debt to GDP ratio, previous studies selected a subset of the most important variables based on economic theory, intuition and conventional wisdom instead of adopting a variable selection method. It is important to note that Badev *et al.* (2014) includes the largest set of explanatory variables but has significant drawbacks in terms of the robustness of its database and investigating the significance of variables by categorizing the variables and investigating significance separately for these groupings. Finally, in

order to show the effect of methodology used on the findings, empirical results for all three methods commonly used in the literature (cross sectional regressions, pooled OLS and fixed effects panel data analyses) are presented.

Table 4: A Comparison of Existing Studies Analyzing Mortgage Market Depth

	Bardhan & Edelstein (2007)	**Warnock & Warnock (2008)**	**Badev *et al.* (2014)**	**(The present study)**
Dependent variable	1) Total outstanding mortgage debt to GDP ratio	1) Total outstanding mortgage debt to GDP (Average over the observation period) 2) Total outstanding mortgage debt to GDP	1) Total outstanding mortgage debt to GDP 2) Percentage of adult population with an outstanding loan to purchase a home (Housing Loan Penetration)	1) Total outstanding mortgage debt to GDP ratio 2) Mortgage loans to total domestic credit ratio
Explanatory variables	Household size, interest rate spread, urbanization rate, new housing completions, housing stock, ratio of financial assets to GDP, savings rate	Strength of legal rights, credit information, inflation volatility, country size	GDP per capita, Urban population share, Inflation, Inflation volatility, Age dependency ratio, Population growth, Population density, Government-owned banks, Foreign-owned banks, Overall activities restrictiveness, Bank concentration – assets, Restrictions on real estate, H-statistic, Lerner index, Insurance premiums (Life) / GDP, Insurance company assets / GDP, Stock market capitalization / GDP, Stock market turnover ratio, Private bond market capitalization / GDP, Public bond market capitalization / GDP, Dealing with construction permits – procedures, Registering property – cost, Enforcing contracts – cost, Strength of legal rights index, Depth of credit information index, Index of government participation in housing finance markets, Dummies; primary funding source is retail, primary funding source is wholesale, primary funding source is mortgage bonds, secondary funding source is retail, secondary funding source is wholesale, secondary funding source is mortgage bonds	Mortgage representative interest rate, volatility of mortgage interest rates, real GDP growth, inflation, share of secondary mortgage market in mortgage debt, strength of legal rights, depth of credit information, banks' capital to assets ratio, urbanization rate, GNI per capita PPP, unemployment, average household size, development dummy
Sample period	1991 to 2002	2001 to 2005	2006-2010*	2005 to 2012

Table 4: A Comparison of Existing Studies Analyzing Mortgage Market Depth (continued)

Variable selection	No	No	No	Yes
Methodology for analysis	Pooled OLS regression	Cross sectional regression**	Cross sectional regression Panel data analysis	Cross sectional regression Pooled OLS regression Panel data analysis
Countries studied	18 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, USA.	62 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, USA, Canada, Algeria, Ghana, Morocco, South Africa, Tunisia, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kazakhstan, Latvia, Poland, Romania, Russia, Slovakia, Slovenia, Bangladesh, China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Taiwan, Thailand, Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Peru, Venezuela, Iran, Israel, Saudi Arabia, Turkey, Australia, Hong Kong, Japan, New Zealand, Singapore.	Up to 148 countries, depending on analysis.	31 European countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Malta Netherlands, Portugal, Slovak Republic, Slovenia, Spain, Sweden, UK, Iceland, Norway, Bulgaria, Hungary, Latvia, Lithuania, Poland, Romania, Russian Federation, Turkey.

* For cross sectional analysis.
** The term cross sectional regression refers to the OLS analysis using the data averaged over the analysis period.

3.3 Data

In the field of housing finance, there is no single source from which all of the necessary data can be obtained for constructing cross-country models. As indicated in Badev *et al.* (2014, p.25) some institutions have recently started systematic data collection efforts, including the Bank for International Settlements (BIS) on housing prices and Housing Finance Information Network (HOFINET) on the characteristics of mortgage markets, but these are still limited to a relatively small number of countries. Accordingly, for the present study, data has been collected from a wide range of sources, including the European Mortgage Federation (EMF), World Bank, United Nations Development Programme (UNDP), the Organisation for Economic Co-operation and Development (OECD), Eurostat and International Monetary Fund (IMF) World Economic Outlook reports. The country sample in this thesis (i.e. 31 countries) has been selected directly from those countries covered by the EMF Hypostat reports, as these reports provide the only comparable data sets for the mortgage market-related indicators. For some countries, the Hypostat reports provide data for the pre-2005 period as well; however, to ensure the robustness of the dataset (to have a manageable amount of missing data), we have used the data for the 2005 to 2012 period.

The variables of this study are determined along the lines of Bardhan and Edelstein (2007:21), which stated that the economic theory, intuition and conventional wisdom suggest financial, demographic, institutional and economic characteristics of a country should determine the size of a country's mortgage market.

The modelling results presented in this Chapter seeks to investigate the basic associations regarding the depth of the mortgage markets in a sample of 31 countries (23 developed and 8 developing countries) between the years 2005 and 2012. The US is also covered by the Hypostat reports but excluded from the analyses to circumscribe the study to the European region. Hypostat data is publicly available and covers high number of European countries which makes it the optimum choice for the analyses presented in this thesis. Additionally, the advantage of this sample period is that it covers a balanced period before and after the global financial crisis.

For the modeling exercise, two dependent variables are used, namely, the outstanding residential mortgage debt balance-to-GDP ratio; and the share of residential mortgage credits within the total credits of the banking sector[28].

3.3.1 Data Sources

In this section, main data sources that are used for data collection in order to construct the cross-country models are covered together with brief explanations on variables.

Hypostat

This report is published by the European Mortgage Federation on an annual basis. The statistical annex of the report includes yearly statistics on EU mortgage and housing markets. Moreover, information from several developed and developing countries are also included. Table 5 provides names of the countries that are included in the Hypostat 2013 annex tables[29].

For the analyses in this Chapter, Hypostat 2013 annex tables are the main source of data. In order to find a balance between the number of variables and having manageable amount of missing values, only data related to 2005-2012 period is taken into account[30].

[28] Appendix A gives details of some of the data problems that are encountered, and the expected relationships between the dependent variables and the selected explanatory variables.

[29] IMF classification is followed. Croatia is not taken into consideration due to abundant number of missing values. Moreover, the US is also covered by the Hypostat reports but excluded from the analyses to circumscribe the study to the European region.

[30] For some developed countries Hypostat 2013 presents data starting from the year 2000.

Table 5: Countries covered in the Hypostat 2013

Advanced Countries (23)	**Developing Countries (8)**
Austria	Bulgaria
Belgium	Hungary
Cyprus	Latvia
Czech Republic	Lithuania
Denmark	Poland
Estonia	Romania
Finland	Russia
France	Turkey
Germany	
Greece	
Malta	
Ireland	
Italy	
Luxembourg	
Netherlands	
Portugal	
Slovak Republic	
Slovenia	
Spain	
Sweden	
UK	
Iceland	
Norway	

Residential Mortgage Debt to GDP Ratio: This data is provided in the 5st table of statistical tables of Hypostat 2013. It is calculated by dividing the gross residential mortgage loans to GDP of that country.

Representative Interest Rates on New Mortgage Loans: Provided in table 4 of the statistical tables of Hypostat 2013. This variable is determined by national experts of the EMF. It presents the annual interest rate on the mortgage loans that are most widely used in that specific market.

Share of Secondary Residential Mortgage Market Issuances to Residential Mortgage Debt: This variable is obtained by merging the data in various Hypostat 2013 tables. In order to calculate it, total covered bond issuance backed by mortgages (table 14 of Hypostat 2013) and total residential mortgage backed securities issuances (table

16 of Hypostat 2013) for a specific year is added. This sum is divided by the gross residential loans (table 1 of Hypostat 2013) to obtain the relevant indicator.

Spread of Representative Interest Rates over Consumer Prices: to obtain this indicator, Representative Interest Rates on New Mortgage Loans is divided the realized Consumer Prices.

World Bank Doing Business Database

The main aim of the Doing Business Project is to provide measures of business regulations and their enforcement for a wide range of countries which is expected to create competition among these countries for more efficient regulation and provide sound benchmarks for reform. Among several methodologies given in that database Getting Credit methodology provides important information which could serve the aims of this study[31].

Strength of Legal Rights: This index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and hence facilitate lending. It has a range of 0 to 10 where an increase in the score shows that the laws under consideration are better designed for expansion of credit. The index includes 8 criteria related collateral law and 2 criteria related to bankruptcy law.[32].

A score of 1 is assigned for each of the following features of the laws:

- Any business may use movable assets as collateral while keeping possession of the assets, and any financial institution may receive such assets as collateral.

[31] Information in this section is retrieved from, http://www.doingbusiness.org/methodology/getting-credit on 23 March 2013.

[32] In 2015, Worldbank updated the methodology fort his index, increasing the range from 0-10 to 0-12.

- By law, without requiring a specific description of the collateral, a business may grant a nonpossessory security right in a single category of movable assets.
- By law, without requiring a specific description of the collateral, a business may grant a nonpossessory security right in substantially all its movable assets.
- A security right may extend to future or after-acquired assets and may extend automatically to the products, proceeds or replacements of the original assets.
- A general description of debts and obligations is permitted in the collateral agreement and in registration documents. This means that all types of debts and obligations can be secured between the parties. Moreover, the collateral agreement can contain a maximum amount for the encumbrance of the asset.
- A collateral registry (or registration institution) for security interests over movable property is in operation which is integrated geographically and by asset type. Also the electronic database should be indexed by the names of debtors.
- Secured creditors are paid first when a debtor defaults outside an insolvency procedure. This includes general tax claims and employee claims.
- Secured creditors are paid first when a business is liquidated. This includes general tax claims and employee claims.
- Secured creditors either are not subject to an automatic stay or moratorium on enforcement procedures when a debtor enters a court-supervised reorganization procedure, or the law provides secured creditors with grounds for relief from an automatic stay or moratorium or sets a time limit for the automatic stay.
- The law allows parties to agree in a collateral agreement that the lender may enforce its security right out of court.

Depth of Credit Information: This index measures rules and practices affecting the coverage, scope and accessibility of credit information in a country. Such

information can be available through a public or private credit registry. A score of 1 is assigned for each of the following six criteria provided below:

- Data on firms and individuals are distributed.
- Not only positive credit information (including, outstanding loan amounts and pattern of on-time repayments) but also negative information (including, late payments and the number and amount of defaults and bankruptcies) are distributed.
- Data from retailers and utility companies and financial institutions are distributed.
- More than 2 years of historical data are distributed. A score of 0 is given when data on defaults are deleted after they are repaid.
- Data on loan amounts below 1% of income per capita are distributed. Credit registries should have a minimum coverage of 1% of the adult population.
- Law requires that borrowers have the right to access their data in the largest credit registry or bureau.

World Bank Database

World Bank shares extensive amount of data in its website for its main mission to alleviate poverty by satisfying transparent and accountable data which could enable comparison of various jurisdictions.

Real GDP Growth Rate: Provides real GDP growth for a specific country.

Inflation: It is the annual percent change in consumer prices.

Capital to Assets Ratio: This is the ratio of bank capital and reserves to total assets. According to World Bank definition, capital and reserves include funds contributed by owners, retained earnings, general and special reserves, provisions, and valuation adjustments. Capital includes tier 1 capital (paid-up shares and common stock) and tier 2 capital. Total assets include all nonfinancial and financial assets. After the

introduction of global capital requirements framework, namely Basel II, in 2004, residential mortgage loans have become advantageous for the banks regarding their capital requirements. The Basel-I standard of 50% risk weight is reduced to 35% risk weight for these loans. Therefore, this could have an effect on the residential mortgage stock and share of residential mortgage loans within a country. Details of these standards and their relevance to riskiness are covered in Chapter 4 of this thesis.

Urbanization Rate: This ratio is obtained from World Bank Urban Population indicator. Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.

Domestic Credit Provided by Banking Sector to GDP: According to the World Bank definition, domestic credit provided by the banking sector includes all credit. Only the exposures to the central government is excluded. The banking sector includes monetary authorities and deposit money banks, as well as other banking institutions where data are available.

UNDP Database

In order to calculate the Human Development Index, the United Nations Development Programme compiles significant amount of data.

GNI Per Capita PPP: For the calculation of GNI per capita purchasing power parity (PPP), aggregate income of an economy generated by its production and its ownership of factors of production is taken, the incomes paid for the use of factors of production owned by the rest of the world is subtracted. For each country resulting amount is converted to international dollars using PPP rates and divided by the population in the middle of the year in order to calculate this indicator.

Other Sources

The other sources that is used for collecting data related to unemployment, development dummy and average household size is given below.

Unemployment: In order to collect seasonally adjusted harmonized unemployment data, OECD database is used together with the Eurostat database. Additionally, for Ukraine and Russia, data is obtained from the www.econstats.com web site[33].

Development: In order to classify the countries in the sample according to their development levels, IMF World Economic Outlook classification that corresponds to the specific year is used.

Average Household Size: This indicator is mainly obtained from the Eurostat database. Data is obtained from OECD for Russian Federation[34].

3.3.2 Descriptive Statistics

Table 6 presents the descriptive statistics of model variables for the overall sample.[35] Specifically, for each country in the sample the average value of each variable is obtained over the 2005-2012 period, and these averages are reported in Table 6. Number of observations available for each variable (n, # of countries for which the data is available) is provided in the first column.

[33] http://www.econstats.com/weo/

[34] http://www.oecd.org/els/family/47701118.pdf

[35] Descriptive statistics for each country can be found in Appendix A.

Table 6: Descriptive Statistics for Model Variables, 2005 – 2012

	n	Mean	St. Dev	Median	min	max	range
RMD_GDP (%)	31	41.31	29.54	37.25	2.05	104.08	102.03
MortgagetoCredit (%)	31	30.28	14.08	29.4	6.49	66.07	59.58
CredittoGDP (%)	31	120.3	66.65	124.81	21.27	274.25	252.98
Interest (%)	31	5.49	2.95	4.49	3.17	15.44	12.27
Vol_Interest	31	0.98	0.51	0.96	0.31	3.26	2.96
R_GDP_G (%)	31	1.81	1.4	1.57	-1.31	4.5	5.8
Inflation (%)	31	3.49	2.12	2.61	1.5	9.69	8.19
Vol_CPI	31	1.67	1.06	1.35	0.57	5.06	4.49
Secondary (%)	31	7.14	11	5.18	0	59.47	59.47
Premium (%)	31	1.97	1.7	1.82	-1.71	6.42	8.13
Legal (0-10)	31	6.5	2.16	6.5	3	10	7
Credit_Inf (0-6)	29	4.7	0.87	5	2	6	4
CapitaltoAssets (%)	31	7.19	2.43	6.47	3.13	12.99	9.86
Urban (%)	31	73.12	12.05	71.85	50.14	97.41	47.27
GNI_PPP ($)	31	25883	10453	24692	10660	52407	41746
Unemp (%)	31	8.13	2.81	7.74	3.3	15.25	11.95
Development (Dummy)	31	0.74	0.44	1	0	1	1
Hhold_Size	31	2.55	0.37	2.5	1.99	3.85	1.86
Age_Dependency (%)	31	23.03	4.52	23.87	10.48	30.63	20.15
InsurancetoGDP (%)	29	31.33	31.31	20.22	0.3	95.56	95.26
Pop_Growth (%)	31	0.36	0.78	0.42	-1.72	1.86	3.57
House_Price (Index)	30	104.5	11.53	104.15	81.56	126.6	45.04

During the period 2005–2012, the average residential mortgage debt-to-GDP ratio (RMD_GDP) was 41.3% for the 31 countries. While the Russian Federation has the smallest mortgage market, representing 2.05% of the GDP, the Netherlands has the largest mortgage market, accounting for 104.1% of its GDP. The second dependent variable or proxy for the level of mortgage market development, namely, the ratio of mortgage loans to total credits, has a narrower range between 6.5% for the Russian Federation and 66.1% for Sweden.

The annual representative interest rates on new mortgage loans vary between 3.16% (Finland) and 15.43% (Turkey), with an average rate of 5.49%. For overall sample, the average real GDP growth rate is 1.81%, and Greece, Italy and Portugal has a negative growth rates. The gross national income per capita ranges between $10,660

in Romania and $52,407 in Luxembourg. Similarly, significant dispersions are also observed both in unemployment rates and total domestic credit to GDP ratios.

The urbanization rate exhibits reasonably less variation. Slovenia has the lowest urbanization rate at 50.14% and Belgium has the highest ratio, at 97.41%. Likewise, the average household size ranges between 1.99 for Denmark and 3.85 for Turkey. The spread of representative interest rates over inflation (premium) is negative in four countries, including Estonia, Latvia, Lithuania and Iceland. In contrast, this indicator is considerably high in Hungary (6.42%), Turkey (6.25%) and Poland (3.65%). Lastly, the share of secondary mortgage market issuances in the total residential mortgage debt is 7.1% on average. While Denmark has the largest secondary mortgage market (59.4%), seven countries, namely Bulgaria, Estonia, Lithuania, Malta, Luxemburg, Romania, Slovenia and Turkey, have no or negligible secondary markets for mortgage loans.

3.4 Modeling Approach

There is no theoretical framework for modeling the depth of mortgage markets in a cross country setting. Unlike the previous studies, which selected a subset of variables based on the economic theory, intuition and conventional wisdom, this study presents an initial attempt to use variable selection methods in order to model cross-country variations in the depth of mortgage markets. The intention here is to reduce the number of variables to a list that is to the best interest of the reader.

In this part, following literature, a benchmark model is constructed which relates several variables to residential mortgage debt to GDP ratio. Significance of additional variables that are discussed in previous studies such as secondary market issuances, representative interest rates and financial institutions capital to assets ratios are also investigated. The data set used in these analyses satisfies a balance with number of countries and quality of data.

The objective in constructing such a model is to analyze the present state of the mortgage market compared to market equilibrium (both emerging and/or developed countries). Based on the outputs of that model, the potential for Turkish mortgage market is analyzed under various scenarios in the following sections. Additionally, possible developments that would help a forming deeper mortgage debt to GDP[36] level will be discussed. Therefore, possible government interventions that could help development of this market will be discussed in this context.

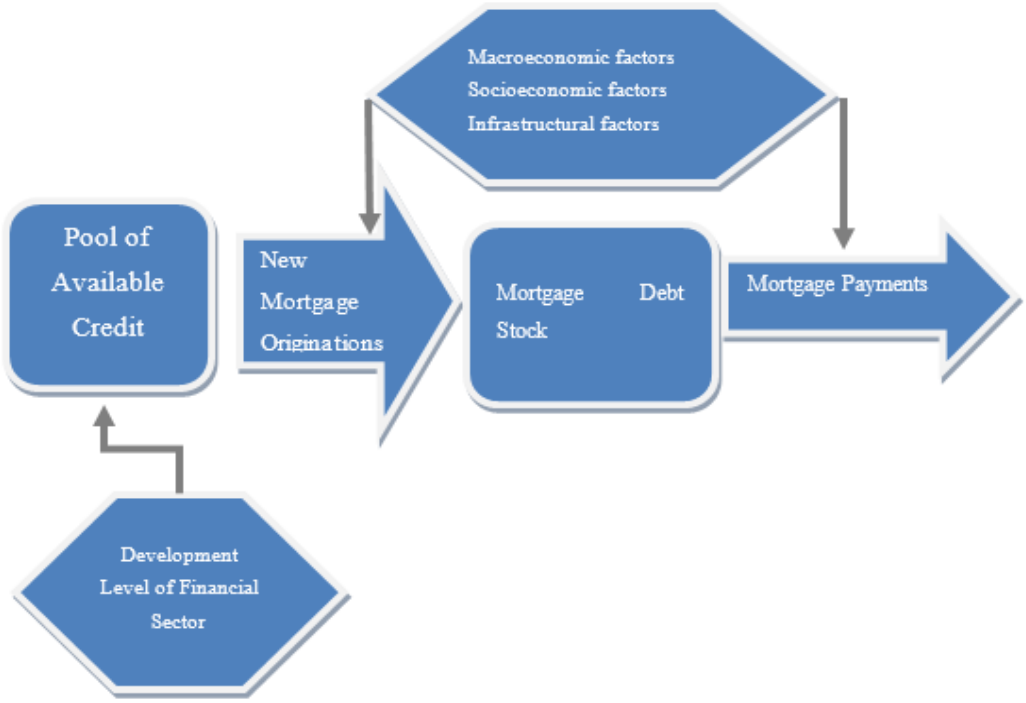


Figure 6: Mortgage Debt Stock

Figure 6 shows how the mortgage stock at a given time is formed. Housing market system is affected from not only demand side but also supply side factors.

[36] Several factors can be considered in evaluating housing markets. However, all other factors except for mortgage debt/GDP have certain drawbacks. For a discussion regarding this issue see Warnock and Warnock (2008: 4).

Additionally, as indicated in Bardhan and Edelstein (2007:25), it is worth stressing that many of the explanatory variables are not completely exogenous.

Malpezzi (2012:34) indicated that supporting the growth of housing finance systems also helps the development of the financial system in general. Available funds for mortgage finance could change from country to country due to factors such as deposit base, maturity of funding, ability of a certain country to obtain long term external sources, etc. In order to control for that effect residential mortgage debt to GDP indicator is transformed to share of residential mortgage credits in total domestic credits of the banking sector of that specific country.

The modeling approach used in this part is depicted in Figure 7. OLS, pooled OLS and panel data analysis results are provided in this thesis[37]. These approaches are used in order to be able to comparable results with the ones in literature.

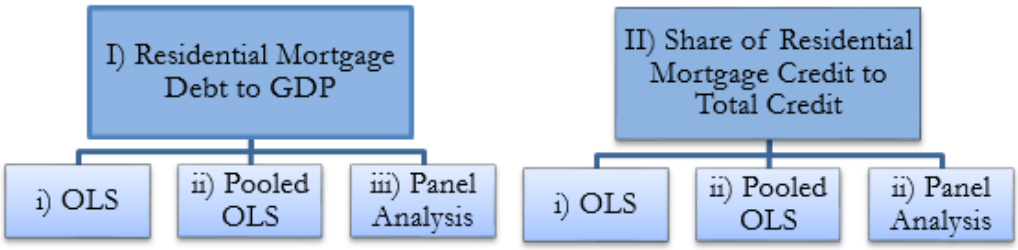


Figure 7: General Modeling Approach

[37] In the analyses R Software 3.1.2 is used.

3.4.1 Methodology and Variable Selection Procedure

Estimation and model selection techniques used in this part of the thesis are covered in this section. A linear regression model is presented with the following notation for i^{th} observation,

$$y_i = x_i\beta + u_i \quad (3)$$

and in vector notation

$$y = X\beta + u \quad (4)$$

where;

y is the vector of dependent variables,

X is the regression matrix and

u is the error vector.

The OLS Estimator is given by,

$$\hat{\beta}_{OLS}=(X`X)^{-1}(X`y) \quad (5)$$

The pooled OLS estimator is obtained by stacking the data over *i* and *t* into one long regression with *NT* observations (Cameron and Trivedi, 2005:702) and estimating by,

$$y_{it} = \alpha + x_{it}^{`}\beta + u_{it}, \text{ i=1…N, t=1…T.} \quad (6)$$

The individual-specific effects model allows each cross-sectional unit to have a different intercept term though all slopes are the same (Cameron and Trivedi, 2005:700),

$$y_{it} = \alpha_i + x_{it}^{`}\beta + u_{it}, \quad (7)$$

One variant of the model (7) treats α_i as an unobserved random variable that is potentially correlated with the observed regressors x_{it}. This variant is called the fixed effects model (Cameron and Trivedi, 2005:700).

The other variant of the individual specific effects model assumes that the unobservable individual effects α_i are random variables that are distributed independently of the regressors (Cameron and Trivedi, 2005:700). This model is called the random effects (RE) model, with the additional assumptions,

$$\alpha_i \sim [\alpha, \sigma_\alpha^2] \text{ and} \quad (8)$$

$$u_{it} \sim [0, \sigma_u^2] \quad (9)$$

In order to deal with the heteroscedasticity issue, *vcovHC()* function of the *sandwich* package of the R-software is used. The function uses White's heteroscedasticity consistent variance-covariance estimator (named HC0 in the literature) given below.

$$HC0 = (X`X)^{-1} X` diag[u_i^2] X (X`X)^{-1} \quad (10)$$

For variable selection, various R software tools are used together with cross validation technique.

In order to predict *y* in linear regression analysis, *regsubsets()* function of the *leaps* package in R software implements an exhaustive search for the best subsets of the explanatory variables (Lumley, 2013:1). In the application of this chapter *regsubsets()* returns four best models of each size (i.e. size refers to the number of variables taken into included in the model).

Similarly, *bestglm()* function of the *bestglm* package in R software performs a full enumeration for subset selection. It is used when the input matrix contains factor variables with more than two levels (McLeod and Xu, 2013:5). Best model is selected by using BIC criterion. BIC is a function of likelihood, and includes a component that penalizes a higher number of explanatory variables by increasing the BIC value. Therefore, given two models, the model with the lower BIC is preferred.

Leave one out cross validation methodology is run using R software and the following approach. Let *S* be the sample of measurements

$$S = \{(x_i, y_i) | i = 1 \dots N\} \quad (11)$$

a. Leave observation *i* out.
b. Estimate regression coefficients on the sample $S_{\setminus i}$, where $S_{\setminus i}$ denotes the sample *S* with observation *i* omitted.
c. Using the regression coefficients estimated in step 2, predict i[th] response variable by using i[th] explanatory variables, $\hat{y}(x_i; \beta, S_{\setminus i})$.
d. Calculate the loss for i[th] case, $[y_i, \hat{y}(x_i; \beta, S_{\setminus i})]$.
e. Repeat step (a) to (d) for every single observation.
f. Choose the model which minimizes total loss.

By stressing that outliers in the validation sample should have a bounded influence on the criterion used to choose the model Ronchetti, Field and Blanchard (1997) proposes using the following loss function.

$$\sum_{k=1}^{N} \rho(y_k - \hat{y}(x_k; \beta, S_{\setminus k})) \quad (12)$$

where ρ can be any robust objective function.

According to Hennig and Kutlukaya (2007) "the task of choosing a loss function is about the translation of an informal aim or interest that a researcher may have in the given application into the formal language of mathematics" and "the choice of a loss function requires informal decisions, which necessarily have to be subjective, or at least contain subjective elements".

Taking this information into consideration, the following objective function is chosen which reduces the effects of possible outliers (influential variables) on model selection.

Let $u_i = y_i - \hat{y}(x_i; \beta, S_{\setminus i})$ (13)

$$L[y_i, \hat{y}(x_i; \beta, S_{\setminus i})] = \begin{cases} u_i^2 \; if \; abs(u_i) < k \\ k^2 \; if \; abs(u_i) \geq k \end{cases} \quad (14)$$

where $S_{\setminus i}$ is the subset of the data excluding the i[th] observation and $L[y_i, \hat{y}(x_i; \beta, S_{\setminus i})]$ is the loss function and *k* is determined case by case to cover a small portion of the residuals.

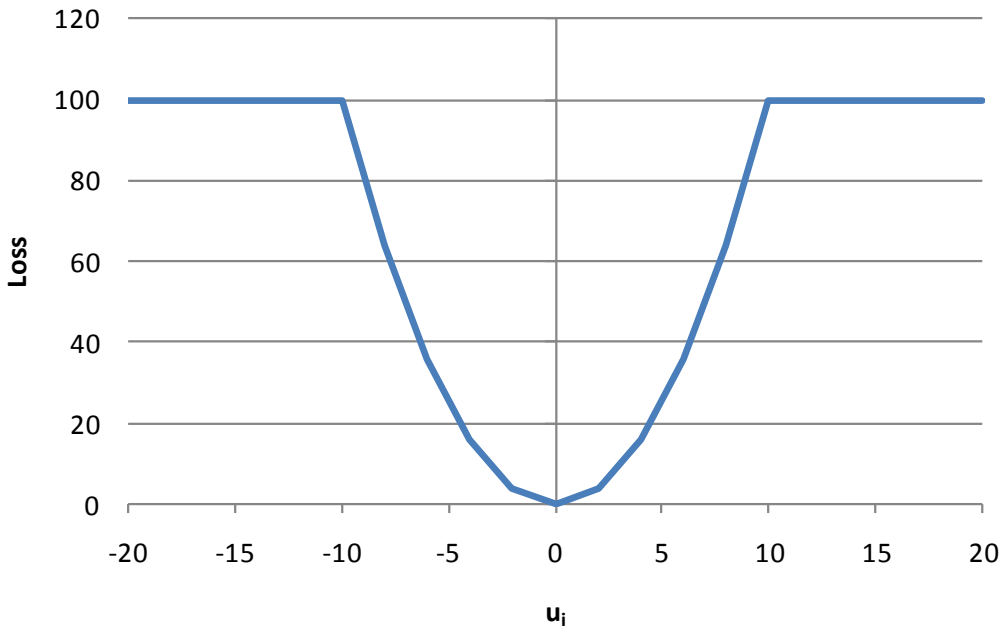


Figure 8: Representative Loss Function when k=10. [38]

Since there is no theoretical model for modeling residential mortgage debt to GDP or share of residential mortgage credit to total credit, a methodology should be determined upfront in order to select the most appropriate model.

Variable selection algorithm can be summarized by the following three steps: 1) Variable selection is done using R functions *regsubsets* for the OLS, pooled OLS analysis and *bestglm* for the panel regression analysis, 2) When the best model obtained does not differ significantly from the other best performing models (i.e., second best, third best model), cross validation technique is used in order to determine the final model, 3) Steps (1)-(2) are repeated in order to evaluate the effect of additional variables when there are missing values[39]. As the final layer of

[38] Corresponds to 10% error tolerance.

[39] Variables that have missing data values are not included at the beginning of the analysis, in order to run the models with maximum number of countries and prevent the change in the number of observations during variable selection steps (i.e. excluding a variable might lead to an increase in the number of observations in the model if the excluded variable has some missing values).

robustness check, all the best performing models that are obtained through the process described above are also compared against the models estimated via robust regression method[40]. Robust regression analysis confirmed the model results presented in this thesis; therefore for simplicity those analyses are not presented[41]. Lastly, it should be noted again that the findings presented in this thesis are correlations rather than causations.

3.4.2 Modeling Residential Mortgage Debt to GDP

In analyzing the depth of housing finance markets, dividing the relevant indicators by the GDP is a widely accepted indicator as it eliminates country-size effects. As explained in the previous sections, Hypostat 2013 dataset provides comparable statistics of residential mortgage debt to GDP level for various developed and developing countries.

3.4.2.1 Ordinary Least Squares

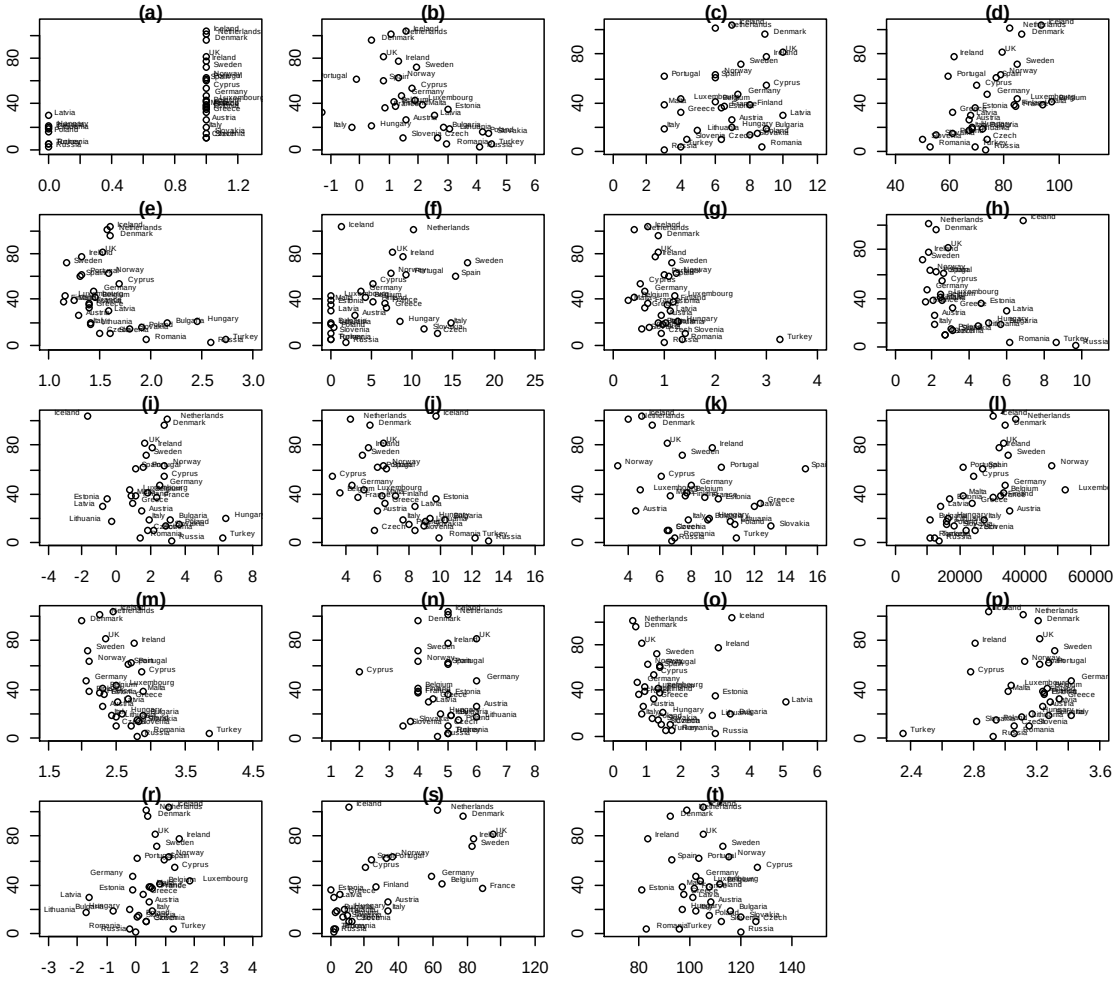
OLS analysis is based on an averaged data set, in which all variables are averaged over the period 2005 to 2012 for each country in our sample. Figure 9 presents 19 plots which individually provide the relationship between depth/size of the mortgage market measured by RMD_GDP and the explanatory variables. Undoubtedly, developed economies have considerably deeper mortgage markets (*plot a*). Plot b displays that as the average GDP growth rate increases, the size of the mortgage market decreases. Urbanization rate (*plot d*) and gross national income per capita (*plot l*) are positively correlated with the depth of mortgage markets. Expectedly, both representative interest rates and volatility of interest rates are negatively

[40] MM-estimator is used for the analyses.

[41] Only the results of the first OLS model is provided in the Appendix.

associated with the size of the mortgage markets (*plots e and g*). Unemployment rate also seems to have negative impact on the size of mortgage markets (*plot k*). Additionally, banks' capital-to-asset ratio is negatively correlated with the mortgage market size (*plot j*).[42] Figure 9 also shows that factors including the strength of legal rights (*plot c*), credit information score (*plot n*), household size (*plot m*) and secondary mortgage market volume (*plot f*) do not have a clear relation with the residential mortgage debt to GDP ratio.

[42]As the capital requirements of the banks become binding (i.e. capital adequacy ratios get closer to regulatory minimum) it can be expected from financial institutions to shift more of their balance sheets to mortgages because of the risk weight advantage in these products (i.e. risk weight of mortgages is 35% in the Basel-II framework, whereas for unrated corporate credit this weight is 100%)



In the figures above, each of the vertical axes corresponds to the Residential Mortgage Debt-to-GDP ratio, while the horizontal axes correspond to (a) Development, (b) Real GDP Growth Rate, (c) Legal Rights Index, (d) Urbanization Rate, (e) Representative Interest Rate, (f) Secondary, (g) Volatility of Representative Interest Rate, (h) Inflation Rate, (i) Interest Premium over Consumer Prices, (j) Banks' Capital to Assets Ratio, (k) Unemployment Rate, (l) GNI Per Capita PPP, (m) Household Size, and (n) Credit Information Score, (o) Inflation Volatility, (p) Age Dependency Ratio, (r) Population Growth Rate, (s) Insurance Company Assets to GDP, (t) House Price Index.

Figure 9: Residential Mortgage Debt to GDP vs. Explanatory Variables

Correlation matrix of the dependent variable and explanatory variables are provided in Figure 10. This matrix suggests high linear correlation between development and GNI_PPP. This is sensible as the main determinant of the IMF classification in specifying a country as advanced is its per capita income level. Variables related to

financial sector and macroeconomic stability seem to be strongly correlated. For instance, there is strong correlation between capital to assets ratio and representative interest rates, capital to assets ratio and consumer prices and consumer prices and representative interest rates.

	RMD_GDP	MortgagetoCredit	Interest	Vol_Interest	R_GDP_G	Cons_Prices	Vol_CPI	Secondary	Premium
RMD_GDP	1	0.76741	-0.44319968	-0.35138091	-0.488326	-0.39727592	-0.13820987	0.44901655	-0.26029422
MortgagetoCredit	0.76741	1	-0.46590294	-0.30393592	-0.3490703	-0.44089982	-0.02955306	0.30981167	-0.24665474
Interest	-0.4431997	-0.46590294	1	0.58917399	0.4797821	0.78688182	0.19498721	-0.15330954	0.70066192
Vol_Interest	-0.3513809	-0.30393592	0.58917399	1	0.303069	0.47949588	0.09572602	-0.11179308	0.3842564
R_GDP_G	-0.488326	-0.3490703	0.47978207	0.30306898	1	0.54675487	0.36489373	-0.36643001	0.14278504
Cons_Prices	-0.3972759	-0.44089982	0.78688182	0.47949588	0.5467549	1	0.61526427	-0.3332533	0.11283426
Vol_CPI	-0.1382099	-0.02955306	0.19498721	0.09572602	0.3648937	0.61526427	1	-0.33092164	-0.38932796
Secondary	0.4490166	0.30981167	-0.15330954	-0.11179308	-0.36643	-0.3332533	-0.33092164	1	0.14014944
Premium	-0.2602942	-0.24665474	0.70066192	0.3842564	0.142785	0.11283426	-0.38932796	0.14014944	1
Legal	0.252133	0.31880733	-0.1018949	-0.17628881	0.1334709	-0.09101026	0.22451399	0.17761166	-0.0238867
CapitaltoAssets	-0.5275352	-0.44049434	0.70871285	0.53055694	0.5542372	0.86959352	0.53403402	-0.30359333	0.13812312
Urban	0.5214254	0.49066066	-0.20892051	-0.25246568	-0.1877308	-0.14440969	-0.14798079	0.20762583	-0.19136489
GNI_PPP	0.6057257	0.56034069	-0.54652955	-0.21797667	-0.4764849	-0.63876132	-0.48163516	0.25834122	-0.15850257
Unemp	-0.3306485	-0.23740969	0.12436227	0.14021171	0.1323602	0.15986774	0.27594777	-0.08284435	0.01560674
Development	0.5531851	0.3799159	-0.71442304	-0.4067702	-0.5481351	-0.73588351	-0.49359373	0.31477686	-0.31938959
Hhold_Size	-0.4901301	-0.67904171	0.64390041	0.51214255	0.4790147	0.57675696	0.2090636	-0.38512959	0.369513
Age_Dependency	0.1007419	0.32086755	-0.49996401	-0.33812053	-0.6124274	-0.4295493	-0.12710498	0.18220312	-0.29846649
Pop_Growth	0.3953603	0.07988155	-0.09977377	0.09846605	-0.2228257	-0.29528181	-0.48084336	0.1382664	0.16118414

	Legal	CapitaltoAssets	Urban	GNI_PPP	Unemp	Development	Hhold_Size	Age_Dependency	Pop_Growth
RMD_GDP	0.25213303	-0.5275352	0.52142536	0.60572574	-0.33064851	0.5531851	-0.49013006	0.100741933	0.39536027
MortgagetoCredit	0.318807333	-0.4404943	0.49066066	0.56034069	-0.23740969	0.3799159	-0.67904171	0.320867554	0.07988155
Interest	-0.101894896	0.7087128	-0.20892051	-0.54652955	0.12436227	-0.714423	0.64390041	-0.499964007	-0.09977377
Vol_Interest	-0.176288808	0.5305569	-0.25246568	-0.21797667	0.14021171	-0.4067702	0.51214255	-0.33812053	0.09846605
R_GDP_G	0.133470924	0.5542372	-0.18773083	-0.47648493	0.13236018	-0.5481351	0.47901468	-0.612427446	-0.22282567
Cons_Prices	-0.091010259	0.8695935	-0.14440969	-0.63876132	0.15986774	-0.7358835	0.57675696	-0.429549296	-0.29528181
Vol_CPI	0.224513989	0.534034	-0.14798079	-0.48163516	0.27594777	-0.4935937	0.2090636	-0.127104984	-0.48084336
Secondary	0.177611665	-0.3035933	0.20762583	0.25834122	-0.08284435	0.3147769	-0.38512959	0.182203117	0.1382664
Premium	-0.023886704	0.1381231	-0.19136489	-0.15850257	0.01560674	-0.3193896	0.369513	-0.298466488	0.16118414
Legal	1	-0.1486504	-0.04105051	-0.02413988	0.0207464	-0.1114196	-0.22409543	-0.008777064	-0.14889002
CapitaltoAssets	-0.148650355	1	-0.35842074	-0.67633995	0.27026673	-0.7005804	0.54017955	-0.331427963	-0.38053667
Urban	-0.04105051	-0.3584207	1	0.50233465	-0.3978796	0.3317255	-0.42606871	0.103450586	0.3468894
GNI_PPP	-0.024139878	-0.6763399	0.50233465	1	-0.55488607	0.6989968	-0.63198318	0.214502935	0.61804707
Unemp	0.0207464	0.2702667	-0.3978796	-0.55488607	1	-0.2890149	0.39831733	0.032767617	-0.35065592
Development	-0.111419605	-0.7005804	0.33172546	0.69899676	-0.28901493	1	-0.50642955	0.259514469	0.57929348
Hhold_Size	-0.224095426	0.5401795	-0.42606871	-0.63198318	0.39831733	-0.5064295	1	-0.669036885	0.04290043
Age_Dependency	-0.008777064	-0.331428	0.10345059	0.21450294	0.03276762	0.2595145	-0.66903689	1	-0.34433364
Pop_Growth	-0.148890019	-0.3805367	0.3468894	0.61804707	-0.35065592	0.5792935	0.04290043	-0.344333643	1

Figure 10: Correlation Matrix

The OLS results with all the variables discussed in the data section is provided in Table 7. According to these results, most of the variables that are included to the model are insignificant. Additionally variance inflation factors indicate a multicollinearity problem. This is not surprising as there is very high correlation among some of the explanatory variables like representative interest rates and inflation, capital-to-assets and inflation.

Table 7: Full Model for Residential Mortgage Debt to GDP Ratio

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code	VIF
(Intercept)	52.741	238.522	0.221	0.828		
log(Interest)	91.995	70.563	1.304	0.213		57.160
Vol_Interest	-0.556	12.124	-0.046	0.964		2.745
R_GDP_G	-12.992	5.079	-2.558	0.023	*	3.601
log(Cons_Prices)	-65.559	46.462	-1.411	0.180		40.445
Vol_CPI	2.614	6.666	0.392	0.701		3.576
Secondary	0.383	0.471	0.814	0.429		1.911
Premium	-17.301	12.335	-1.403	0.183		31.552
Legal	3.928	2.416	1.626	0.126		1.950
CapitaltoAssets	2.679	4.339	0.617	0.547		7.927
Urban	0.963	0.480	2.008	0.064	.	2.386
GNI_PPP	0.001	0.001	0.915	0.376		8.444
Unemp	0.500	1.967	0.254	0.803		2.182
Development	9.537	21.541	0.443	0.665		6.552
Hhold_Size	10.820	33.708	0.321	0.753		11.119
log(Age_Dependency)	-67.780	42.297	-1.602	0.131		6.367
Pop_Growth	-8.844	12.795	-0.691	0.501		7.185
Multiple R-squared	0.775					
Adjusted R-squared	0.518					
p-value	0.022					

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

After this initial identification, variable selection strategy given in the methodology section is implemented. The plot that is obtained after employing the *regsubsets()* function of R using Bayesian Information Criterion is provided in Figure 11. In that figure four best models (i.e. minimum BIC) of each size (in terms of variables) are depicted.

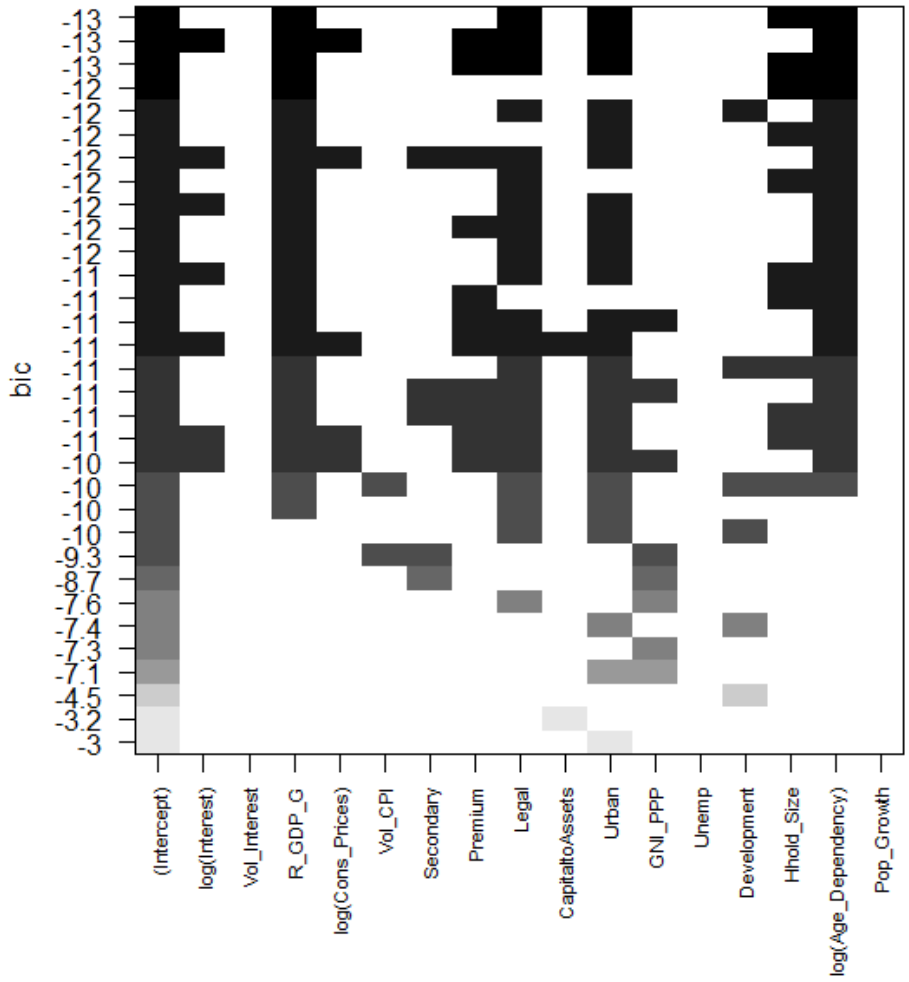


Figure 11: Regsubsets Output

In Figure 11, each row indicates to a different model and the model specified at the top row is the best model (in terms of BIC criterion[43]). Accordingly, in the model yielding lowest BIC, only R_GDP_G, Legal, Urban, Hhold Size and Age Dependency variables are included. On the other hand there are several models creating close BIC values. For instance, the BIC of the next two models are also very close to the best model. Additionally F-tests do not indicate a statistically significant

[43] BIC is a function of likelihood and includes a component penalizing higher number of explanatory variables by increasing the BIC value. Therefore, given two models, the model with the lower BIC is preferred.

difference at 95% confidence level between the best model and the fourth model which includes smaller number of variables.

In order to choose among these models, leave one out cross validation techniques is applied. Resulting total losses related to each model are provided in Table 8[44].

Table 8: Out of Sample Performances of the Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Full Model
Log(Interest)		√				
Growth_Rate	√	√	√	√	√	
Legal	√	√	√		√	
Urban	√	√	√		√	
Hhold Size	√		√	√		
Log(Age Dependency)	√	√	√	√	√	
Log (Inflation)		√				
Premium		√	√			
Development					√	
Total Loss	8280	8510	8241	10671	9276	11556

Among those candidate models, Model 3 provides the best out of sample performance. The OLS results of Model 3 are given in Table 9.

Table 9: OLS Results for Model 3

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code	VIF
(Intercept)	358.188	129.294	2.770	0.011	*	
R_GDP_G	-13.815	3.104	-4.451	0.000	***	1.708
Premium	-3.315	2.142	-1.548	0.135		1.207
Legal	3.682	1.689	2.180	0.039	*	1.210
Urban	0.678	0.331	2.050	0.051	.	1.442
Hhold_Size	-32.683	16.213	-2.016	0.055	.	3.266
log(Age_Dependency)	-88.501	25.860	-3.422	0.002	**	3.022
Multiple R-squared	0.697					
Adjusted R-squared	0.621					
p-value:	0.000					

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

[44] For these calculations, a cut off value of 25% is used.

Accordingly, in the best performing model, controlling for real GDP growth, the strength of legal rights and urbanization rate are positively associated with mortgage debt-to-GDP, the premium level (insignificant at 10% significance level), household size and age dependency ratio are negatively associated in the best performing model[45,46].

Standard R plots for residuals of this model are presented in Figure 12. These plots do not indicate a specific model problem such as non-normality, heteroscedasticity or outliers.

[45] Robust Regression Results obtained by employing MM estimator is also presented in the Appendix B.

[46] The control variable, real GDP growth rate has negatively associated with mortgage debt-to-GDP. In order to show that this is not a short term relationship that is affected from the global financial crisis, Appendix B gives long run relationship between real GDP growth and residential mortgage debt to GDP ratio. This shows that the result obtained is not due to global financial crisis which has had significant effect on the mortgage markets of the advanced countries.

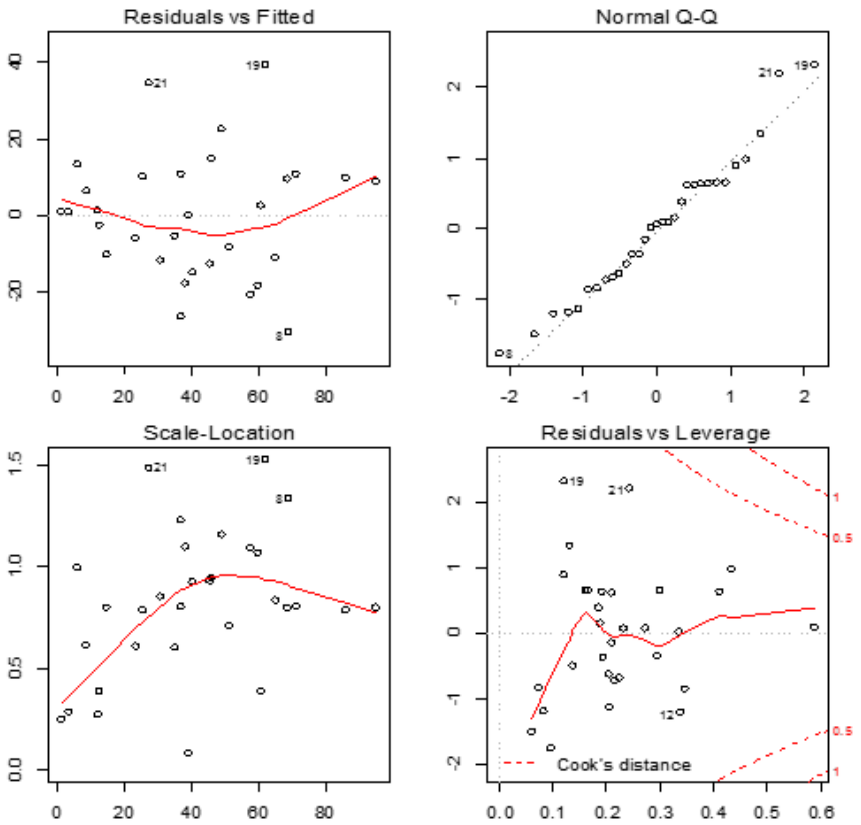


Figure 12: Standard R Plots for Residuals

Figure 12 gives the scatter plot of actual values of average residential mortgage debt to GDP between 2005 and 2012 and fitted values. This plot shows that legal rights index, urbanization rate, household size, age dependency ration and premium in the mortgage market and real GDP growth rate provide reasonable information to estimate residential mortgage debt to GDP ratios of various countries.

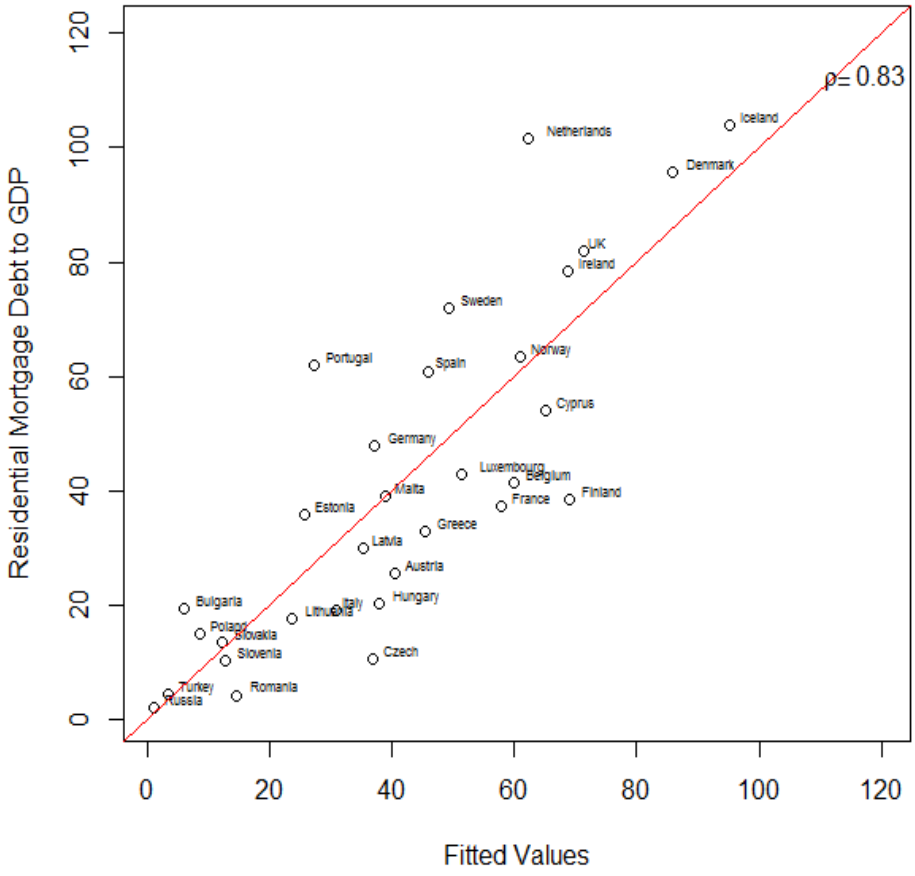


Figure 13: Actual versus Fitted Values based on 2005-2012 Averages

Due to missing data problems, credit information index, insurance company assets to GDP and house price variables that is discussed in the data section have not been included into the initial model (full model). However, in order to check whether these variables could contribute to the explanatory power, the same methodology is run for available dataset. Results that are presented in Appendix C show that insurance company assets to GDP and house price variables appear in the best performing models.

3.4.2.2 Pooled OLS

As explained in the literature review section, pooled OLS is a widely accepted and employed technique in this field as it helps overcoming the data limitations. In Figure 14 distribution of residential mortgage debt to GDP values are provided for the 31 countries in the sample.

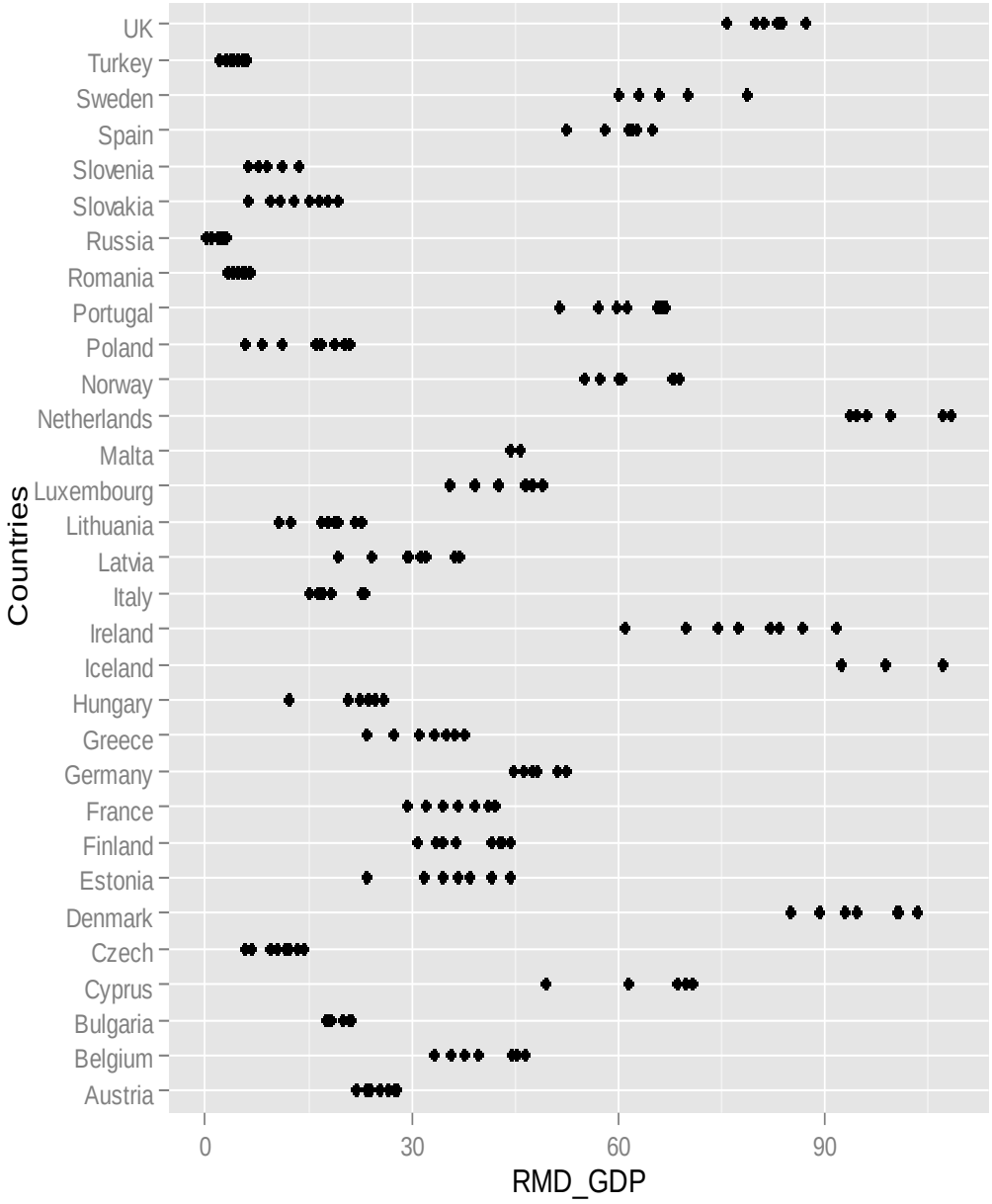


Figure 14: Residential Mortgage Debt to GDP Levels (2005-2012)

In Table 10, pooled OLS results for the full model related to residential mortgage debt to GDP are provided[47].

Table 10: Pooled OLS Results for Residential Mortgage Debt to GDP

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
(Intercept)	64.050	37.380	1.713	0.088	.
log(Interest)	15.870	8.969	1.769	0.078	.
R_GDP_G	-0.681	0.318	-2.142	0.033	*
log(Cons_Prices)	-23.920	13.410	-1.784	0.076	.
Vol_CPI	1.025	0.778	1.317	0.189	
Secondary	0.515	0.106	4.878	0.000	***
Spread	-3.330	1.467	-2.270	0.024	*
Legal	2.568	0.655	3.922	0.000	***
CapitaltoAssets	-1.914	0.910	-2.103	0.037	*
Urban	0.509	0.142	3.599	0.000	***
GNI_PPP	0.000	0.000	1.843	0.067	.
Unemp	0.102	0.467	0.219	0.827	
Development	21.610	4.893	4.417	0.000	***
log(Age_Dependency)	-19.290	7.909	-2.440	0.016	*
Pop_Growth	-1.393	1.570	-0.888	0.376	
Multiple R-squared	0.636				
Adjusted R-squared	0.610				
p-value	0.000				

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

For variable selection, the *regsubsets()* function of R-software by employing Bayesian Information Criterion is used. Figure 15 displays the best four models (i.e. minimum BIC) of each size (in terms of variables).

[47] Household size, house price index and insurance assets to GDP is not included into the panel data as only limited number of data points were available for the countries in the sample. On the other hand, similar to the OLS analysis, credit information index is included separately due to limited number of missing values.

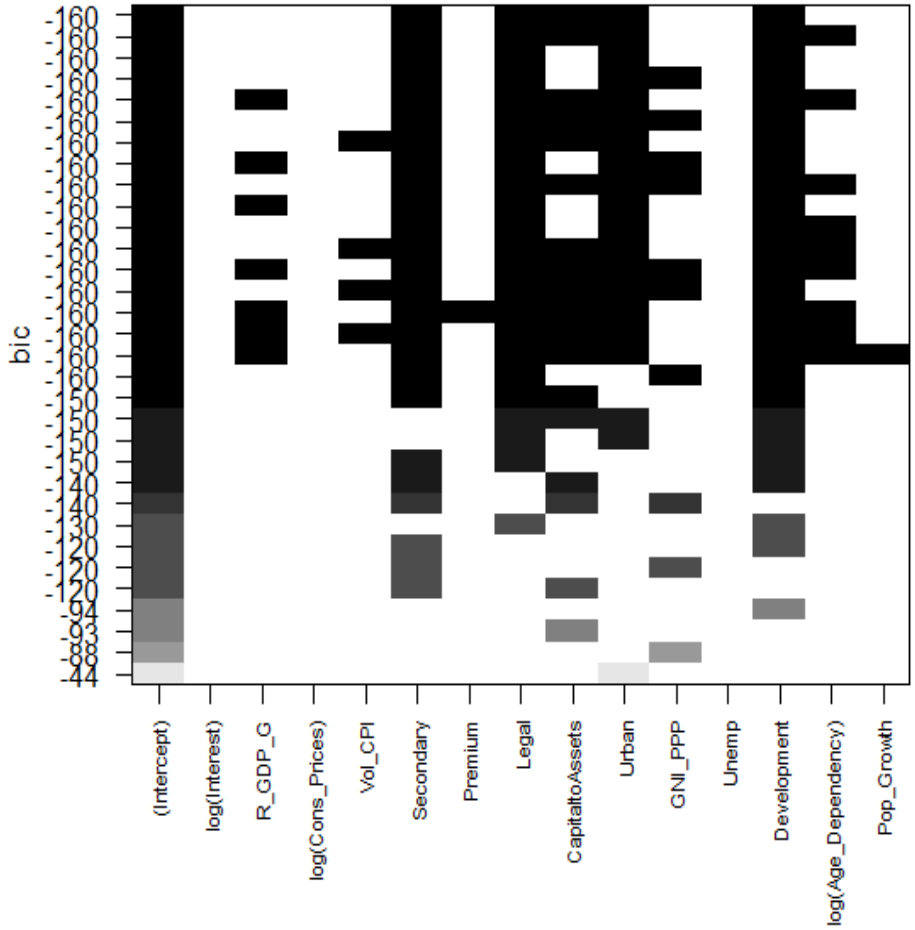


Figure 15: Regsubsets Output

Parallel to the methodology described in the previous section leave one out cross validation technique is applied to determine the final model. Resulting total losses corresponding to those models are provided in Table 11 [48].

[48] For these calculations, a cut off value of 25% is used.

Table 11: Out of Sample Performances of the Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Full Model
Secondary	√	√	√	√	√	
Legal	√	√	√	√	√	
CapitaltoAssets	√	√			√	
Urban	√	√	√	√	√	
Development	√	√	√	√	√	
log(Age_Dependency)		√			√	
GNI_PPP				√	√	
Total Loss	51559	51147	51667	51706	51373	51215

Among those candidate models, Model 2 provides the best out of sample performance. The pooled OLS results of Model 2 are given in Table 12.

Table 12: Pooled OLS Results for Model 2

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code	VIF
(Intercept)	21.9301	24.8554	0.882	0.37863		
Secondary	0.4906	0.1054	4.655	5.78E-06	***	1.142
Legal	2.9464	0.6386	4.614	6.92E-06	***	1.177
CapitaltoAssets	-2.4053	0.806	-2.984	0.00319	**	2.351
Urban	0.5416	0.1278	4.237	3.41E-05	***	1.256
Development	24.9568	3.814	6.544	4.63E-10	***	2.072
log(Age_Dependency)	-13.8265	6.1251	-2.257	0.02503	*	1.219
Multiple R-squared	0.609					
Adjusted R-squared	0.598					
p-value	0.000					
Breusch-Pagan test	0.001					

Similar to the cross sectional regression results above, strength of legal rights, urbanization rate and age dependency ratio appear in the best performing model for residential mortgage debt to GDP. Additionally, secondary mortgage market share is positively associated with the mortgage debt to GDP ratio whereas banks capital to assets ratio is negatively associated with this variable in a pooled OLS setting. The statistical significance of the pooled OLS regression coefficients is stronger than that of the cross sectional regression coefficients due to increased number of observations.

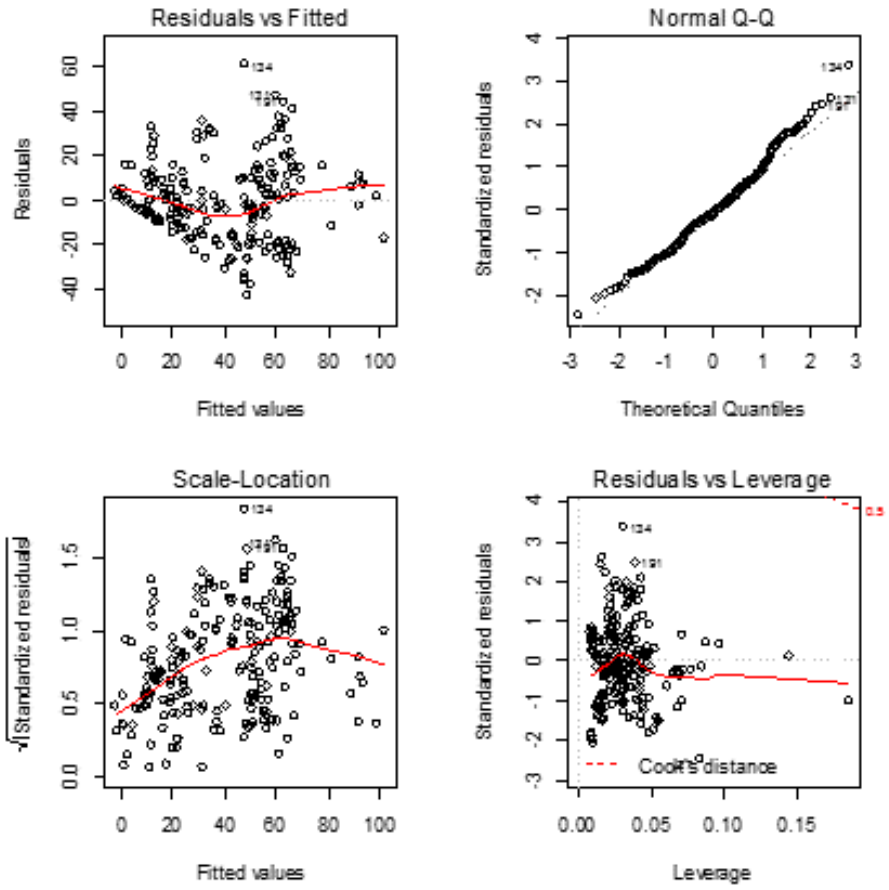


Figure 16: Standard R Plots for Residuals

The studentized Breusch-Pagan test indicates heteroscedasticity problem. Nevertheless, using heteroscedasticity consistent covariance matrix does not alter the significance of the variables (results are provided in Table 13).

Table 13: Pooled OLS Results for Model 5 – Heteroscedasticity Consistent Covariance Estimation

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
(Intercept)	21.930	24.250	0.904	0.367	
Secondary	0.491	0.105	4.693	0.000	***
Legal	2.946	0.637	4.625	0.000	***
CapitaltoAssets	-2.405	0.974	-2.470	0.014	*
Urban	0.542	0.149	3.625	0.000	***
Development	24.957	4.519	5.523	0.000	***
log(Age_Dependency)	-13.827	5.153	-2.683	0.008	**

Figure 17 provides actual versus fitted values for the pooled OLS analysis of residential mortgage debt to GDP level. This figure shows that the model given above produces sensible results for estimating residential mortgage debt to GDP values in different countries and different years.

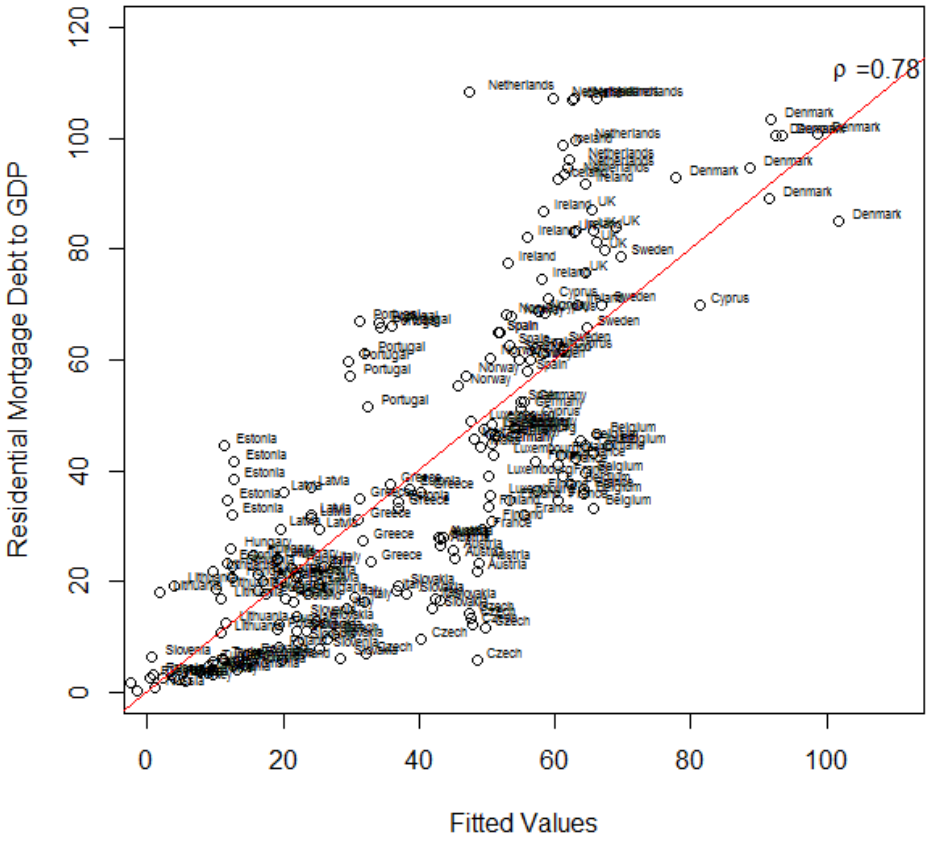


Figure 17: Actual vs. Fitted Values for Residential Mortgage Debt to GDP– Pooled OLS

Additionally, analysis provided in Appendix C show that credit information index variable also appears in the best performing models for the restricted data set.

3.4.2.3 Panel Data Analysis

In this section the data that is described in the previous section is used in the analysis. Results of the fixed effects model[49] including all variables are provided in Table 14. Individual country effects are provided in Appendix C (Table 63).

Table 14: Fixed Effects Regression Results –Residential Mortgage Debt to GDP

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
log(Interest)	4.636	2.193	2.114	0.036	*
R_GDP_G	-0.411	0.069	-5.981	0.000	***
log(Cons_Prices)	-9.640	3.165	-3.046	0.003	**
Vol_CPI	0.573	0.190	3.024	0.003	**
Secondary	0.068	0.043	1.576	0.117	
Premium	-1.078	0.375	-2.877	0.005	**
Legal	3.232	0.876	3.689	0.000	***
CapitaltoAssets	-0.160	0.309	-0.518	0.605	
Urban	1.758	0.532	3.307	0.001	**
GNI_PPP	0.000	0.000	-0.190	0.850	
Unemp	0.017	0.142	0.117	0.907	
Development	1.949	1.647	1.184	0.238	
log(Age_Dependency)	41.395	11.888	3.482	0.001	***
Pop_Growth	0.143	0.379	0.377	0.707	
Multiple R-squared	0.557				
Adjusted R-squared	0.440				
p-value	0.000				

Unbalanced Panel: n=31, N=214
Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

Variable selection is done by using *bestglm()* function of R software. Models creating high BIC values are presented in Table 15 together with the corresponding cross validation total loss values[50].

[49] Variable selection functions are available only for fixed effects models in R software. Therefore, to guarantee comparability across sections, only fixed effects models are provided in this section. Additionally, fixed effects estimator is used in Badev *et al.* (2014).

[50] Cut off value of 10% is used.

Table 15: Out of Sample Model Performance of the Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Full Model
R_GDP_G	√	√	√	√	√	
Vol_CPI	√	√	√	√		
Legal	√	√	√	√	√	
Urban	√	√	√	√	√	
log(Age_Dependency)	√	√	√	√	√	
Secondary		√				
log(Interest)			√			
log(Cons_Prices)			√	√		
Premium			√	√		
Total Loss	3153	3183	3155	3188	3173	3179

Among these models Model 1 gives smallest out of sample estimation error. The estimation results for that model are given in Table 16.

Table 16: Fixed Effects Regression Results for the Final Model

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
R_GDP_G	-0.443	0.064	-6.933	0.000	***
Vol_CPI	0.503	0.162	3.093	0.002	**
Legal	3.133	1.664	1.883	0.061	.
Urban	1.946	0.588	3.309	0.001	**
log(Age_Dependency)	40.663	9.944	4.089	0.000	***
R Squared	0.520				
Adjusted R Squared	0.432				
p-value	0.000				
F-test for individual effects	0.000				
Breusch-Pagan (p-value)	0.003				
Hausman Test (p-value)	0.234				

Individual country effects are given in Appendix D (Table 64). Test for individual effects indicate that this model is preferred to corresponding pooled OLS model. Serial autocorrelation and cross sectional dependence tests are not applied as the number of years in the analysis is limited (Torres-Reyna, 2012: 20, 21).

According to this model, controlling for the GDP growth rate, strength of legal rights and urbanization rate are positively associated with the depth of mortgage markets.

Additionally, in contrast to the results of the previous sections and the findings of Badev *et al.* (2014), after eliminating the individual country specific effects, age dependency ratio is positively associated with the depth of mortgage market.

Table 17: Fixed Effects Regression Results for the Final Model – Heteroscedasticity Consistent Covariance

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
R_GDP_G	-0.44323	0.063108	-7.0233	4.42E-11	***
Vol_CPI	0.502579	0.171722	2.9267	0.003873	**
Legal	3.13286	1.395211	2.2454	0.02597	*
Urban	1.946073	0.68601	2.8368	0.005085	**
log(Age_Dependency)	40.66251	13.00542	3.1266	0.002066	**

Breusch-Pagan test indicates to heteroscedasticity problem. The same model that is estimated using heteroscedasticity consistent covariance matrix is provided in Table 17. Under this setting, the significance of the variables are not affected by the use of robust standard errors. Additionally, standard R plots for the residuals are provided in Figure 18 and these plots do not indicate a major modeling problem.

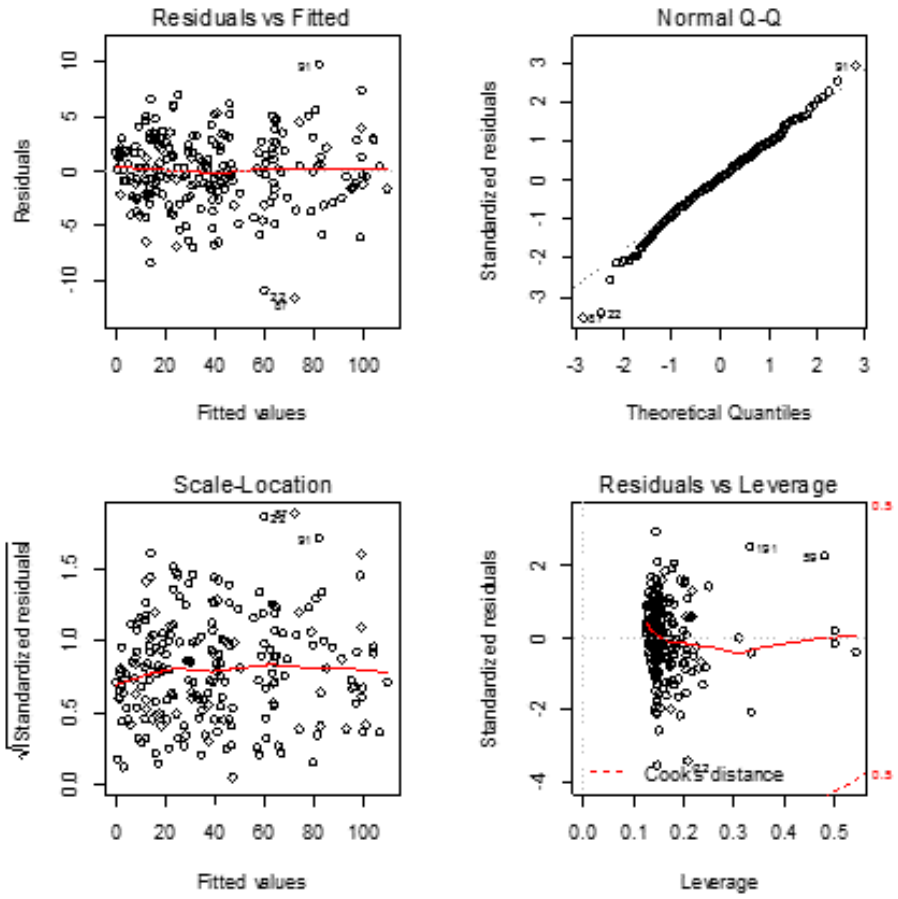


Figure 18: Standard R Plots

The Hausman test indicates that the random effects model is preferred to this model. Results regarding the same model that is estimated with random effects are provided in Table 18. Parameter estimates under both fixed and random effects models are quite close. Cameron and Trivedi (2005:699) showed that fixed effects estimator is consistent when the assumed model is random effects. The findings related to random effects model is provided for illustrational purposes and the results of the fixed effects model is used in the following sections.

Table 18: Random Effects Regression Results for the Final Model

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
(Intercept)	-212.555	27.161	-7.826	0.000	***
R_GDP_G	-0.461	0.061	-7.493	0.000	***
Vol_CPI	0.446	0.171	2.608	0.010	**
Legal	3.395	0.792	4.287	0.000	***
Urban	1.541	0.286	5.390	0.000	***
log(Age_Dependency)	38.322	8.195	4.676	0.000	***
R Squared	0.491				
Adjusted R Squared	0.477				
p-value	0.000				

The fitted values (fixed effects final model) and the corresponding residential mortgage debt to GDP levels are provided in Figure 19. This indicates a reasonable fit for the dependent variable.

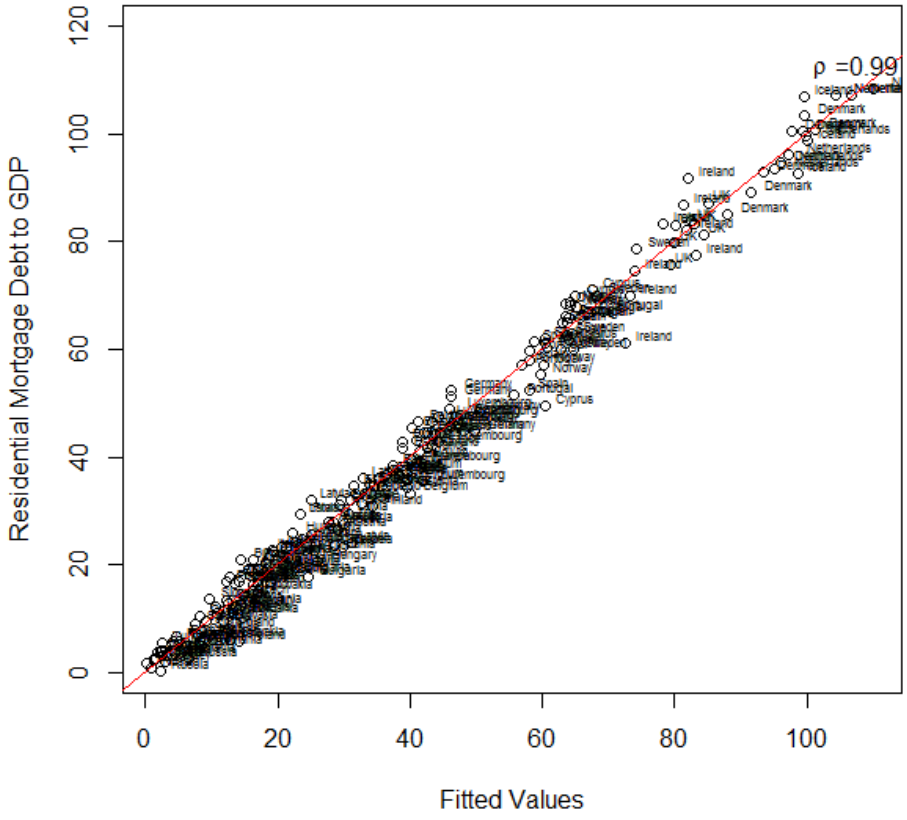


Figure 19: Residential mortgage debt to GDP and Fitted Values

Finally, the credit information index variable is added to the models separately. The results provided in the annex show that this variable appears in the best performing models.

3.4.3 Modeling Residential Mortgage Credit to Total Credit

Renaud (2005:5) indicates that mortgage finance in very small financial systems lack economies of scale and scope. In other words, the residential mortgage debt to GDP level in different countries could be affected by the development level of the financial sectors of those countries. In order to control for that effect and analyze what percentage of total credit available is directed to mortgage segment, residential mortgage debt to GDP variable is divided by the domestic credit provided by banking sector to GDP variable. This calculation yields the variable "residential mortgage credit to total domestic credit".

3.4.3.1 Ordinary Least Squares

The analyses in this section are based on the data that is obtained by averaging relevant data over 2005-2012 period. Figure 20 shows the relationship between residential mortgage debt to GDP and residential mortgage debt to credit ratios. According to this plot, there is significant correlation among these variables. Nevertheless, modeling residential mortgage debt to credit ratio also gives valuable results.

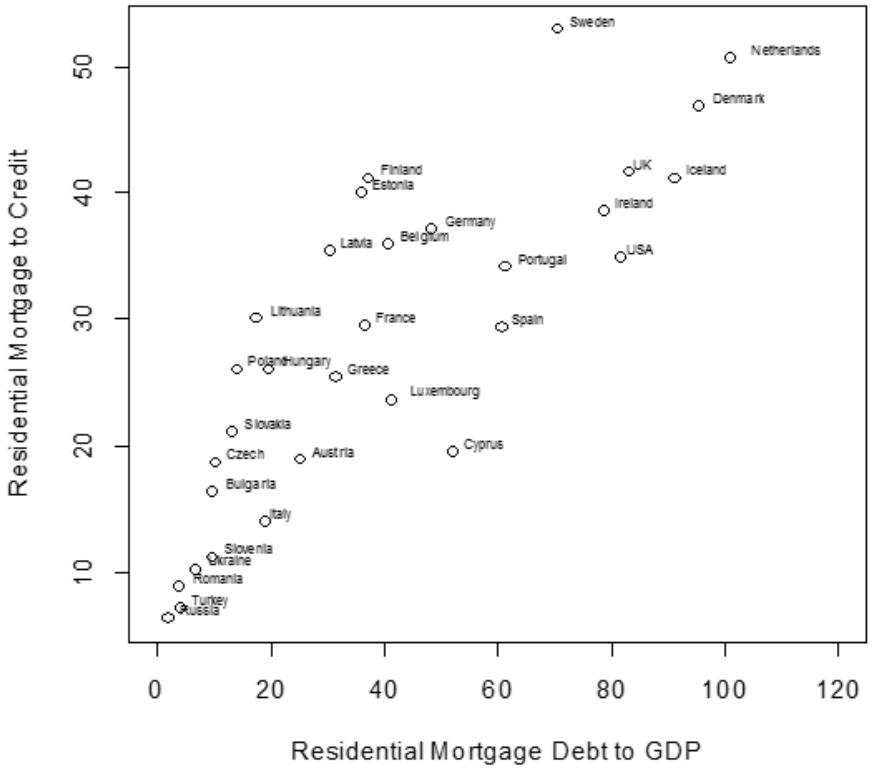


Figure 20: Residential Mortgage Debt to GDP vs. Residential Mortgage Debt to Credit Ratio

Table 19 presents the OLS results for the share of mortgage credit among domestic credit. None of the explanatory variables are significant in this model. As expected, there is multicollinearity problem.

Table 19: Full Model for Mortgage Credit to Total Credit Ratio

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code	VIF
(Intercept)	52.160	126.400	0.413	0.686		
log(Interest)	27.060	37.390	0.724	0.481		57.160
Vol_Interest	3.612	6.425	0.562	0.583		2.745
R_GDP_G	-3.929	2.692	-1.460	0.167		3.601
log(Cons_Prices)	-32.290	24.620	-1.311	0.211		40.445
Vol_CPI	3.130	3.533	0.886	0.391		3.576
Secondary	-0.118	0.249	-0.474	0.643		1.911
Premium	-3.735	6.537	-0.571	0.577		31.552
Legal	1.751	1.280	1.368	0.193		1.950
CapitaltoAssets	2.402	2.299	1.045	0.314		7.927
Urban	0.558	0.254	2.194	0.046	*	2.386
GNI_PPP	0.001	0.001	0.946	0.360		8.444
Unemp	0.840	1.042	0.806	0.434		2.182
Development	2.982	11.420	0.261	0.798		6.552
Hhold_Size	-10.790	17.860	-0.604	0.556		11.119
log(Age_Dependency)	-27.150	22.420	-1.211	0.246		6.367
Pop_Growth	-8.430	6.780	-1.243	0.234		7.185
Multiple R-squared	0.722					
Adjusted R-squared	0.404					
p-value	0.065					

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

The plot that is obtained after employing the *regsubsets()* function of R using Bayesian Information Criterion is provided in Figure 21. In that figure best four models (i.e. minimum BIC) of each size (in terms of variables) are depicted.

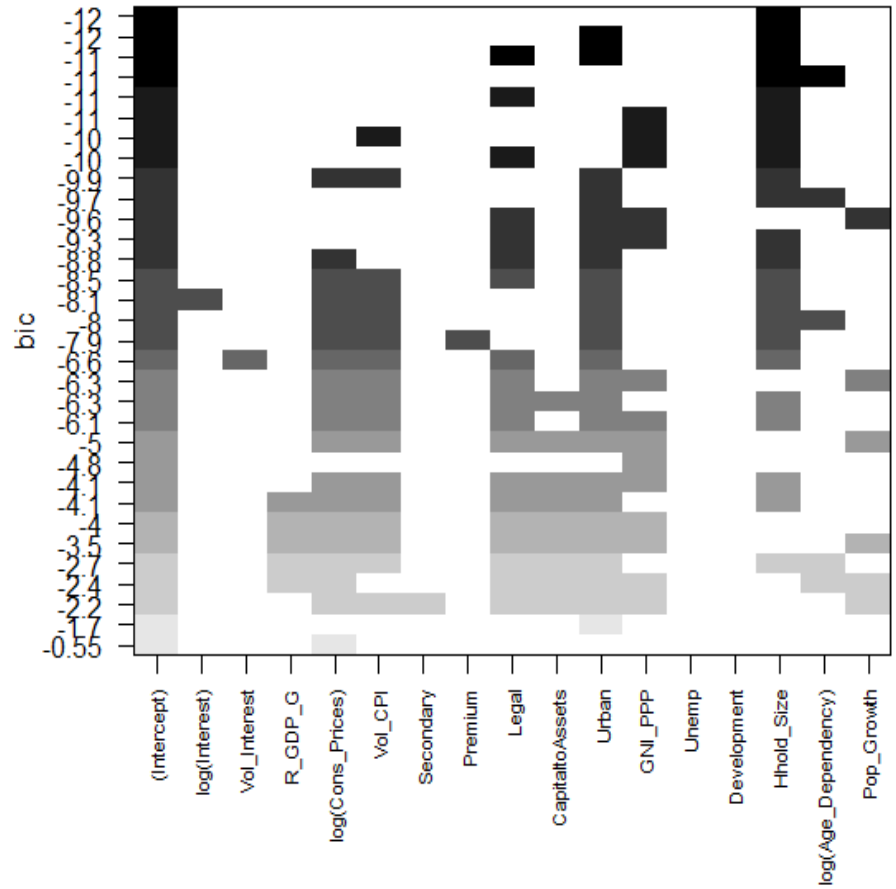


Figure 21: Regsubsets Output

According to Figure 21, in the best model (in terms of BIC criterion) only household size is included. There are also several other models creating close BIC values. For instance, the BIC of the first five models are close to the best model. Additionally F-test does not indicate a statistically significant difference at 95% confidence level between the best model and the next three models (which have higher number of variables). As a result, models creating high BIC values are compared in terms of their out of sample performances using leave one out cross validation. Resulting total losses for corresponding models are provided in Table 20 [51].

[51] For these calculations, a cut off value of 15% is used.

Table 20: Out of Sample Performances of the Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Full Model
Urban		√	√			
Log (Age_Dependency)				√		
Hhold_Size	√	√	√	√	√	
Legal			√		√	
Total Loss	2806	2633	2654	3001	2885	3277

Among those candidate models, Model 2 provides the best out of sample performance. The OLS results of that model are given in Table 21. This model suggests that urbanization rate, and household size are the main variables that are associated with the financial institutions' orientation towards extending more mortgage lending (compared to other credit types).

Table 21: OLS Results for Model 4

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
(Intercept)	64.849	22.571	2.873	0.008	**
Urban	0.287	0.171	1.683	0.103	
Hhold_Size	-21.831	5.556	-3.930	0.001	***
Multiple R-squared	0.511				
Adjusted R-squared	0.476				
p-value	0.000				

Standard R plots for residuals of this model are provided in Figure 22. These plots do not indicate a problem regarding the model. Also VIFs were investigated which do not indicate to a multicollinearity problem for this model.

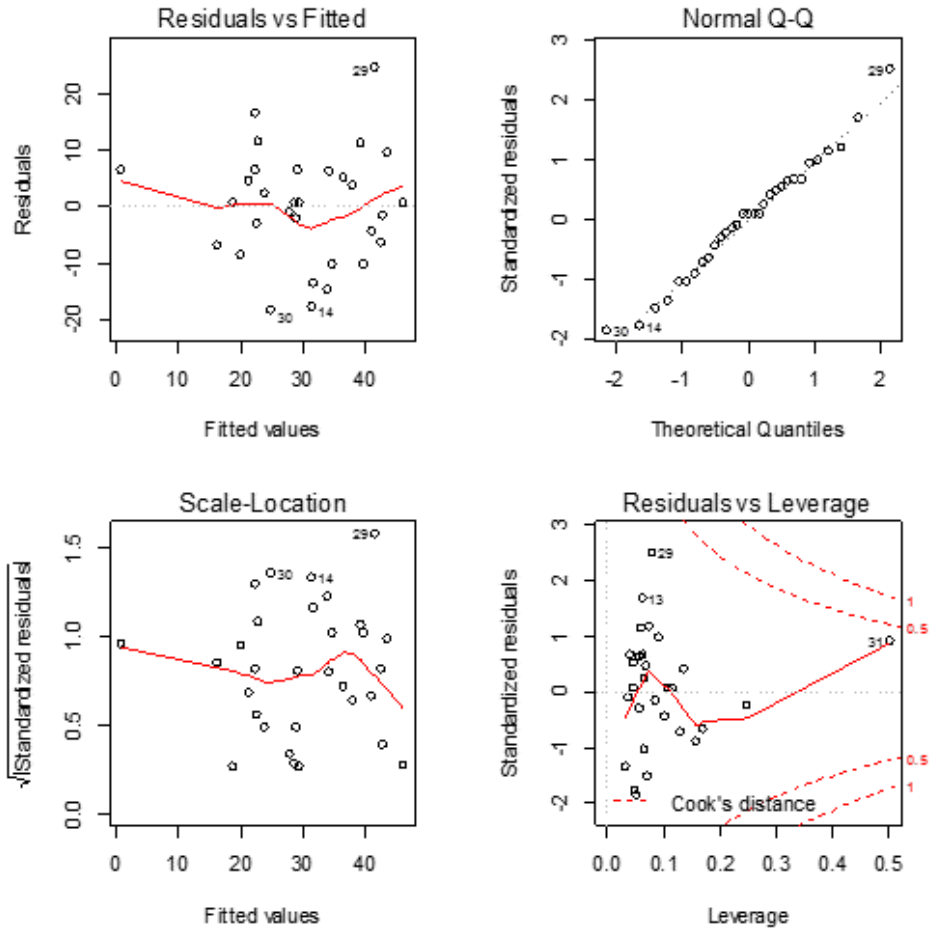


Figure 22: Standard R Plots for Model 4

Figure 23 gives the scatter plot of actual values of average residential mortgage debt to GDP between 2005 and 2012 and fitted values. This plot shows that urbanization rate, and household size help successfully estimate the share of residential mortgage credit to total credit of various countries (in terms of averages within a certain timeframe).

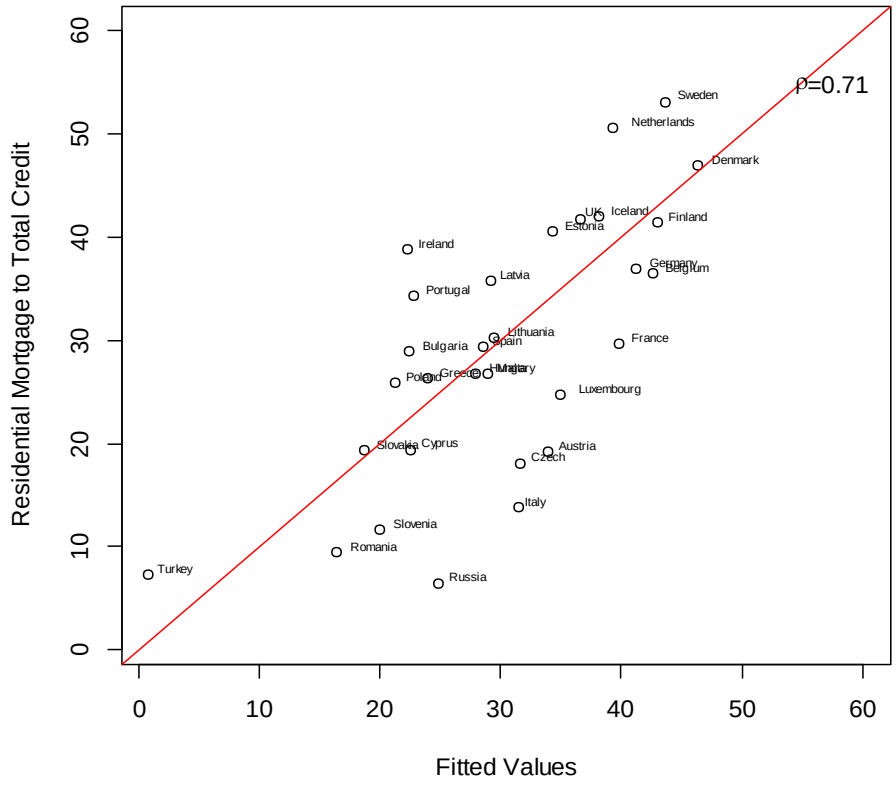


Figure 23: Actual versus Fitted Values

The variables that have missing values are also analyzed. The analysis on restricted data set is given in Appendix C. Accordingly, it is observed that House Price Index appears in some of the best performing models in terms of the BIC values.

3.4.3.2 Pooled OLS

Table 22 presents the pooled OLS results for the share of mortgage credit among domestic credit with all available variables.

Table 22: Pooled OLS Results for Mortgage Credit to Total Credit Ratio

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
(Intercept)	-13.840	19.130	-0.723	0.470	
log(Interest)	0.253	4.583	0.055	0.956	
R_GDP_G	-0.112	0.162	-0.689	0.491	
log(Cons_Prices)	-7.227	6.850	-1.055	0.293	
Vol_CPI	0.431	0.400	1.077	0.283	
Secondary	0.082	0.054	1.513	0.132	
Spread	-0.778	0.748	-1.040	0.300	
Legal	1.751	0.336	5.207	0.000	***
CapitaltoAssets	-0.639	0.493	-1.298	0.196	
Urban	0.318	0.073	4.337	0.000	***
GNI_PPP	0.000	0.000	2.184	0.030	*
Unemp	0.147	0.241	0.608	0.544	
Development	-0.576	2.575	-0.224	0.823	
log(Age_Dependency)	6.925	4.056	1.707	0.089	.
Pop_Growth	-1.655	0.797	-2.075	0.039	*
Multiple R-squared	0.542				
Adjusted R-squared	0.509				
p-value	0.000				

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

For variable selection, the *regsubsets()* function of R using Bayesian Information Criterion is used. Figure 24 displays the four best models (i.e. minimum BIC) of each size (in terms of variables).

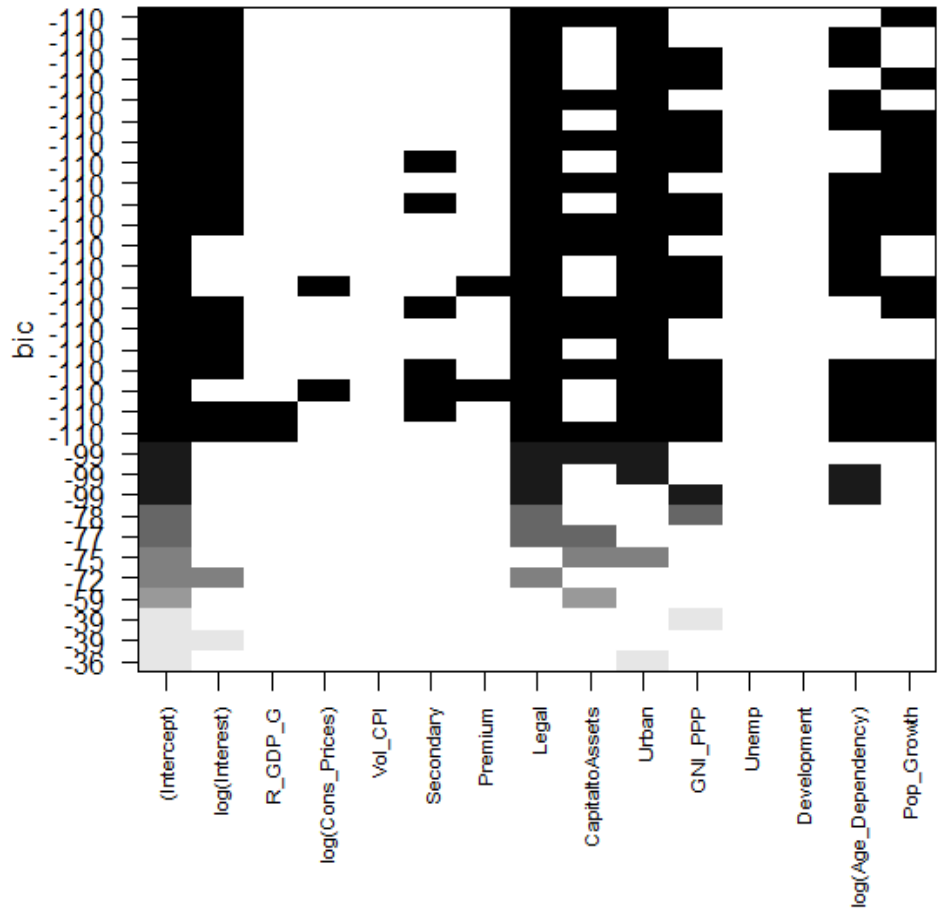


Figure 24: Regsubsets Output

Parallel to the methodology described in the previous section leave one out cross validation techniques is applied to determine the final model. Resulting total losses are provided in Table 23[52].

[52] For these calculations, a cut off value of 15% is used.

Table 23: Out of Sample Performances of the Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Full Model
log(Interest)	√	√	√	√	√	
Legal	√	√	√	√	√	
CapitaltoAssets	√				√	
Urban	√	√	√	√	√	
Popn_Growth	√			√		
log(Age_Dependency)		√	√		√	
GNI_PPP			√	√		
Total Loss	15039	14778	15370	15591	15023	15380

Among those candidate models, Model 2 provides the best out of sample performance. The pooled OLS results of Model 2 are given in Table 24.

Table 24: Pooled OLS Results for Model 2

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code	VIF
(Intercept)	-35.228	12.899	-2.731	0.007	**	
log(Interest)	-7.636	1.666	-4.582	0.000	***	1.403
Legal	2.142	0.302	7.099	0.000	***	1.004
Urban	0.417	0.061	6.813	0.000	***	1.051
log(Age_Dependency)	10.495	3.360	3.124	0.002	**	1.373
Multiple R-squared	0.609					
Adjusted R-squared	0.598					
p-value	0.000					
Breusch-Pagan test	0.248					

For the mortgage credit to total credits ratio, it is observed that, similar to the cross sectional regression results, urbanization rate and legal rights index are positively associated. Additionally, mortgage market-related variable; representative mortgage interest rate has statistically significant effect on the share of mortgage credits within all credits. Breusch-Pagan test does not indicate a heteroscedasticity problem in this model. Therefore, heteroscedasticity consistent covariance estimate is not provided for this model. Additionally, standard R plots regarding that model are provided in Figure 25.

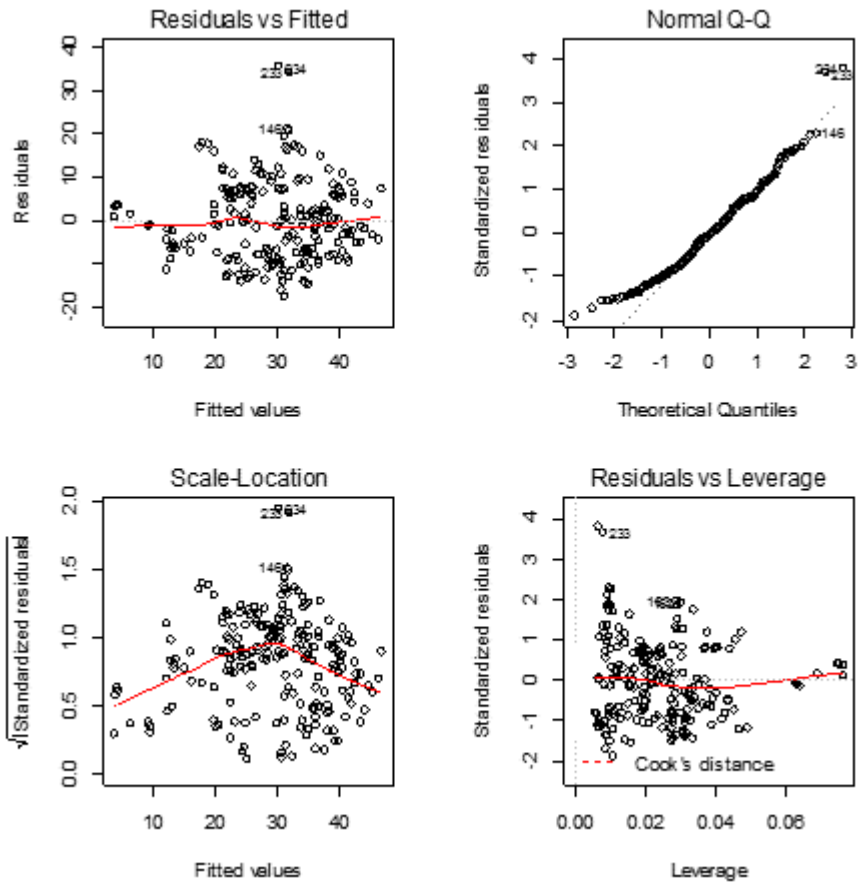


Figure 25: Standard R Plots for Model 2

Figure 26 gives the scatter plot of actual values and fitted values. This plot shows that real GDP growth rate, strength of legal rights, urbanization rate, representative interest rates and secondary market development help successfully estimate the share of residential mortgage credit to total credit ratios of various countries. On the other hand, underestimation for the developed countries (top right corner) and overestimation for the developed countries (bottom left corner) indicate that for these analysis constructing two different models for developed and developing countries might be more appropriate.

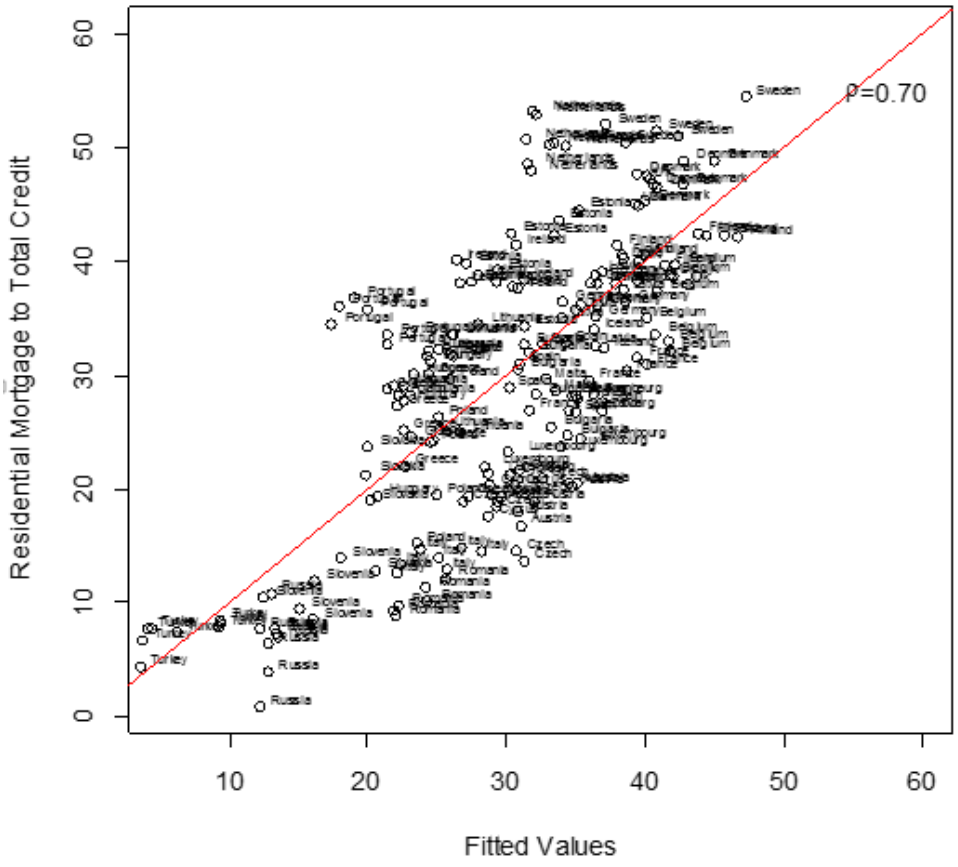


Figure 26: Actual versus Fitted Values

Adding credit information[53] separately to the model do not alter the estimation results. Analysis are provided in the Appendix C.

[53] Credit information variable is missing in two countries.

3.4.3.3 Panel Data Analysis

In this section, the data that is described in the previous section is used in the analysis. Results of the fixed effects model is provided in Table 25 [54]. Country fixed effects of the above model is given in the Appendix D (Table 65).

Table 25: Fixed Effects Regression Results –Residential Mortgage Credit to Total Credit – Full Model

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
log(Interest)	-2.014	1.552	-1.297	0.196	
R_GDP_G	-0.224	0.050	-4.502	0.000	***
log(Cons_Prices)	-3.493	2.232	-1.565	0.120	
Vol_CPI	-0.038	0.135	-0.280	0.780	
Secondary	0.022	0.031	0.736	0.463	
Premium	-0.493	0.266	-1.854	0.066	.
Legal	2.348	0.620	3.790	0.000	***
CapitaltoAssets	0.692	0.228	3.031	0.003	**
Urban	-0.592	0.387	-1.530	0.128	
GNI_PPP	0.001	0.000	3.268	0.001	**
Unemp	-0.161	0.100	-1.603	0.111	
Development	2.772	1.328	2.088	0.038	*
log(Age_Dependency)	0.037	8.456	0.004	0.997	
Pop_Growth	-0.248	0.267	-0.930	0.354	
Multiple R-squared	0.288				
Adjusted R-squared	0.225				
p-value	0.000				

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

Variable selection is done by using *bestglm()* function of R-software. Models creating high BIC values are presented in Table 26 together with the corresponding cross validation sum of squared error values[55].

[54] Reasons for choosing fixed effects model is provided in section 3.4.2.3.

[55] Cut off value of 5% is used.

Table 26: Out of Sample Model Performance of the Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Full Model
log(Interest)	√	√	√	√	√	
R_GDP_G	√	√	√	√	√	
Legal	√	√	√	√	√	
CapitaltoAssets	√	√	√	√		
GNI_PPP	√	√	√	√	√	
Development	√		√		√	
Unemp			√	√		
Total Loss	1253	1279	1282	1304	1272	1352

Model 1 gives smallest out of sample estimation error. The estimation results for that model are given in Table 27.

Table 27: Fixed Effects Regression Results for the Final Model.

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
log(Interest)	-3.102	1.101	-2.819	0.005	**
R_GDP_G	-0.169	0.045	-3.800	0.000	***
Legal	1.896	0.668	2.838	0.005	**
CapitaltoAssets	0.483	0.338	1.427	0.155	
GNI_PPP	0.001	0.000	1.941	0.054	.
Development	2.629	0.421	6.242	0.000	***
R Squared	0.239				
Adjusted R Squared	0.196				
p-value	0.000				
F-test for individual effects	0.000				
Breusch-Pagan (p-value)	0.000				
Hausman Test (p-value)	0.964				

Significance Codes: '***' 0.001, '**' 0.01, '*' 0.05, '.' 0.1

Individual country effects are given in Appendix D (Table 66). Test for individual effects indicate that this model is preferred to corresponding pooled OLS model. Serial autocorrelation and cross sectional dependence tests are not applied as the number of years in the analysis is limited (Torres-Reyna, 2012: 20, 21). Breusch-Pagan test indicates to heterocedasticity problem. Estimation results with heteroscedasticity consistent standard covariance matrix are provided in Table 28.

Table 28: Fixed Effects Regression Results for the Final Model - Heteroscedasticity Consistent Covariance.

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
log(Interest)	-3.102	0.892	-3.477	0.001	***
R_GDP_G	-0.169	0.042	-4.060	0.000	***
Legal	1.896	0.727	2.610	0.010	**
CapitaltoAssets	0.483	0.271	1.780	0.077	.
GNI_PPP	0.001	0.000	2.328	0.021	*
Development	2.629	0.915	2.875	0.005	**

Standard R plots for the residuals are provided in Figure 27. These plots do not indicate other modeling problems.

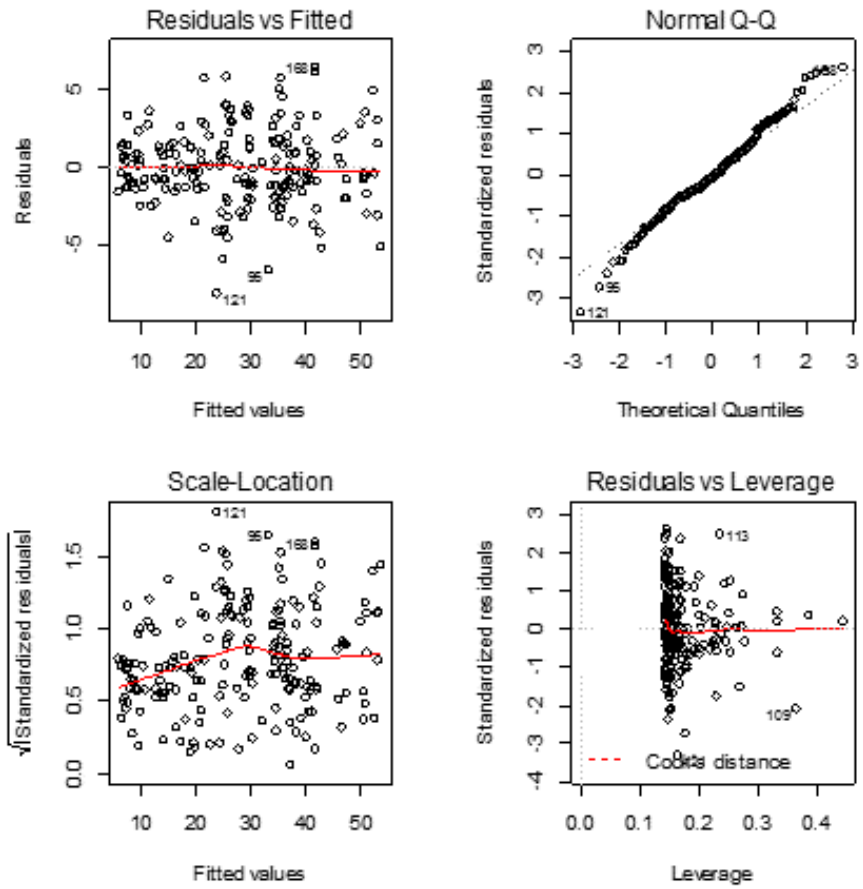


Figure 27: Standard R Plots

Finally, the Hausman test indicates that the random effects model is preferred to this model. Results for the same model that is estimated with random effects are provided in Table 29. As explained in the previous section, it is not possible to employ variable selection under random effects setting. Therefore in the following sections fixed effects model is chosen as the final model used in scenario analysis. It should also be emphasized that the parameter estimates for explanatory variables are quite close under both approaches.

Table 29: Random Effects Regression Results for the Final Model

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
(Intercept)	0.356	5.253	0.068	0.946	
log(Interest)	-3.181	0.908	-3.503	0.001	***
R_GDP_G	-0.170	0.043	-3.988	0.000	***
Legal	1.988	0.494	4.025	0.000	***
CapitaltoAssets	0.465	0.203	2.289	0.023	*
GNI_PPP	0.001	0.000	5.470	0.000	***
Development	2.483	1.215	2.044	0.042	*
R-Squared	0.299				
Adj. R-Squared	0.289				
p-value	0.000				

The fitted values and the corresponding residential mortgage debt to GDP levels are provided in Figure 28. This indicates a reasonable fit for the dependent variable.

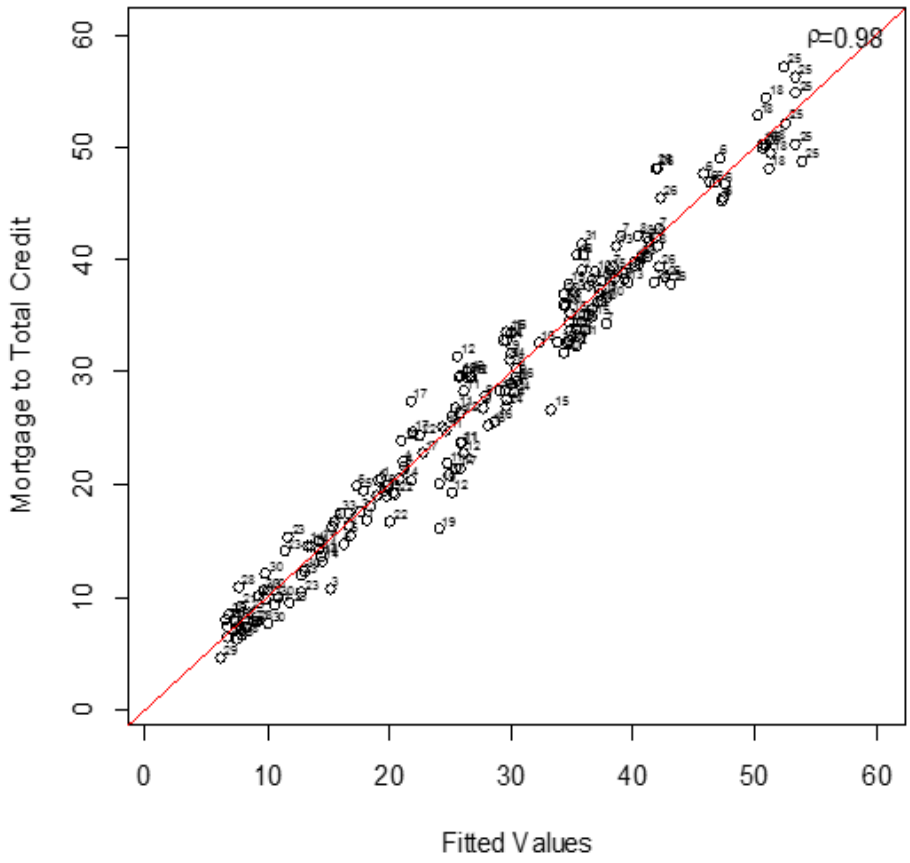


Figure 28: Mortgage to Credit Ratio and Fitted Values

To sum up, when the effect of financial sector development in countries are controlled and the ratio of mortgage credits to total credits is used as an alternative dependent variable, it is observed that the stage of development of an economy (*development dummy*), strength of legal rights, banks capital to assets ratio (*CapitaltoAssets*) and the per capita income (*GNI_PPP*) variables have positive relationship with the share of mortgage credits within total credits. Whereas, the representative interest rates are negatively associated, as expected.

Finally, the credit information index variable is added to the models separately. The results provided in Appendix C show that this variable appears in the best performing models.

3.4.4 Assessment of Model Results

In the recent years, structural reforms are taking place in the housing finance systems of many countries. For instance, 2008-2009 global financial crisis has had a huge impact on the mortgage markets of many countries and revealed the importance of macroprudential/countercyclical regulation[56]. On the other hand, in the last decade many Eastern European countries have witnessed extreme growth in their mortgage markets and recently there is a balancing process in these markets. As rightly highlighted by Badev *et al.* (2014), analyzing and diagnosing the performance is a necessary condition for reforming mortgage finance systems. However cross-country comparisons in this field were confined due to data limitations.

The quantitative analysis presented above uses a rich data set to investigate the associations with respect to the depth of mortgage markets in Europe during the period 2005–2012. To date, academic research on the quantitative analysis of the depth of mortgage markets across a broad set of countries has been limited. Analysis provided in the sections above are the most comprehensive in this field for the European region in terms of coverage of countries, historical data and empirical analyses provided. The empirical findings that are obtained from best performing models for each modeling method are summarized in Table 30 and Table 31, and discussed along the lines of existing studies. As models presented provide associations rather than causalities, drawing concrete policy conclusions is not easy. Nevertheless empirical relationships allow us to make predictions on the development of mortgage markets (Badev *et al.* (2014)).

[56] See Scanlon and Elsinga (2014) for a detailed analysis of policy changes affecting the mortgage markets of the UK and the Netherlands after the global financial crisis.

Table 30: Empirical Results of Best Performance Models for Residential Mortgage Debt to GDP Ratio

	Cross Sectional Regression	Pooled OLS Regression	Panel Data Analysis
Legal Rights Index	√	√	√
Urbanisation Rate	√	√	√
Age Dependency Ratio	√	√	√
Growth Rate	√		√
Secondary Market Development		√	
Premium over Inflation	√		
Volatility of Inflation			√
Banks Capital to Assets Ratio		√	
Average Household Size	√		
Development Dummy		√	

Table 31: Empirical Results of Best Performance Models for Mortgage Credit to Total Credit Ratio

	Cross Sectional Regression	Pooled OLS Regression	Panel Data Analysis
Representative Interest Rate		√	√
Legal Rights Index		√	√
Urbanisation Rate	√	√	
Average Household Size	√		
Age Dependency Ratio		√	
Growth Rate			√
Banks Capital to Assets Ratio			√
Gross National Income Per Capita PPP			√
Development Dummy			√

The set of variables covered in Table 30 and Table 31 narrows down the variable set given in the data section of this chapter for the researchers working on local mortgage markets. It can be seen that many variables appear in the best models for both dependent variables. To start with, it is observed that, independent of the modeling approach, strength of legal rights index, urbanization rate and age dependency ratio is significantly in all of the best performing models for mortgage debt-to-GDP ratio (Table 30). This finding is consistent with the studies of Renaud (2005), Bardhan and Edelstein (2007), Warnock and Warnock (2008), Malpezzi (2012) and Badev *et*

al. (2014). Developed economies have deeper residential mortgage markets, and that the depth of the market increases with the urbanization rate. This supports the findings of the previous researches by Renaud (2005) and Bardhan and Edelstein (2007), who concluded that a country's urbanization rate is a significant determinant of its residential mortgage debt to GDP ratio. Bardhan and Edelstein (2007) explained the link between urbanization and depth of mortgage markets from various angles such as; banking availability in urban areas, migration and higher transaction availability[57]. Additionally, as Hansen (2013) noted, due to urbanization, property prices are generally higher in major cities compared to national averages and this increases the necessity for long term funding (i.e. housing finance). Consequently, as urban populations continue to grow and urbanization accelerates, the need for a housing finance system escalates (Renaud, 1998; Chiquier *and* Lea, 2009). In line with the findings of these studies, urbanized countries have deeper residential mortgage markets, and the depth of the market increases in line with the strength of legal rights in that economy[58]. Hence, policy makers in developing countries where there are emerging mortgage markets should focus on improving the legal and regulatory framework that controls the loan origination, consumer protection and the enforcement of lenders' rights.

The best models for the mortgage credit to total credit ratio, the ratio which shows the portion of the available credit within a jurisdiction that is directed to mortgage segment, does not provide stronger results as in the case of modeling the mortgage depth. Nevertheless, strength of legal rights and urbanization rate appears in two of the three best performing model. This shows that strength of legal rights and urbanization rate not only positively associated with the depth of the mortgage markets that is measured by mortgage debt to GDP ratio, but also positively associated with financial institutions orientation towards mortgages. Additionally,

[57] Also Barajas *et al.* (2013) provides a good explanation on the link between urbanization and financial deepening.

[58] It is hard to have such an assertion for age dependency ratio as its sign changes from one approach to another.

the representative interest rate variable is significant in the pooled OLS and panel data models, indicating that an increase in the representative interest rates is associated with a decrease in the share of mortgages in banks total credit portfolios.

To sum up, strength of legal rights in mortgage lending process and urbanization rate not only positively associated with the depth of mortgage markets that is measured by mortgage debt to GDP ratio, but also positively associated with financial institutions orientation towards mortgages. Hence, policy makers in developing countries should focus on improving the legal and regulatory framework that controls the loan origination, consumer protection and the enforcement of lenders' rights in order to support the development of the mortgage market. Furthermore, planned urban development should be the focus of policy makers as urbanization process enhances access to mortgage loans.

Additional analyses for those variables that have significant amount of missing values also provided valuable results. For example, in the restricted samples, insurance assets to GDP ratio and house price index appear in the best performing models using cross sectional analysis and credit information index appears in the pooled OLS and panel data analyses.

It is also important to note that representative mortgage interest rate variable does not appear in any of the best performing models for modeling residential mortgage debt to GDP ratio. Indeed, given that mortgage lending across jurisdictions differs considerably, it is a strong assumption to assume that the representative interest rate variable carries all significant information (i.e. range of instruments, maturity structure). Additionally, this variable is considered without taking into account the deductibility of mortgage interest payments (tax relief) and maturity adjustment on interest rates.

3.4.5 Limitations of the Methodology

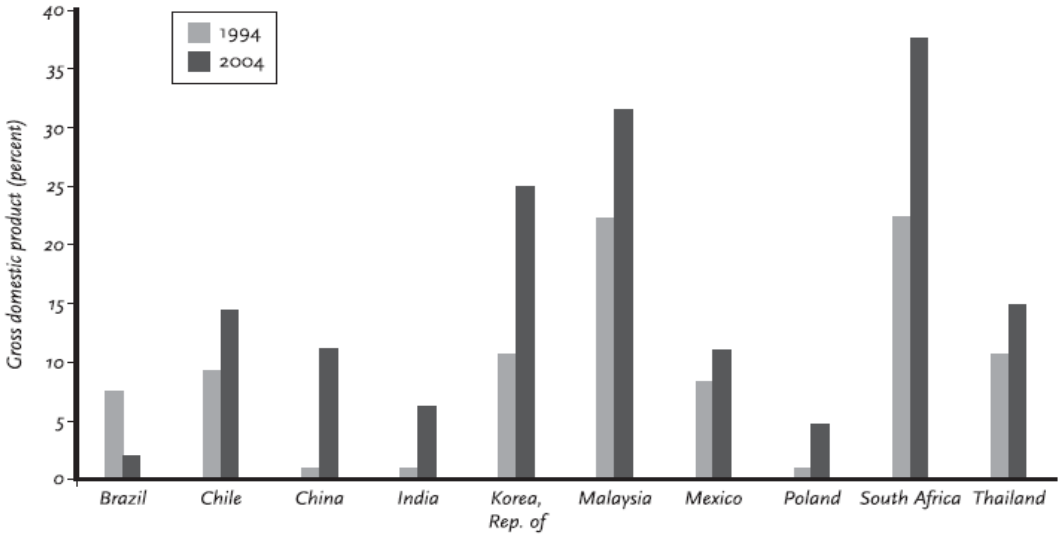
The methodology presented above might have some limitations, in the sense that cross-country regressions are often criticized for omitting important country characteristics (Djankov *et al.*, 2007, p.20). To address this, the variable selection procedure attempts to investigate the determinants of mortgage growth over the broadest possible set of explanatory variables, and thus reduces the possibility of effects from omitted variables. For further research, instead of using a development dummy, it is possible to classify the sample of countries into developed and developing subsamples, and then employ a regression analysis for each subsample separately; however, due to the limited number of data points in the cross sectional analysis, it was not possible to run the variable selection from the broad set of explanatory variables. Nonetheless, the actual versus fitted value graphs indicate that except for the graph for pooled OLS analysis for the variation in mortgage credit to total credit, all graphs indicate a good fit for both developed and developing countries. Lastly, due to the short history of data, it is not possible to make causality assessments regarding the depth of mortgage market in cross country setting for this data set.

The findings and analytical approach presented above is expected to open the way for further research with respect to the depth of mortgage markets in a cross-country setting. More concrete results could be obtained as the quality of the data for the European countries improves. As such, a further research may take the effect of tax relief into account when gathering data on mortgage interest rates. Moreover, investigating the role of savings rate, LTV ceilings, maturity structure, range of products and outright ownership rate[59] in the development of mortgage markets remains as important factors for future research.

[59] This data is available in the Hypostat 2013 but excluded from the analysis due to very high number of missing data points.

3.5 Developing Country Experiences

As discussed in the previous chapters, mortgage markets are generally underdeveloped in most of the developing countries. In only few developing countries such as Republic of Korea, South Africa, Chile and Malaysia housing finance has reached significant volumes and showed strong growth (Figure 29). The driving force behind their success stories are briefly explained in this section.



Source: Chiquier and Lea, 2009i:3

Figure 29: Mortgage Debt/GDP – Emerging Markets

3.5.1 Korean Republic

The primary mortgage market has been dominated by the government owned National Housing Fund which provides below market loans to low-to moderate income households. The secondary market was created in 1999 with the establishment of state-owned Korean Mortgage Corporation which buys mortgages and creates mortgage backed securities (Kim, 2004:329).

Korean housing market has witnessed a significant change in the previous two decades. Until 1992, the outstanding volume of housing loans did not exceed more than 10% of nominal Gross Domestic Product. However, this ratio reached 13% in 2000 and 32% in 2007 (UN-Habitat, 2009i:29-31). At the same time average maturity of the mortgage loans increased significantly.

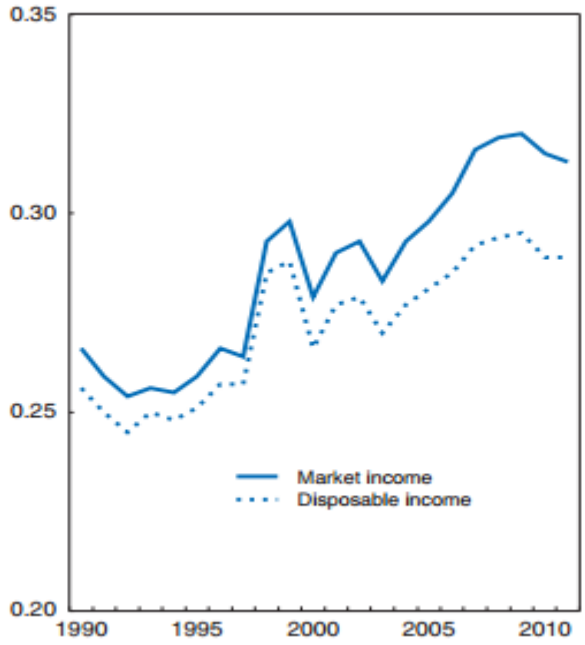
During the rapid industrialization in Korea some sectors such as housing have been given relatively lower priority. Consequently significant increases in house prices were witnessed due to low level of housing supply and urbanization (UN-Habitat, 2009i:4,6). 1988 was the milestone in Korean housing sector as the government significantly altered its housing policy in that year. Between 1989 and 1992 around two million new houses were built in order to cope with housing shortage (Kim, 2004:324).

Later on, Korean housing market was deeply affected from the financial crisis. As a result from 1997 to 1998 the real and nominal national housing indexes fell by 18.5 percent and 12.4 percent, respectively (UN-Habitat, 2009i:12).

To serve the low and middle income families the Korea Housing Finance Corporation (KHFC) launched in 2004 with the mission of promoting the stable and long-run supply of housing finance[60]. Chan *et al.* (2006) highlighted that KHFC has contributed to the lengthening of mortgage products via introducing 30 year fixed rate mortgages[61]. It is interesting to note that income inequality was increasing in Korea while the mortgage market was experiencing a significant growth between 2000 and 2007 (Figure 30).

[60] http://www.hf.go.kr/hfp/eng/about/corp.jsp

[61] According to Chan *et al.* (2006), when KHFC founded only 25% of housing loans had maturities greater than 10-year. This ratio has doubled in less than one year after the establishment of the KHFC.



Source: OECD Economic Surveys Korea – 2012

Figure 30: Income Inequality in Korean Republic

During the development of the market, Korean governments not only worked for the expansion of the market but also intervened aggressively to stabilize house prices[62] (Kim, 2004:338). For instance in order to control the boom in the housing market Korean government introduced several measures between 2003 and 2007,

> Direct measures included, price ceilings on pre-sales, impact fees, disclosure of construction costs, cost adjusted pricing for pre-sales, registration of housing transactions and their prices, land transaction permission and increased taxes. Indirect measures included, controls on mortgage credit, mortgage rates, and Loan to-Value (LTV) ratios. To increase supply, policymakers also proposed relocating public agencies and announced a nationwide plan to build so-called 'innovation cities'. (UN-Habitat, 2009i: 18)

[62] Beltratti and Morana (2008) indicate that house price shocks create larger effects on the macro-economy than stock market shocks.

Most recent statistics about Korean mortgage market indicate that a significant portion of outstanding mortgage loans are adjustable rate (more than 90 percent). Moreover, high home price to income ratios and the continuing deposit-based funding has been indicated as obstacles to the growth of fixed rate mortgage offerings[63]. Strong loan growth in Korea led the housing agencies to be severely involved in housing finance market and hence required these agencies to focus more on risks associated with the housing loans. In Korea, housing agencies have government guarantee and the government has to cover the losses in access of KHFCs capacity (Chan *et al.* (2006)).

Korean Financial Services Authority has the responsibility of supervising the housing finance sector. Chang (2010:2) argue that Korea pursued a countercyclical macro-prudential approach to prevent the overheating of mortgage lending and to minimize the risk of loan default. These developments present important findings for the countries having fast growth in their mortgage markets.

3.5.2 Malaysia

Many countries in Asia established housing finance agencies that are directly supported by the government in order to support the development of domestic housing finance markets and related secondary markets[64]. In counties such as Japan, India, Hong Kong, Korea and Malaysia governmental housing agencies played a constructive role in the establishment of residential mortgage bond market by removing barriers to securitization, providing liquidity and systematic issuances of MBSs (Chan *et al.* (2006)).

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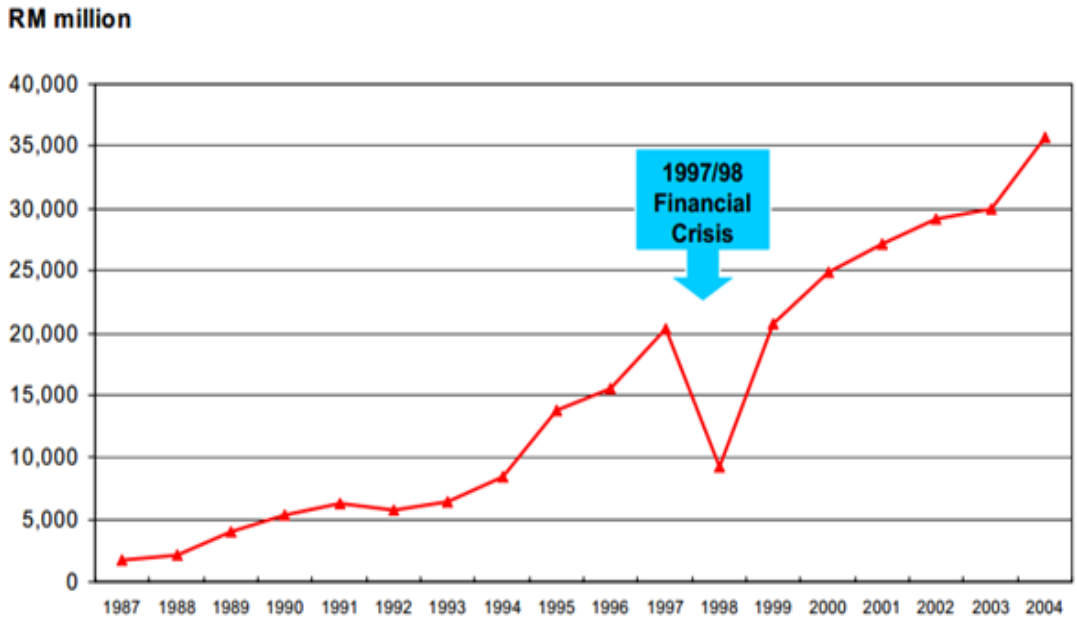
[63] Retrieved from http://www.hofinet.org/countries/description.aspx?regionID=2&id=88 on 9 September 2013.

[64] See Chan *et al.* (2006) for a more detailed discussion about Japan, India, Hong Kong, Korea and Malaysia.

Malaysian government has started promoting house ownership after 1970s. Amount of funds for the housing finance purposes increased from around 10 billion Malaysian Ringgit in 1982 to 30 billion in 1991 and 180 billion in 2004 (Kokularupan, 2005: 7). Malaysia was one of the earliest countries establishing a secondary mortgage market. Following the liquidity problems experienced in 80s, Cagamas, a special purpose vehicle, was set up in 1987 where Malaysian Central Bank had 20% share and the financial institutions has 80% share. The aim of Camagas has been providing liquidity for mortgage originators by narrowing the gap between the maturity structure of the housing loans and the source of funds (Kokularupan, 2005: 16), reducing market risk, supporting homeownership and financing building sector (Vural, 2009:127).

Camagas works as the intermediary in the market. The company buys loans from financial institutions and issues securities that are backed by these loans. Investors are not directly exposed to the underlying risks of the loans and debts since purchases are on with recourse basis (Kokularupan, 2005: 30).

Figure 31 shows the amount of approved housing loans in Malaysia per year. This shows the importance of government support and establishment of secondary market for the development of a mortgage market.



Source: Kokularupan, 2005:19

Figure 31: Approved Housing Loans in Malaysia

Today two types of mortgage loans are offered by financial institutions in Malaysia, conventional and Islamic, and conventional loans account for nearly 90% of mortgages. Moreover, the most widely used product is plain-vanilla mortgages and housing loans have an average repayment period ranging from 20 to 35 years (Endut and Hua, 2009: 110).

Fast growth in the mortgage market also creates some side effects and vulnerabilities for economies. Endut and Hua (2009:112) indicate that parallel to mortgage market development, household debt to GDP ratio increased from 47% in 2000 to 67% in 2007. Authors urged the policymakers that increased household indebtedness could have important macroeconomic consequences especially when the debt is mostly floating rate.

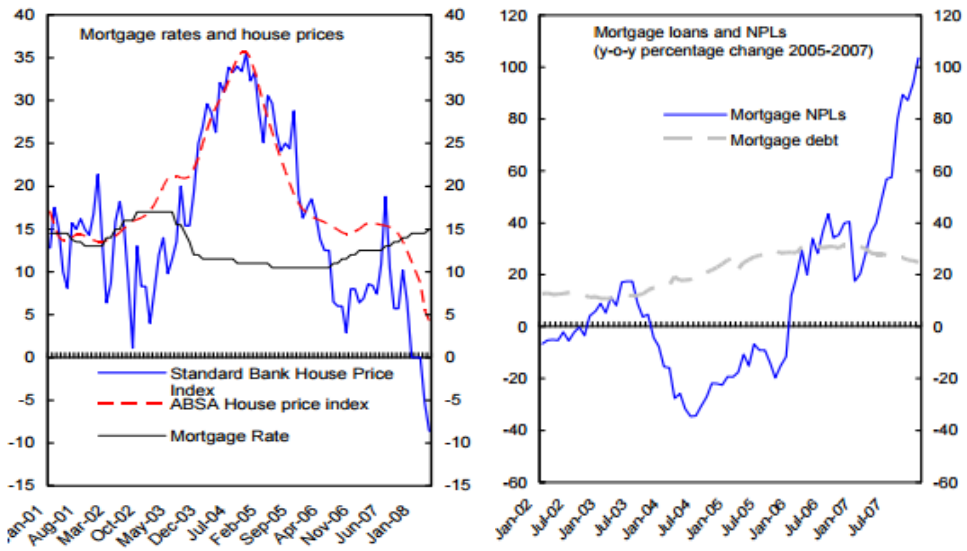
3.5.3 South Africa

South Africa has witnessed a fast urbanization and population growth during the last two decades. Therefore, need for housing and housing backlog has increased substantially (Karley, 2003).

Housing policy of South Africa has focused on affordability since 1994, in which year the government initiated a housing subsidy program called Reconstruction and Development Program for low income households. Until 2011, that program created around three million housing units (CAHF, 2011: 93). The program mainly focused on three pillars; National Housing Subsidy Scheme, stabilizing housing environment and mobilizing housing finance (Rust, 2006:7).

Additionally, in 2004 "Comprehensive Plan for the Development of Sustainable Human Settlements" was initiated. Some of the major objectives of the program were supporting residential property market, adjusting institutional arrangements and creating jobs and housing (Rust, 2006:10).

Access to financial services was dramatically improved with the signing of Financial Sector Charter (FSC) in 2003 under which the financial sector has committed to extend US$5 billion to low income earners (CAHF, 2011: 123-124).



Source: IMF (2008)

Figure 32: Mortgage Rates, House Prices and Nonperforming Mortgage Loans

Fast growth in the South Africa mortgage market also creates some risks. After 2006, there has been a significant decrease in the house prices that is accompanied with increased mortgage non-performing loans (Figure 32).

3.5.4 Chile

Chile mortgage market is mainly dominated by banks. As of 2007, banks extended 85% of all mortgage credit where the largest lender was the state owned bank, Banco Estado. Moreover 80% of all mortgage loans were fixed rate mortgages[65]. Growth in mortgage debt to GDP level continued during the past decade and reached 18.5% as of 2008 and 20% as of 2013 (IMF, 2013:24).

Chile was one of the first countries to initiate reforms that subsidizes the demand for low and middle income households (one time cash-payment of a fixed amount) to buy housing and that model affected housing policy in many countries (Navarro,

[65] Retrieved from http://www.housing-finance-network.org/index.php?id=351 on 9 September 2013.

2005). The following excerpt from the UN-HABITAT report clearly shows the housing policy of Chile.

> During the sixteen years from 1990 to 2005, the Chilean government directly subsidized the purchase of 1.2 million new housing units -roughly a quarter of the new dwellings built during this period- benefiting mainly families of the lower end of the income scale. (UN-HABITAT, 2009ii:1)

In order to help families with limited access to the mortgage finance, Chilean governments have launched various support programmes. These programmes included credit enhancements to the lenders (i.e. implicit guarantee for the mortgage loan to be sold in the secondary market at 100% of its face value and default insurance) and subsidies for the borrowers. However, in the last decade the amount of such subsidies have decreased (Navarro, 2005).

Garcia (2008) noted that since 1999 household debt has been increasing in Chile faster than disposable income. As a result, household debt to disposable income ratio reached around 60%.

3.5.5 Lessons from Developing Country Experiences

Studying country examples indicate that some specific characteristics of these countries have created the difference. For instance, in Malaysia a well-established secondary market come to the forefront in boosting the development of the primary market. In countries like Chile and South Africa, social subsidy programmes have been the engine of the mortgage market growth and in Korea a strong urbanization trend characterizes that development.

Emerging country experiences indicate the critical role of government intervention not only for the development but also for the stabilization of the market. These examples show that government intervention is needed for the establishment and functioning of secondary market.

Moreover, not only the growth in residential mortgage market but also closely monitoring the household indebtedness is important. Therefore, while supporting the development of the market, national supervisors need to closely monitor the trends in non-performing loans and household debt levels.

Additionally, while supporting the growth of mortgage market is important for developing countries, it is not sufficient to create positive externalities such as reducing income inequality. For instance, the Korean case is a good example of a simultaneous rise in mortgage market depth and inequality.

3.6 Recent Socioeconomic Developments in Turkey and the Potential of the Mortgage Market

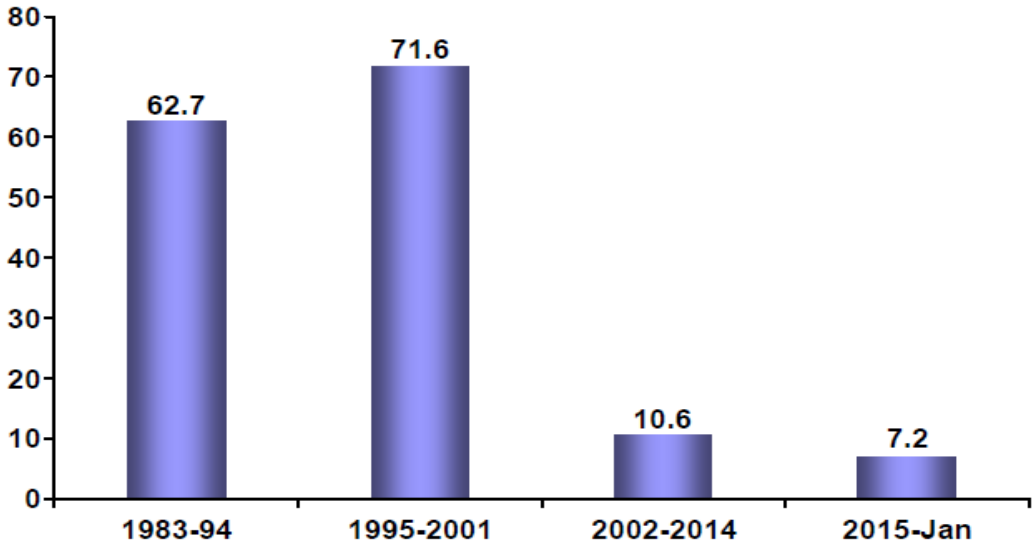
In this section, recent socioeconomic developments in Turkey is discussed. Afterwards, the potential of the Turkish mortgage market is investigated by using scenario analysis.

3.6.1 Recent Socioeconomic Developments in Turkey

Turkey has a dynamic economy which is the 18th largest in the world and the 6th largest in the Europe[66] as of 2014. As a result significant changes in the rules and systems are being encountered that are directly affecting the lives of the Turkish people and financial services industry is one of the sectors leading this change. Contrary to size of the economy, the mortgage market is newly growing. There have been several reasons behind that lag such as; unstable macroeconomic conditions, frequent crisis, domination of national bond market by government bonds, underdeveloped and corrupted banking system and the insufficient regulatory infrastructure until 2000s.

[66] http://www.worldbank.org/en/country/turkey/overview

After the economic crisis of 2000-2001 in Turkey, important structural reforms were initiated including, fiscal policy reform, updating the mandate of the Central Bank of Republic of Turkey by supporting its independence and specifically targeting price stability, a significant banking reform where the operations of public banks were restructured, removal of duty losses from balance sheets and recapitalization of banks. There has been a noteworthy improvement in the macroeconomic indicators of Turkey in the last decade after these reforms. This period resembles 80's of the US economy (i.e. low and downward trending interest rates, expectations of future price increases and rise in households incomes) which was followed by a boom in the mortgage market.



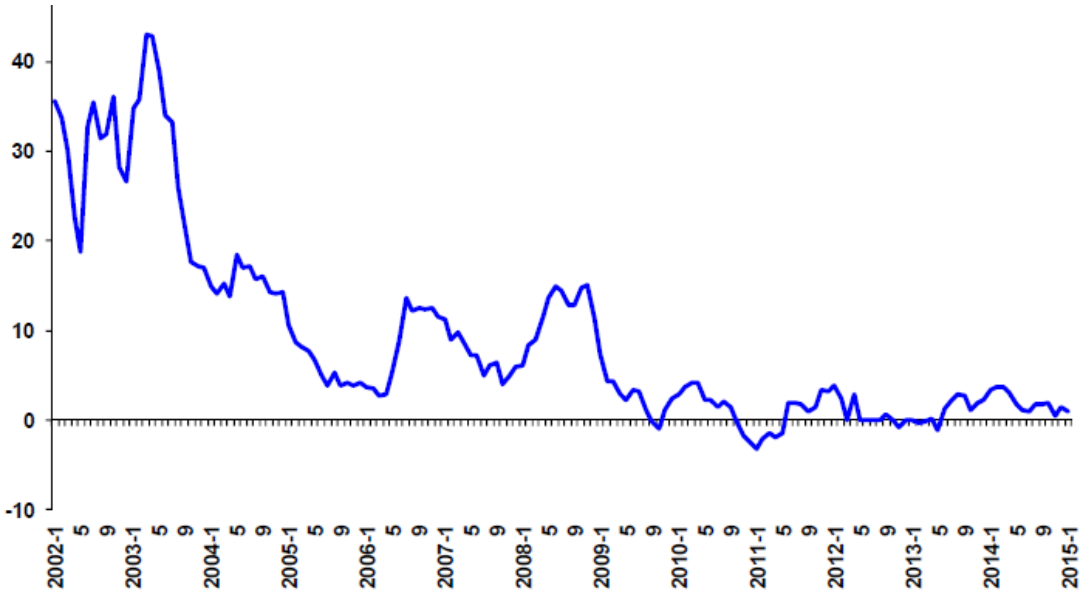
Source: Undersecratariat of Treasury[67]

Figure 33: Average Annual Inflation Rates (%)

Figure 33 shows average inflation rates in Turkey in the past 30 years. There has been a substantial reduction in average inflation rate after 2002, which contributes

[67] Retrieved from https://hazine.gov.tr/File/?path=ROOT%2fDocuments%2fGeneral+Content%2fEkonomi_Sunumu_ENG.pdf on 4 March 2015.

considerably the macroeconomic stability in Turkey. Moreover, according to Figure 34, the real interest rates of zero coupon treasury auctions decreased from the levels of 35% in 2002 to around one percent in 2012.

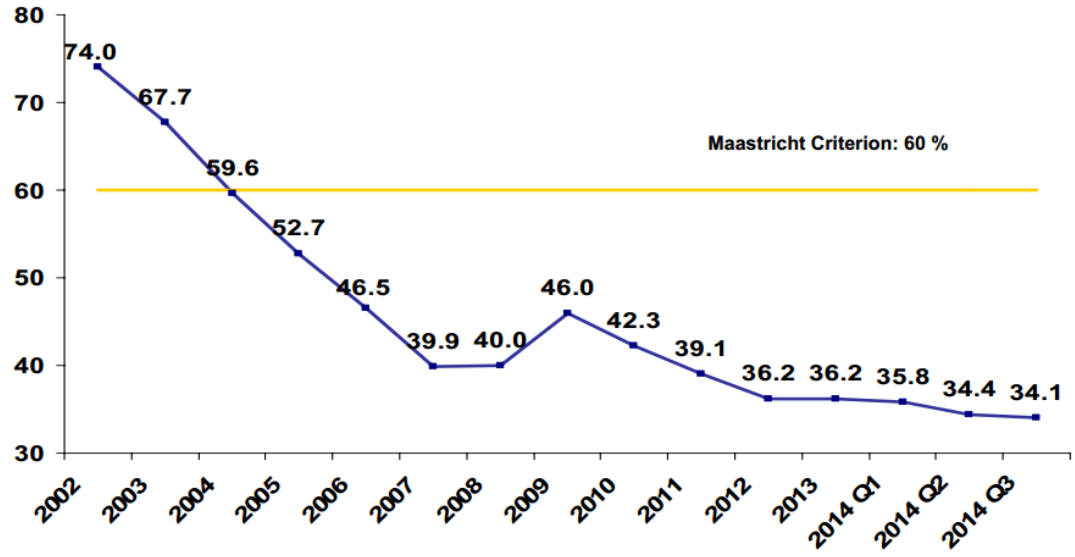


Source: Undersecratariat of Treasury[68]

Figure 34: Real Interest Rates of Zero Coupon Treasury Auctions

The public sector gross debt/GDP ratio for Turkey (Figure 35) shows that the borrowing requirement of Turkish Treasury has decreased substantially in recent years which also creates space for private firms and credit institutions in the capital markets. In this period banks have also altered their strategies from funding government borrowing to funding firms and consumers.

[68] Retrieved from https://hazine.gov.tr/File/?path=ROOT%2fDocuments%2fGeneral+Content%2fEkonomi_Sunumu_ENG.pdf on 4 March 2015.

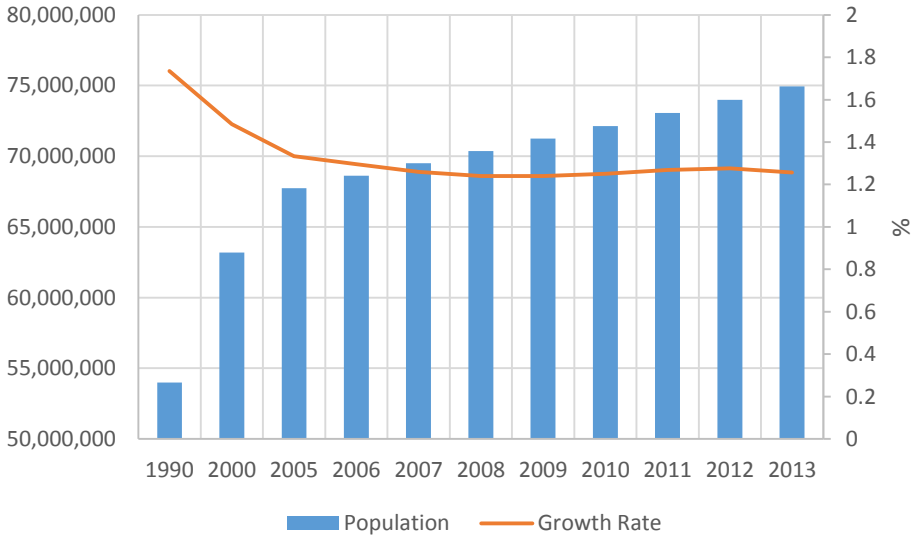


Source: Undersecretariat of Treasury[69]

Figure 35: Public Sector Gross Debt Stock/GDP

In addition to major changes the economy, Turkey has also experienced significant changes in its demographics. Turkish population has significantly increased in the last two decades. Total population which was less than 55 million in 1990 reached around 75 million by 2013. Additionally, population growth rate has dramatically decreased from 1.6% levels in 1990s to around 1.2% level.

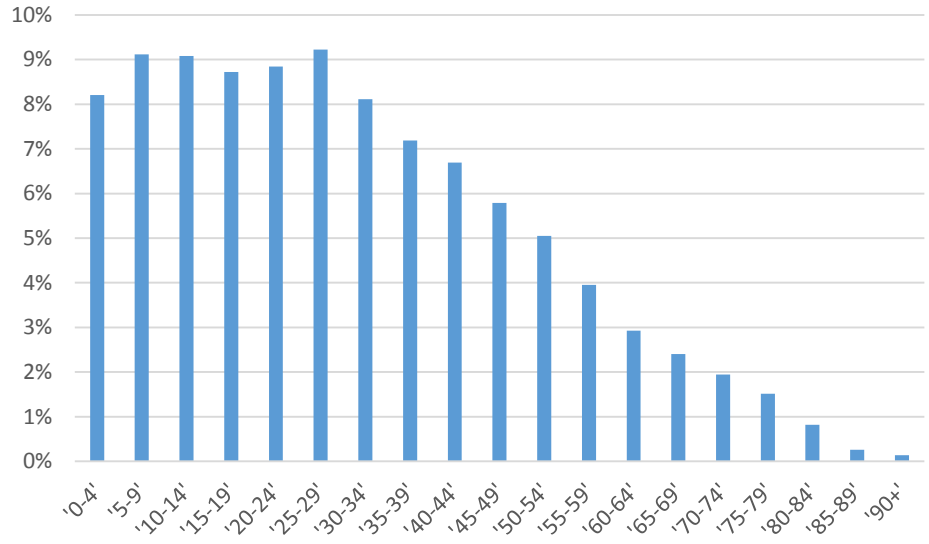
[69] Retrieved from https://hazine.gov.tr/File/?path=ROOT%2fDocuments%2fGeneral+Content%2f Ekonomi_Sunumu_ENG.pdf on 4 March 2015.



Data Source: Worldbank

Figure 36: Population Dynamics

Turkey has a young population. According to Figure 37, under 20 years old group constitute around 35% of the population and under 30 years old groups constitutes around 53% of the population. These population dynamics indicate the potential need for housing in Turkey. In addition to this, average household size, is highest in Turkey when compared to the European countries and this is also another indicator of future housing demand in Turkey.

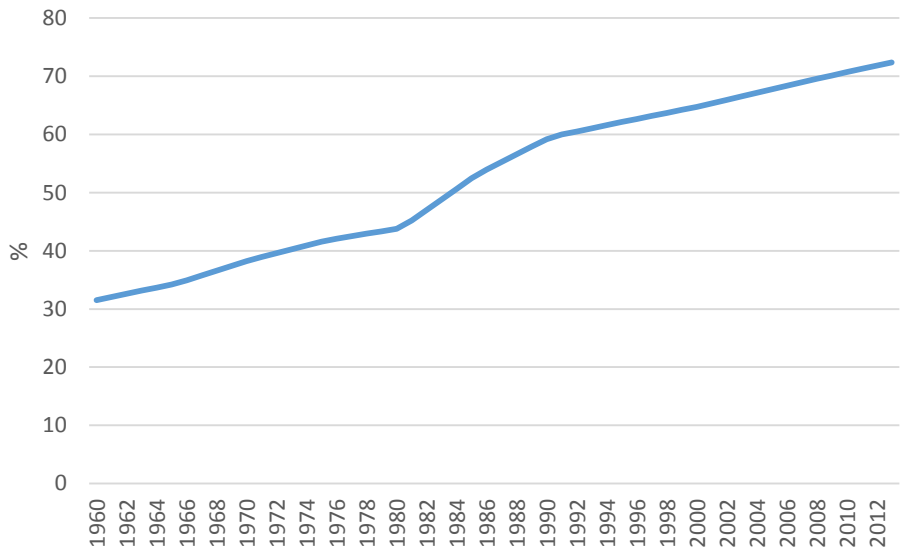


Data Source: Turkstat (2007)

Figure 37: Age Distribution of the Population

Figure 38 provides the historical development of urbanization rate in Turkey. In 1960s, around 70% of the population in Turkey was living in rural areas. Between 1960 and 1980 urbanization rate increased steadily. After 1980s, the pace of urbanization increased considerably, and by 1990 urbanization rate reached 60%. The major reason behind this development was allowing people to construct slums (*gecekondu*)[70] in cities on the land that belong to Turkish Treasury. After 1990s, although the speed of urbanization slowed down, it still continued and urbanization rate reached 72% as of 2013.

[70] *Gecekondu* can be simply defined as unauthorized housing units without the required permits. The fast urbanization process after 1980s fueled the boom of *gecekondu* in Turkey. Elliott (2010) further highlighted the 1984 general pardon for unauthorized constructions which provided legal title to *gecekondus* as an important factor in this process.



Data Source: Worldbank

Figure 38: Historical Development of Urbanization Rate

Table 32 illustrates the income distribution problem in Turkey. In urban areas, while lowest 20% of the population has a share of 6.4% of the total income, the highest 20% has a share of 46.4%. On the other hand in rural areas this divergence is a little bit lower. In recent years, Gini coefficient has shown some improvement and the latest figure is 39.2% in urban and 36.5% in rural areas.

Table 32: Income Distribution in Turkey -2013

Percentile	*Urban*	*Rural*
20th	6.4	6.7
40th	10.9	11.4
60th	15.2	16.1
80th	21.1	22.6
100th	46.4	43.3
Gini Coefficient	0.392	0.365
20/80 percentiles	7.2	6.5

Data Source: Turkstat

In contrast to these macroeconomic developments poverty is still an important issue for Turkey. According to Turkstat statistics when poverty line is defined as 4.3 dollars, around two percent of the population lives under the poverty line[71]. Whereas, according to OECD calculations poverty rate in Turkey is at 19% as of 2012[72].

Housing policy in Turkey can be analyzed under three main periods[73]. In the 1923-1950 period in order to reduce the impact of global depression, housing policy focused on rent control. The second period, namely 1950-1980 period, is characterized by the boom of slums and unsuccessful policies aiming to prevent this development. After 1980, there has been structural developments initially focusing on the role of government through Social Housing Fund (Toplu Konut Fonu) and later the establishment of the mortgage market in which private institutions play the major role following regulatory and infrastructural reforms (Vural, 2009:131-133).

In Turkey, housing finance had been mainly provided by governmental organizations until 1990s. Established in 1926, Emlak & Eytam Bank[74] was the first financial institution that was focusing on housing needs of individuals. SSK in 1950s, OYAK in early 1960s and BAGKUR in late 1980s were the governmental organizations providing housing credit for individuals (Kocameşe, 2009:43). After 1961 all constitutions in Turkey included specific provisions regarding the government's role in warranting housing for citizens. According to current constitution, the state should take measures to meet the need for housing within the framework of a plan that takes into account the characteristics of cities and environmental conditions, and also support community housing projects (Article 57). In 1981, "Toplu Konut İdaresi" (TOKİ) was set up which financed around one-million housing units between 1984 and 1994 (Vural, 2009:133). Private banks started extending housing credit in 70s

[71] http://www.tuik.gov.tr/PreHaberBultenleri.do?id=16204

[72] The same indicator is at 8% for Germany and 15.1% for Spain.

[73] In addition to the information in this section, Elliott (2010) provides a comprehensive overview of the history of housing policy in Turkey.

[74] The name of that bank later changed to Türkiye Emlak Bankası.

and following liberalisation of the economy, the weight of private banks in the housing finance sector gradually increased and the share of TOKİ and government banks contracted.

The Mass Housing Law (Nr. 2985) was approved by the parliament in 1984. The requirements for constructers to meet the housing demand in Turkey and provisions regarding the support of the government is determined according to this Law. This Law also covers provisions about the TOKİ. As a result, TOKİ is positioned as an institutions to support social housing (including disaster housing) and supporting environmental and urban development of Turkey. In addition, with Law Nr. 5162 dated 2004, TOKİ was empowered with relevant powers to prepare and update zoning plans and condemnation for slum transformation projects.

TOKİ estimates that it currently meets around 5-10% of the housing needs of Turkey. TOKİ further notes that 85% of the projects are for social housing whereas 15% is in the form of revenue sharing. In the social housing projects, customers need to make a certain amount of down-payment and the remaining balance needs to be paid according to a repayment plan where installments increase in line with public sector wage index which is announced by the Ministry of Finance. Maturities range between 10-20 years. TOKİ indicated in its website that the current demand for its social housing properties remotely exceed demand[75].

Today, TOKİ has several subsidiaries including Emlak Konut Real Estate Investment Trust (Emlak GYO), TOBAŞ and GEDAŞ. In recent years, TOKİ's investment in projects targeting high income groups have been criticized. For instance, Sönmez (2011) argued that top 25 projects that has been recently initiated by TOKİ makes the agency a rent-distributing agent for high-income social groups[76]. Moreover, from a socioeconomic perspective, many studies in the literature

[75] A much detailed information about the mission and projects of TOKİ, see http://www.toki.gov.tr/en/housing-programs.html.

[76] Related article can be reached at http://www.reflectionsturkey.com/?p=489

criticized TOKİ because of urban renewal projects which impact the resident's social lives[77]. Additionally, the transparency of the institution and esthetic of the projects built by the agency were the other main criticisms pointed to the TOKİ.

In recent years, we have also witnessed municipality housing companies taking active role in the major projects including urban renewal projects. Some major companies of such type are KİPTAŞ and Istanbul Konut in Istanbul.

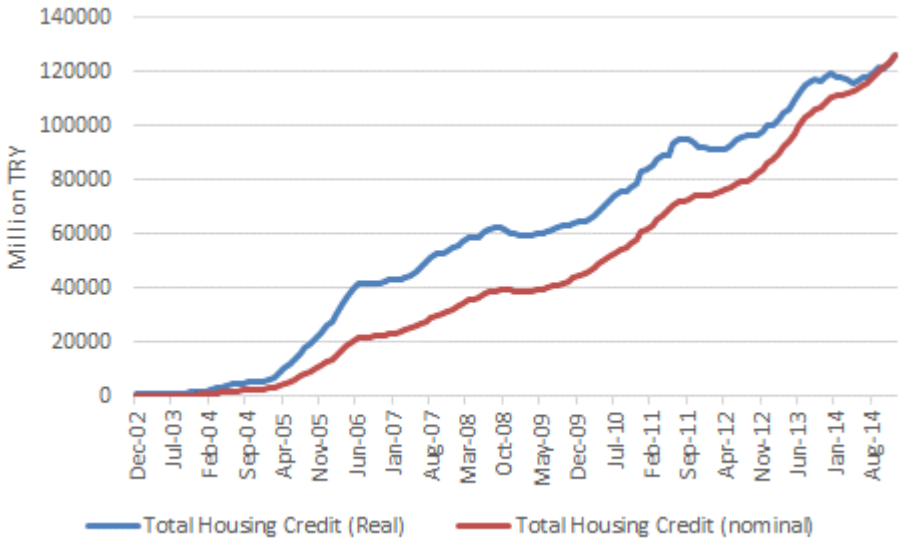
Due to rapid urbanization in Turkey housing demand is also increasing in the urban areas. However, housing finance and housing production is lagging behind the need (GYODER, 2008). Karakaş and Özsan (2005:37) argued that Turkey's long-lasting housing related problems were lack of building and occupancy permits, deficiencies in urban planning and affordability. The authors also pointed to the earthquake risk[78] in Turkey and argued that around 40% of the urban housing stock needs structural strengthening[79]. In 1999, two major earthquakes around İzmit and Düzce region caused around 20 thousand deaths and 300 thousand buildings to be destroyed. They also noted that the homeownership rate seems to be satisfying. Nevertheless, illegal squatter housing, summer homes and dwellings without permits constitutes more than 50% of home owners. Elliott (2010) estimates around 10 million people are living in informal settlements widely known as -gecekondu- in Turkey. In addition to this, Kocameşe (2009) highlighted illegal and poor quality buildings as another main problem related to Turkish real estate sector. Lastly, Elliott (2010) estimated that around 650-700 thousand new homes has to be built in Turkey in order to meet the housing needs created by urbanization, population growth and replacement requirements.

[77] See Candan (2008) and Demirli (2011).

[78] Erdik (2002) indicated that in the last century earthquakes in Turkey led to around 110 thousand deaths and around 600 thousand destroyed housing units.

[79] Among 19 million buildings in Turkey, Turkstat estimates that around 40% is shanty and 67% lacks settlement permit.

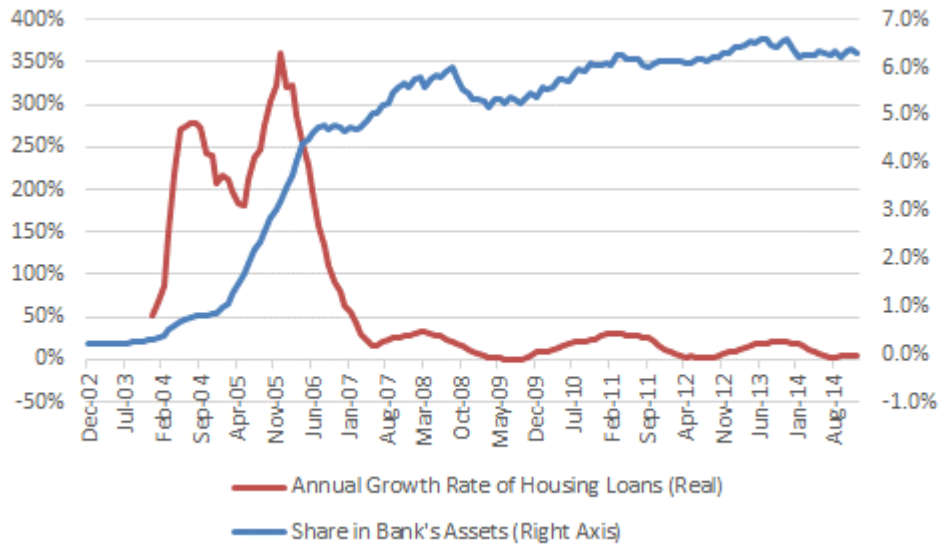
Models in Section 3.4 show factors such as strength of legal rights, household size, secondary market development, and urbanization rate are strongly associated with of the level of development of a mortgage market. In Turkey, there has been progress related to some of these factors and in parallel Turkish housing credit market has shown a mild growth compared to its size in early 2000.



Data Source: BRSA, Turkstat

Figure 39: Housing Credits Extended by Banks

Although housing finance was intermediated mostly by governmental agencies until 1990s, today most of the banks are offering mortgage products in Turkey. Figure 39 shows the real and nominal development of the amount of housing credits extended by banks in Turkey after 2002. According to this figure, there has been a considerable growth in the amount of loans extended with the housing finance purpose following the macroeconomic stability and reduction in interest rates (from 2 billion TRY in 2005 to 130 billion TRY in 2015). Nonetheless, Turkish mortgage market is still under-penetrated and has significant growth potential (Deloitte, 2009:148).



Data Source: BRSA, Online Monthly Bulletin

Figure 40: Growth in Housing Credits

The share of housing credits compared to total banking assets have also increased substantially, from around 0.5% in 2004 to 6% in 2010 (Figure 7). Moreover, one year change of real housing loans decreased from 350% level in 2005 to around 10-30% level in 2011. This shows that the growth of the market has slowed down after a fast growth between 2004 and 2007.

The insurance side, on the other hand, has not shown much progress in the past. In Turkey, Turkish Catastrophic Insurance Pool was established after the 1999 earthquake and it is mandatory for all buildings. However, mortgage insurance is not a developed market in Turkey and public data could not be found on the size of the market[80].

The regulatory structure is an important pillar for the effective functioning and growth of housing finance sector. In recent years there have been also significant

[80] There are two main types of insurance products related to mortgages; insurance products for lenders and insurance products for borrowers. Mortgage insurance products include life insurance policies, title insurance, mortgage credit protection insurance, etc. See Önal (2010) for a comprehensive discussion on mortgage products and the development of this market in Turkey.

developments in the regulatory framework which could significantly affect the development of mortgage market.

Following the stabilization in the economy, Turkish authorities focused on establishing a well-functioning mortgage market. As a result in March 2007 "The Law Amending the Laws Related to Housing Finance System Nr. 5582" (HFS Law) was enacted with the purpose of establishing the secondary market in Turkey by giving primary responsibility to Capital Markets Board (CMB)[81].

With HFS law, both covered debt instruments and securitisation tools were introduced to Turkish capital markets. In this law, housing finance is defined as extension of loans to consumers to acquire houses; leasing of houses to the consumers through financial leasing; and extension of loans to consumers where such loans are secured by the houses that the consumer owns. In Turkey, housing finance can be provided by the housing finance institutions; banks, leasing companies and consumer finance companies. However, the size of other entities except for banks is extremely small when compared to the banks.

HFS Law included important articles that support the development of the system. For instance, with this Law, borrowers are allowed to choose between fix and variable interest rates, some tax exemptions are introduced (such as banking and insurance transactions tax and stamp duty), transaction costs were lowered (by abolishing "financial activity fee") and time needed to foreclose mortgages is shortened[82]. Moreover, certain rules were introduced to inform lenders about mortgages. To illustrate, for fixed interest mortgage loans, a 2% prepayment fee of the remaining debt is initiated while there is no fee for variable interest mortgages.

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[81] The mentioned law made amendments in several laws such as Capital Markets Law, Law of Foreclosure, Consumer Protection Law, Financial Leasing Law, Mass Housing Law and Tax Laws. Moreover, two by-laws were enacted for covered debt instruments (covered bonds) and securitization tools (asset backed and mortgage backed securities).

[82] This section derives heavily on a presentation of the CMB which is available at http://www.gyoder.org.tr/zirve7/Z7sunum/Ibrahim.Donmez.Konut.Finansmani.Kanunu.pdf?AspxAutoDetectCookieSupport=1

Furthermore, with this law housing finance institutions are required to inform the lenders about the risks of using variable rate mortgages. Additionally, a housing appraisal system is introduced which is required in the mortgage lending, in the process of foreclosure of the receivables arising from housing finance and in inclusion of receivables into portfolios of mortgage securities.

In addition, legal infrastructure in Turkey is strengthened with the Capital Markets Law Nr. 6362 that was published in Official Gazette in 30 December 2012. With this Law the definition of housing finance is widened by including the secondary market operations, authority of the Capital Markets Board regarding the secondary market (including both securitization and covered bonds) is strengthened, flexibility is given to the mortgage finance companies in their secondary market operations and lease certificate companies is introduced.

Consumer Protection Act Nr. 6502 dated 7 October 2013, introduced additional rules for prepayment penalties. Specifically, it is stated that a consumer can make one or more early payments or prepay the mortgage in full. In case of early payments and full prepayments financial institutions has to make all necessary discounts on interest payments and other costs accordingly. In case of at least one early payments, the financial institution can request a prepayment penalty only if this is clearly indicated in the mortgage agreement and this penalty is limited to less than 1 percent of the early payment amount if the remaining maturity is less than 36 months and to 2% if the remaining maturity is more than 36 months.

One other important aspect of the Consumer Protection Act for the mortgage market is due to its approach to the mortgages extended to the projects that are done within the context of an agreement between the bank and the constructors. According to the article 35 of the mentioned Act, such credit is called connected credit and both the mortgage financing company (i.e. the bank) and the constructor is jointly responsible for compensating losses if there were problems regarding the delivery of the production or there were defective production. The Act states that the responsibility of the bank continues for three more years after the delivery of the project.

Some other recent regulatory actions that could affect the housing finance market in Turkey are; BRSA's decision to allow banks to issue bonds in domestic market up to a certain limit and introduction of 75% Loan to Value (LTV) ratio for residential housing finance loans. Additionally, the private bond market which was working on a small scale in 1980s came to a halt as a result of the crowding out effect of the borrowing requirement of the Treasury in 1990s and 2000s. However, in recent years the market has been reactivated by the issuances of some development and investment banks and mortgage finance companies. In September 2010 Banking Regulation and Supervision Board of Turkey allowed deposit banks to issue bonds according to a list of principles and procedures. In order to issue bonds in the internal market, a bank should have 12% capital adequacy ratio and the total amount of issuance of a bank shall not exceed the limit determined by the BRSA where bank's saving deposits, level of capital adequacy ratio, own funds and their share in the financial sector are important determinants.

Finally, Turkish government has recently announced a housing subsidy programme which is published in the Act Nr: 6637 dated 27 March 2015. The Act stated that the government shall make a direct subsidy that is the lower of 15 thousand Turkish Lira and 20% of the accumulated amount in the bank account, for persons without a house, conditional on opening a bank account that is active for three years and applying the banks after purchasing a house. It is indicated in the Law that the technical details of the implementation of this article will be determined by the Board of Ministers.

3.6.2 Potential of the Turkish Mortgage Market

Turkish Bankers Association (TBB, 2012:5) pointed to population growth, decreasing mortgage interest rates, increasing household assets and developments in legal infrastructure as the main factors affecting the growth of mortgage credit balance in Turkey. TBB (2012:9) estimates mortgage debt to GDP ratio to reach 16% by 2020.

In order to provide a crude estimate on the potential of Turkish mortgage market, three scenarios are established and the results are presented in Table 33. It should be noted that periods of 7-10 years are required in order to measure the effects of mortgage reforms (Renaud, 2005:27). Therefore, scenarios presented in Table 33 are assumed to be the situation after about 10 years.

In this section, analysis presented below can be considered as what-if analysis. In this context Scenario 1 is designed as the most plausible scenario, Scenario 2 is designed as the best-case scenario and Scenario 3 is designed as the worst-case scenario.

Table 33: Scenario Analysis for Turkey

	Current	Scenario 1	Scenario 2	Scenario 3
Development	0	0	1	0
Growth_Rate	2.24	5	3	6
Legal	4	6	8	4
Urban	72.33	80	85	72.33
Secondary	0	5	10	0
Age Dependency	10.80	11.80	11.80	11.80
Capital to Assets	12.00	12.00	11.00	13.00
Volatility of CPI	1.76	1.76	1.76	1.76
Expected RMD_GDP				
-Panel	10.19	33.50	50.39	11.87
-Pooled	11.03	22.40	60.81	7.49
Current RMD_GDP	6.1			

Panel data and pooled OLS results presented in the previous sections are used for the estimation in order to show that different modeling approaches do not lead to dramatically different estimates. “Current” column of Table 33 shows the current value of the variables that are included in the model. According to this column, Turkey is not evaluated as an advanced country by the IMF, growth rate for the year 2012 was 2.24%, strength of legal rights is very weak at 4, urbanization is at 72.3% (behind most of the advanced countries) and a secondary mortgage market does not exist.

First of all, before evaluating the results of these scenarios, we can have an assessment about the current situation. Both the pooled OLS and the panel data analysis estimates show that the current benchmark/frontier calculated from the models is above the current depth of the market. Barajas *et al.* (2013) argued that three different sets of policies could be appropriate for different countries depending on the financial possibility frontier of a country and countries stance relative to frontier. These are market developing policies (to push out the frontier), market enabling policies (to help financial system to move toward the frontier) and market harnessing policies (to prevent a financial system from moving beyond the frontier). It is observed that the frontier calculated for Turkey is too low compared to countries at similar levels of economic development. Therefore, it can be concluded that for Turkey there is a need for both market developing polies (i.e. development of the secondary market) and market enabling policies (i.e. strengthening the legal framework in Turkey).

In the first scenario, the potential level of residential mortgage debt to GDP is assessed under most plausible developments. In that scenario, growth rate is chosen according to the level given in Medium Term Programme (2015-2017) goals, some minor developments in the legal rights index is assumed, urbanization trend in the last decade assumed to continue at the same pace, in line with the developments in the market a small secondary market is assumed to be established, the historical trend in the age dependency ratio is assumed to continue, capital to assets ratio assumed to be constant due to stricter regulations introduced after the global financial crisis and CPI volatility assumed to stay at its current level.

Under these conditions, the expected residential mortgage debt to GDP level is around 20-30% which implies a potential of three-five fold increase in that ratio compared to its current level.

In scenario 2, best case scenario, Turkey is assumed to be evaluated as an advanced country by the IMF, real GDP growth level is assumed to be around 3%, getting closer to advanced country levels, significant achievements are obtained in the legal rights and urbanization speed is assumed to increase in the coming years.

Additionally it is assumed that 10 years from today a secondary market is established amounting 10% of the total mortgages in the market. Under this scenario, the residential mortgage debt to GDP could reach around 50-60% level which is the average level for advanced countries.

The third scenario is the adverse scenario where no significant improvements can be achieved. Consequently, under that scenario Turkey is still classified as developing country, average real GDP growth stands at 6%, there are no important developments in terms of secondary market and legal framework. Moreover, urbanization is assumed to come to an end. Under these conditions the residential mortgage debt to GDP level is expected to stay close to its current level.

3.7 Recommendations

Renaud (2005:17) indicates that lack of comparative work on developing economies lead to strong home-bias in policy advice that is provided by international organizations. In other words, policy advice provided by international agencies are mostly affected by the domestic country of the participants of the missions. Renaud further argued that,

> Yet when governments of emerging economies seek advice, they often do not carefully examine the relevance of the most recent innovations in a very high-income deep financial market like the US to their current needs when the US innovations of much earlier decades might be much more appropriate.

Taking this explanation into account, some suggestions for Turkish authorities are provided below.

Firstly, the analysis provided in the section above show that the current benchmark calculated from the models for Turkey is very low. Moreover, current depth of the market is even lower than this frontier. Therefore, it can be concluded that for Turkey there is a need for both market developing polies (i.e. development of the secondary market) and market enabling policies (i.e. strengthening the legal framework in Turkey). In addition to this, analysis also indicated that there is significant growth

potential of the market which is fueled by the factors such as growing economy, urbanization trend, decreasing household sizes, etc.

Secondly, for many developing countries, affordability is one of the most important issues that should be considered by the policy makers and decreasing interest rates in Turkey creates a positive environment. However, as indicated by Asici (2010) there are no comprehensive government policies focusing on the residential mortgage market, such as tax exemptions and subsidies. TOKİ also stresses that the demand for social housing cannot be satisfied with the projects of TOKİ alone. Moreover, the earthquake risk in many geographical areas in Turkey, and specifically in Istanbul region, also support the assessment that mortgage market development should be supported by the government. Furthermore, as argued by Karakaş and Özsan (2005), Emlakbank stopped its operations in 2001 after the economic crises in Turkey and the gap in the market could not be filled by other banks in the sector. A state bank with an aim to support mortgages for low income families could be useful in this respect.

Country examples indicate the association between the depth of mortgage markets and the development of a secondary market and modeling results partly supports this assessment. However for the establishment of the secondary market a well-organized and active primary market is necessary (Erol and Patel, 2005: 50). Lea (1994) argues that secondary market can provide additional resources for national banks and enable better risk management for the lenders in the primary market. Nevertheless, the development of the primary market that is able to produce sufficient volume of high quality mortgages is a necessary but not sufficient condition for the development of this market. Erol and Patel (2005ii:49) indicated that for the establishment of an active primary market, similar types of products should be originated in significant amounts. With the help of the HFS Law, there has been a significant development in this area but current level of primary market development is not adequate for the establishment of a liquid and effective secondary market. To break this vicious cycle some actions from the government could be helpful.

Taxing plays an important role in the development of the market. In order to support the development of primary mortgage market in Turkey, literature stressed that more tax exemptions are necessary[83]. Also given that the homeownership in the US has only slightly increased after the mortgage securitizations in 1980s[84], Turkey needs to create a balance between supporting the development of the primary market and the secondary market. The Malaysian example can be considered as a good example in this issue. On the other hand IMF (2011:111) suggested that government intervention in housing finance market heightened the fluctuations in house prices and increased mortgage market depth during the buildup phase of the global financial crisis. Therefore, government support should be evaluated as a booster for the development of the market at the inception and the recent global financial crisis has shown that government should reduce its effect in time for the effective functioning of the market.

Thirdly, residential mortgage debt to GDP grows hand in hand with development. Therefore, during the development process of Turkey, mortgage market is expected to expand naturally. Moreover, the analyses regarding the share of mortgage credits within domestic credit indicates that strength of legal rights and urbanization is critical for the fast growth of mortgage credits compared to other types of credits.

Fifthly, there are some internal and external problems limiting the growth of the mortgage market in Turkey. One of these problems is due to credit assessments[85]. Issuances of Turkish Treasury still have very low credit ratings from external credit assessment institutions[86]. In practice, generally the sovereign rating of a country brings a ceiling to the credit assessments of other companies and instruments within

[83] For instance, see Okay (2010).

[84] Renaud (2005:17) provides a chart which shows this effect.

[85] Although in April 2009 G-20 summit, leaders globally decided on reducing the use and importance of external credit assessments, these grades are still the most widely accepted indicator of credit risk in the markets.

[86] For instance, Turkey's sovereign rating has just recently been increased to investment level (BBB) by Fitch and Moody's. S&P long term sovereign rating is still at the junk level.

that country. Therefore, this limits the ratings of issuances in Turkey and which in turn constrains the growth potential of the secondary and hence the primary market.

Eldin *et al.* (2004:19) indicated that national regulatory agencies should maintain a high level of cooperation and instead of regulating the market the focus should be on developing it. In Turkey, there are several governmental institutions such as Capital Markets Board, Banking Regulation and Supervision Agency, Central Bank of the Republic of Turkey and Undersecretariat of Treasury that have implicit responsibilities regarding development of the mortgage market. Coordination of these authorities regarding the development of mortgage market should be satisfied in order to guarantee significant growth in this area. In addition to this, although banking sector has shown a robust growth in the last decade, the capital markets are lagging behind. This is another reason limiting the product variability and volume of the secondary and hence the primary market. Lastly, as the global financial crisis has shown, the use of mortgage market related policies in a countercyclical fashion is also important for the economy as a whole. In this respect, Malaysian and Korean cases exhibits a good example for developing countries.

Sixthly, in the current transition period from slums and informally built housing to planned housing projects, opposition is growing with the argument that culturally significant neighborhoods are being demolished especially by the projects undertaken by the Housing Development Administration (TOKI)[87]. Special emphasis should be given to these growing concerns.

Finally, risk weighting in the capital adequacy requirements that is provided by the Banking Regulation and Supervision Agency for mortgage loans should be cautiously determined, which could provide support for the development of the market and could limit growth when increased riskiness is observed for the future. Basel-I rules created advantage for banks extending mortgage loans. Furthermore, with the introduction of Basel-II, the impact of capital requirement regime on

[87] Retrieved from http://en.nai.nl/platform/reports/item/_pid/kolom2-1/_rp_kolom21_elementId/1_1346015 on 9 September 2013.

mortgage markets increased even further since these rules have been providing advantage for the financial institutions in mortgage lending. In 2012, Turkey started implementing Basel-II rules for capital requirements after one year parallel run. Therefore, with the introduction of Basel-II, more banks could possibly be focusing on the mortgage market which would accelerate the development of primary market. On the other hand, at the inception of the Basel-II implementation Turkish authorities decided to use a 50% risk weight for mortgage credits instead of the 35% risk weight. Currently this application limits the growth potential of the market. In the next chapter, the appropriateness of this decision is discussed in detail.

CHAPTER IV

RISK EVALUATION FOR THE TURKISH MORTGAGE MARKET

The developments in securitization markets and increasing use of mortgage backed securities as collateral for derivatives has generated a great deal of interest in the economics of mortgage and mortgage related securities[88]. Residential mortgage market has become the engine of growing residential housing market in many countries[89] and mortgage lending is one of the most important tools for financial institutions and policy makers. On the other hand, it brings along some important risks; risks for the institutions engaging in mortgage lending in the first round and risks for the financial stability in the second round.

With regard to risks related to mortgage lending, there has been a significant growth in the credit risk modeling literature; changes in the financial services sector and Basel capital frameworks have been the main determinant on this progress in the last two decades. Nonetheless, literature on Turkish mortgage market remained significantly underdeveloped.

This part of the thesis aims to investigate the default and prepayment risk in the Turkish mortgage. In order to provide optimum amount of credit to the economy, financial institutions should optimize the amount of capital and provisions they held. Underestimation of risks may lead to default of an institution which could even harm the financial stability. On the other hand, overestimating risks may result in creating

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[88] See Deng *et al.* (2000) for a detailed discussion.

[89] For a discussion about China, See Deng *et al.* (2005)

credits less than the potential, which leads to less than expected profit and growth for banks and slower growth for the economy. In this chapter, answers are searched for the questions, a) what are the determinants of default risk and prepayment risk in the Turkish mortgage market, b) whether or not current regulations are sufficient for the effective functioning of the market. Additionally, appropriateness of the current prepayment penalty for mortgage loans will also be scrutinized.

For question b) priority is given to capital adequacy and provisioning regulations. Therefore, appropriateness of risk weights applied in the Basel-II context and provisioning requirements coming from related BRSA regulation are scrutinized. Additionally, appropriateness of the current prepayment penalty rule will also be investigated. Given the scarcity of papers regarding Turkish mortgage market, this study aims to be the first rigorous empirical study on Turkish residential mortgage market with a comprehensive loan level data collected from three lenders in Turkey. Another importance of this work is that, there has been no research on the literature which analyzed the characteristics of mortgage borrowers in Turkey. The database collected for modeling prepayment and default will also help investigating the accessibility of mortgages by various population segments and the characteristics of Turkish mortgage borrowers.

4.1 Credit Scoring Models and Basel-II

Credit scoring can be defined as a process that uses recorded information related to individuals and their loan demands in order to predict their future performance with respect to repayment[90]. Financial institutions need to make several decisions regarding mortgages, and due to high number of transactions it is costly to allocate

[90] See Avery *et al.* (1996) for a detailed discussion

loan officers for each application[91] (Glennon *et al.*, 2010:2). Similarly, Lang and Santamero (2003) highlighted credit scoring as the primary retail credit decision tool. Figure 41 explains the use of credit scoring models in evaluating mortgage applications. In addition to this, these models also serve as the basis of the calculation of the capital requirements and the provisioning requirements.

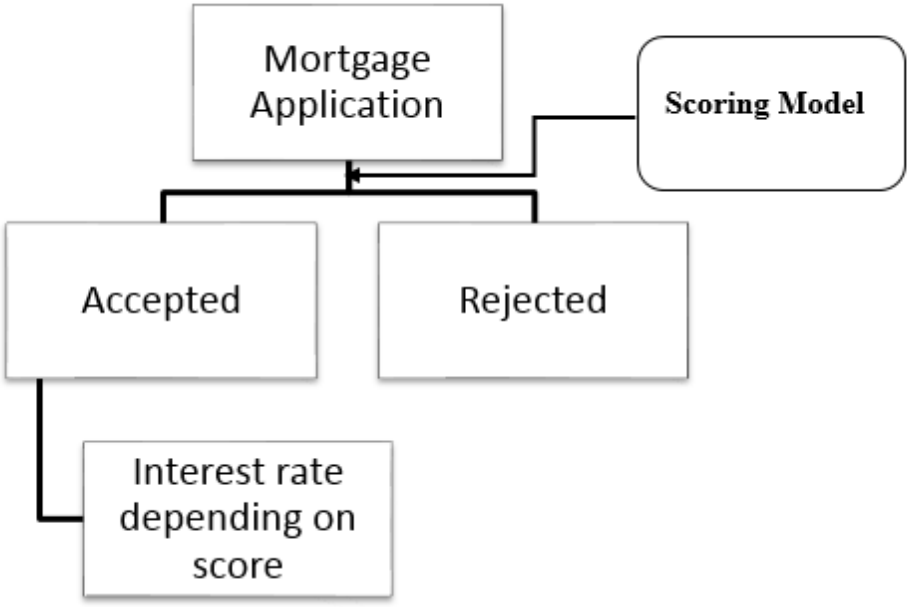
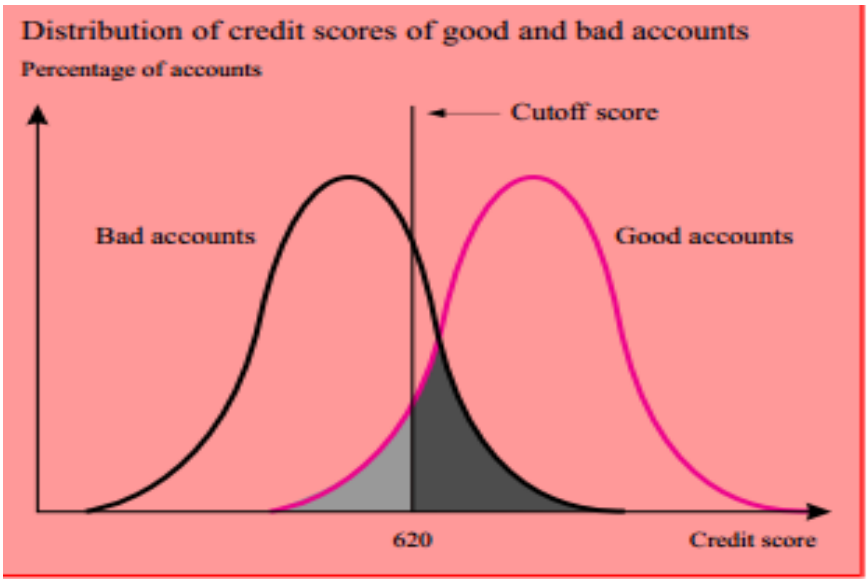


Figure 41: Use of credit scoring models

Figure 42 provides the distributions of credit scores of good and bad accounts. There are both type I and type II risks here. In other words, depending on credit score, a bank can reject a good customer (region on the left of the cut-off value) or accept a bad customer (region on the right of the cut-off value). Banks need to determine this cut-off value in their credit scoring models which have serious implications for the default distribution. This illustration explains the main reason behind obtaining data

[91] In corporate lending, as a part of credit process, each loan is analyzed and monitored separately. Whereas in retail lending there is higher reliance on statistical models and the effect of judgmental factors is lower.

from more than one banks, and this feature makes this study unique (i.e. due to differences in bank practices and risk appetites, significant differences can be observed across bank portfolios).



Source: Avery *et al.* (1996)

Figure 42: Distribution of credit scores for good and bad accounts

Sabato (2010) covered the credit scoring model lifecycle in three phases. These are;

1. Model assessment – in order to develop credit scoring models, past client data are needed.
2. Model implementation – with the implementation of credit scoring model banks have automated (or semi-automated) decision making systems.
3. Model validation – this is more of an issue especially when banks want to use their internal models for the calculation of capital requirements. For internal ratings based approaches under Basel-II banks need to have a regular and well documented model validation cycle. Validation process is dependent on stability and performance analysis. Backtesting and benchmarking (using other estimation techniques or other data sources) are the tools used for this process.

In addition to their use in credit extension decisions, credit scoring models[92] also help monitoring the quality of a portfolio and determining the appropriate level of reserves that should be set aside for losses (Avery et. al. 1996).

For retail portfolios, there are two main approach to credit scoring, the behavioral scorecard approach and the application scorecard approach. In the application scorecard approach, riskiness of the borrower is assessed as of credit application date using the data provided by the customer. When the borrower is a customer of the bank for a certain period of time, then the bank has the opportunity to use the payment behavior of the borrower, i.e. delinquency which allows to construct behavioral scorecards[93].

Credit scoring system of a bank is normally developed internally depending on many specific parameter choices and decisions[94]. Because of that, regulators have enforced stricter rules regarding model development, implementation and validation processes that the banks must adhere to if they want to use their internal models for capital requirements (Sabato: 2010). For instance Basel-II rules allow banks to use their internal scoring models for satisfying minimum capital requirements given that their regulator allow them to use these models under the condition that these models satisfy strict conditions. The advantage of using internal ratings based method for banks is that it provides significant regulatory capital savings.

Basel-II Internal Ratings Based Approach allowed banks to use their default risk estimates in calculating capital adequacy ratio. In this approach, banks need to estimate four parameters;

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[92] The term credit scoring and default modelling used interchangeably throughout this chapter.

[93] Entities such as credit register bureaus allow banks to have behavioral information about customers for which the bank does not have any historical data.

[94] Fair Isaac and Co. (FICO) was one of the most widely used scoring system in the US. Moreover, structural models such as KMV and reduced form models such as Credit Risk Plus are the commonly used vendor models in the banking industry. See Allen *et al.* (2004) for a detailed discussion on vendor models.

-Probability of Default (PD)

-Loss Given Default (LGD)

-Exposure at Default (EAD)

-Maturity (M)

Capital Requirement (K) is;

$$\left[\mathrm{LGD} * \mathrm{N}\left[(1-\mathrm{R})^{-0.5} * \mathrm{G}(\mathrm{PD}) + \left(\frac{\mathrm{R}}{1-\mathrm{R}}\right)^{0.5} * \mathrm{G}(0.999)\right) - \mathrm{PD} * \mathrm{LGD}\right]\left[\frac{1+(M-2.5)*b(PD)}{1-1.5*b(PD)}\right] \qquad (15)$$

where; maturity adjustment function, $b = (0.11852\ 0.05478 * ln(PD))^2$

In this formula, R is the correlation factor,

N is the standard normal cdf,

G is the inverse of the standard normal cdf,

0.999 is the confidence level chosen by the Basel Committee.

The portfolio invariant asymmetric single risk factor model (ASRF model) is used by the Basel Committee in calculating capital requirements. The factor needed in the ASRF model (R) reflects the dependence between asset values of one borrower with another. Similarly the BCBS notes that, the correlations could be described as the dependence of the asset value of a borrower on the general state of the economy - all borrowers are linked to each other by this single risk factor.

A high value of correlation (R) indicates that the portfolio is highly affected by the status of the economy. Therefore, R is higher for corporate loans and lower for retail segment. The low correlation in the retail portfolio shows that defaults of retail customers have a tendency to be more idiosyncratic and less dependent on the economic cycle than corporate defaults (BCBS, 2005i).

In this ASRF model, $\Pr(Loss \leq Capital) \geq 99.9\%$. Additionally, as the expected losses are compensated by provisions, in the capital requirements calculation, expected loss is subtracted. ASRF models are derived from credit portfolios and are based on the law of large numbers. The main idea behind the ASRF model is that when a portfolio consists of a large number of exposures (i.e. the effect of single

exposure is negligible), idiosyncratic risk related to each individual exposure tends to neutralize one-another. In other words, the ASRF model is built on the assumption that the portfolio under consideration is well diversified so that the required capital can be calculated by focusing only on systematic risk (Paudel, 2007). There are three main assumptions underlying the ASRF model.

Assumption 1 - Common systematic risk factor: it is assumed that there is only one common systematic risk factor that effects credit losses.

$$\Pr((L_A < CR_A) \cap (L_B < CR_B)|X) = \Pr((L_A < CR_A)|X).\Pr((L_B < CR_B)|X) \quad (16)$$

Where, *LA* = loss of obligor A, *LB* = loss of obligor B, *CRA* and *CRB* are the capital requirements for exposures A and B, and the factor X is the common systematic risk factor.

Assumption 2 - Indefinitely fine-grained portfolio: ASRF model assumes that the portfolio is well diversified, meaning that idiosyncratic risk is completely eliminated.

$$E(Loss|X)=c(X) \quad (17)$$

The equation above indicates that losses due to each exposure is completely defined by common risk factor *X*.

Gordy (2004) argued that the remaining unsystematic risk is inversely proportional to the effective number of loans.

Assumption 3 – Increasing loss rates in common risk factor:

$$X_1 \geq X_2 \Rightarrow c(X_1) \geq c(X_2) \quad (18)$$

Then the ASRF capital rule is:

The α^{th} (portfolio solvency target) percentile of common risk factor *X*,

$$CapitalRequirement(CR)_\alpha \equiv inf\{cr|\Pr(Loss \leq cr) \geq \alpha\} = inf\{cr|\Pr[E(Loss|X) \leq cr] \geq \alpha\} \quad (19)$$

Now replacing $E(Loss|X)$ with c(X), we get,

$$CR = inf\{c(x)|\Pr[X \leq x] \geq \alpha\} = C(X_\alpha) \quad (20)$$

When we assume that there are only two exposures in the portfolio, then,

$$\text{CR}=C(X_\alpha) = E(L_1 + L_2|x_\alpha) = E(L_1|x_\alpha) + E(L_2|x_\alpha) = CR_1 + CR_2 \quad (21)$$

Showing that the capital requirement of individual loans are independent from the portfolio.

The ASRF model depends on Merton's single asset model (Merton, 1974). In this setting, claims from a company is modelled depending on the value of the company. For instance, default occurs when the market value of the assets of the firm falls below the value of the debt (Aas, 2005:7)[95].

In Merton's model, market value of a firm's underlying assets follows a Geometric Brownian Motion;

$$dV_{i,A} = \mu V_{i,A} d_t + \sigma V_{i,A} dW \quad (22)$$

where W is a standard Weiner process.

Here, value of a firm a firms assets at time T is given by;

$$V_{i,A,T} = V_{i,A,t}\exp(\left(\mu_i - \frac{1}{2}\sigma^2{}_{i,A}\right)T + \sigma_{i,A}\sqrt{T}\epsilon_i) \quad (23)$$

In Merton's model the unconditional probability of default is given by;

$$Pr(\epsilon_i < \frac{\ln\left(\frac{V_{i,A,t}}{D_{i,t}}\right) - (\mu_i - \frac{1}{2}\sigma^2{}_{i,A})T}{\sigma_{i,A}\sqrt{T}}) = N(\frac{\ln\left(\frac{V_{i,A,t}}{D_{i,t}}\right) - (\mu_i - \frac{1}{2}\sigma^2{}_{i,A})T}{\sigma_{i,A}\sqrt{T}}) \quad (24)$$

where; $V_{i,A,t}$ is the market value of the underlying assets of the firm,

$D_{i,t}$ is the debt of the firm at time t,

μ and σ are drift and volatility parameters respectively and,

$\epsilon_i \sim N(0,1)$

[95] In this part proof provided in Aas (2005) is extended so as to make the connections between equations more explicit.

Assume that the shock to normalized asset return of company *i* is given by the equation below[96].

$$Ret_i = \sqrt{1-R}\epsilon_i - \sqrt{R}X \quad (25)$$

where; *X* is the common systemic risk factor and *R* is the correlation as defined in the BCBS IRB risk weight formula[97].

In this setting, $corr(Ret_i, Ret_j)=R$ (26)

Now, if we define a binary random variable $Zi = \begin{cases} 1\ with\ probability\ p_i \\ 0\ with\ probability\ 1-p_i \end{cases}$

Then, $$Zi = \begin{cases} 1\ if\ Ret_i \leq \dfrac{\ln\left(\frac{V_{i,A,t}}{D_{i,t}}\right) - \left(\mu_i - \frac{1}{2}\sigma^2{}_{i,A}\right)T}{\sigma_{i,A}\sqrt{T}} = G(p_i) \\ 0\ if\ Ret_i > \dfrac{\ln\left(\frac{V_{i,A,t}}{D_{i,t}}\right) - \left(\mu_i - \frac{1}{2}\sigma^2{}_{i,A}\right)T}{\sigma_{i,A}\sqrt{T}} = G(p_i) \end{cases} \quad (27)$$

where, G is the inverse of the standard normal distribution.

Then the probability of default conditional on common risk factor *X* is given by;

$$\begin{aligned} \Pr(Z_i = 1|X=x) &= \Pr\left(Ret_i \leq G(p_i)\middle|X=x\right) \\ &= \Pr(\sqrt{1-R}\epsilon_i - \sqrt{R}X \leq G(p_i)|X=x) \\ &= \Pr(\epsilon_i \leq \frac{G(p_i)+\sqrt{R}X}{\sqrt{1-R}}|X=x \\ &= N(\frac{G(p_i)+\sqrt{R}X}{\sqrt{1-R}}) \end{aligned} \quad (28)$$

When we assume a portfolio of N clients with different exposures, E_i, and loss given default values s_i, portfolio loss is simply;

$$\sum_{i=1}^{N} E_i s_i Z_i \quad (29)$$

Define $U_i = s_i Z_i$ which is bounded on the interval [-1,1] and assume that conditional on *X* they are mutually independent. Then the portfolio loss ratio is;

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[96] Here, Aas (2005) noted that interpretation of Ret_i's as asset returns is hardly intuitive. Nevertheless, in ASRF model, it is irrelevant to know firms true asset returns.

[97] Schaefer (2012) showed that this model is equivalent to the intensity model with Gaussian copula.

$$L_R = \frac{\sum_{i=1}^{N} E_i s_i Z_i}{\sum_{i=1}^{N} E_i} \quad (30)$$

Under the condition that the share of largest exposure in the portfolio approaches to 0, Gordy and Heitfeld (2002), Appendix A provides the mathematical proof of the following equations.

$$\lim_{N\to\infty} L_R - E(L_R|X) = 0 \quad (31)$$

where, $E(L_R|X) = \frac{\sum_{i=1}^{N} E_i E(U_i|X)}{\sum_{i=1}^{N} E_i}$

Under the same assumptions, the following equation is also valid,

$$\lim_{N\to\infty} q_\alpha(L_R) - q_\alpha(E(L_R|X)) = 0 \quad (32)$$

Moreover, Gordy and Heitfeld (2002), Appendix B proves that under assumption 3 given above,

$$q_\alpha\big(E(L_R|X)\big) = E(L_R|q_\alpha(x)) = \frac{\sum_{i=1}^{N} E_i E(U_i|q_\alpha(x))}{\sum_{i=1}^{N} E_i} \quad (33)$$

The importance of this equation is that, computing $q_\alpha\big(E(L_R|X)\big)$ may be quite complicated. On the other hand, the right hand side of the above equation is basically the exposure amount weighted average of the individual conditional expected losses.

Assuming LGD's to be known,

$$E\big(U_i\big|X = G(\alpha)\big) = s_i E\big(Z_i\big|X = G(\alpha)\big) = si\ \Pr\big(Z_i = 1\big|X = G(\alpha)\big) \quad (34)$$

Here,

$$\Pr\big(Z_i = 1\big|X = G(\alpha)\big) = N\left(\frac{G(p_i)+\sqrt{R}G(\alpha)}{\sqrt{1-R}}\right) \quad (35)$$

This provides us the following equation,

$$E\big(U_i\big|X = G(\alpha)\big) = si\ N\left(\frac{G(p_i)+\sqrt{R}G(\alpha)}{\sqrt{1-R}}\right) \quad (36)$$

Finally, using this result we get,

$$\lim_{N\to\infty} q_\alpha(L_R) = \sum_{i=1}^{N} w_i s_i\ N\left(\frac{G(p_i)+\sqrt{R}G(\alpha)}{\sqrt{1-R}}\right) \quad (37)$$

where, w_i is the share of an exposure in the total portfolio.

Therefore, total capital requirement of a portfolio is the sum of the individual contributions of each exposure to the portfolio risk.

BCBS (2005i) explains how the asset correlations are calibrated for different portfolios. According to this document, a reverse engineering methodology is used. First of all, economic capital figures from large internationally active banks are obtained together with historical loss data from supervisory databases of the 10 developed countries. Then, economic capital data of the banks was assumed to be obtained from the Basel risk weight formulas with their matching PD and LGD figures being used in the Basel risk weight formulas. In this setting, asset correlations that would approximately result in these capital figures within the Basel model framework, have been determined.

These analyses show that the asset correlations for retail classes are much lower compared to corporate portfolio. This creates one difference of the retail risk weight function compared to general risk weight function. Secondly, the retail risk weight functions exclude a maturity adjustment. Consequently, Basel-II rules for calculating capital requirements for residential mortgage exposures are as follows.

The capital requirement for non-defaulted mortgage exposures under the IRB approach (internal modeling method) of credit risk is calculated according to the following formula.

$$\text{Capital Requirement (K)} = \text{LGD} * \text{N}\left[(1-\text{R})^{-0.5} * \text{G}(\text{PD}) + \left(\frac{\text{R}}{1-\text{R}}\right)^{0.5} * \text{G}(0.999)\right) - \text{PD} * \text{LGD} \quad (38)$$

where, Correlation (R) = 0.15.

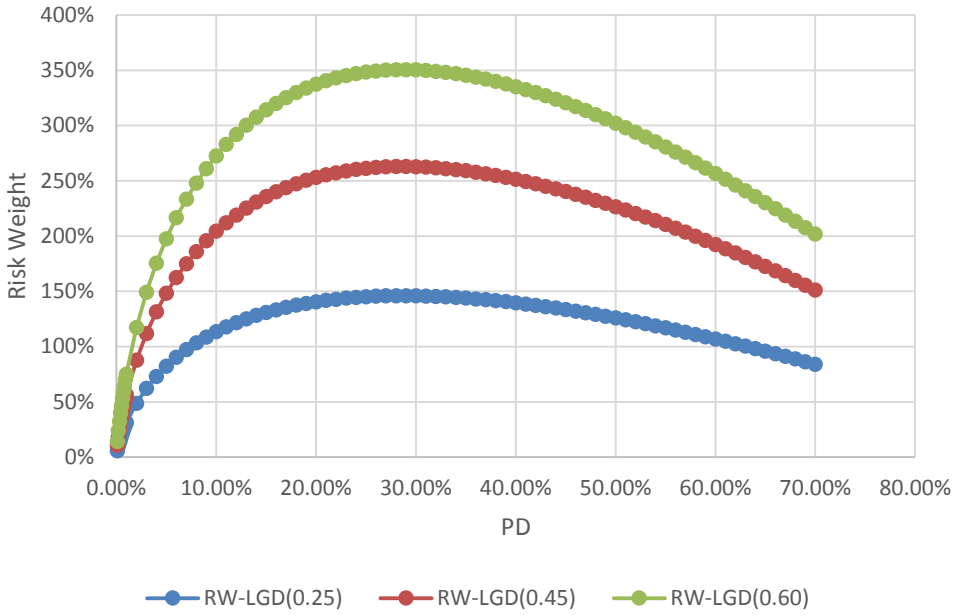

Figure 43: Illustrative risk weights depending on PD

As can be seen from the figure above, compared to the standardized approach to credit risk, the IRB risk weight formula of the Basel Committee provides a better risk differentiation depending on the probability of default and loss given default parameters. Under credit risk standardized approach, all mortgage exposures are assigned to 35% advantageous risk weight. Whereas, under the IRB, by estimating PD and LGD banks can assign various risk weights. For instance, for a mortgage loan that is estimated to have a PD of 1% and LGD of 45%, relevant risk weight is 56%, on the other hand when estimate of PD reduces to 0.40%, the relevant risk weight reduces to around 30%.

One important behavior about the risk weights is that, risk weights are not monotonic in PD. In other words, as the PD increases, risk weights increase up to a certain level. After exceeding that level risk weights start decreasing. This is consistent as the risk weights are indicators of unexpected loss. For the exposures, that have extremely high level of default probability, lenders know the default risk that take and they need to held provisions for the expected loss part.

Figure 44 provides the figure below but this time without excluding the expected loss from the calculation and without multiplying with 12.5 factor[98], which could be used as an indicator for total loss for a bank. Here it can be seen that total loss is strictly increasing in PD.

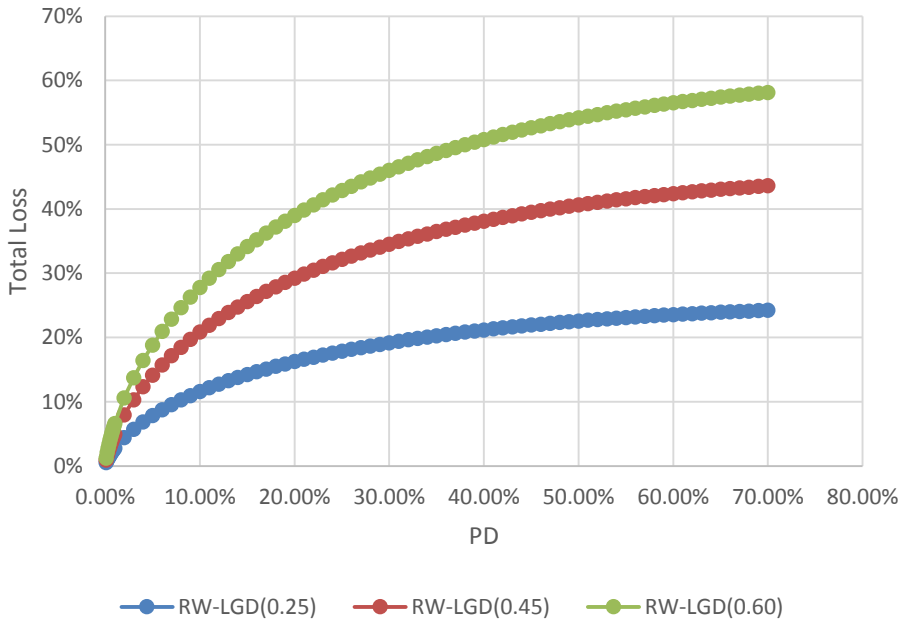

Figure 44: Total Loss

In order to make this calculation, banks need to provide an estimate of the PD and LGD associated with the related pool of exposures, subject to the requirements as set out by the standard. In order to be eligible to use the IRB approach, banks have to heavily invest in statistical modeling and data warehousing solutions. Additionally, to be eligible for IRB approach, it is not enough to construct a model and present to the supervisors. Banks need to show that they incorporate the results of the models with their decision making systems, i.e. to their pricing, credit approval and monitoring processes.

[98] 12.5 multiplier is used for transforming capital adequacy ratio to capital requirements. It is simply, 1/8%.

There are several quantitative requirements of the IRB approach. In allocating exposures to pools, borrower risk characteristics, transaction risk characteristics and delinquency status need to be taken into account. Additionally, Basel-II requires that the one-year PD that is applied could not be less than 0.03% (BCBS, 2006).

Time horizon that should be taken into account in estimating the PD should be at least 1 year. However, the Basel Committee suggests using a longer horizon. In order to estimate PD and LGD banks need to have comprehensive databases. For PD historical data of at least 5 years is required and for LGD at least 7 years of internal data is needed[99]. In the estimation of the PD, the general industry standard which is also accepted by the Basel Committee is obligors' being past due for more than 90 days. However, banks can also make subjective assessments and categorize other exposures as defaulted in case it considers that the obligor is unlikely to pay its debt in line with the contract in full. On the other hand, in loss given default calculation, banks have to measure all relevant factors that create economic loss including discount effects and collecting fees and expenses.

On the LGD parameter, Basel-II Paragraph 470 states that the parameter should be dependent on historical recovery rates and must not exclusively based on estimated market value of the collateral. Banks are required to be conservative in estimating LGD. One way of achieving this conservatism regarding the mortgage products is to take into account not only the effects of revaluation of the collateral (i.e. the house) but also the possible losses due to fire sale[100].

As indicated in the previous sections, banks have two options for capital calculation under Basel-II, namely; standardized approach and internal ratings based approach

[99] Basel-II also allows for using external data given data a strong link can be demonstrated either between the bank's process of assigning exposures to a pool and the process used by the external data source, or between the bank's internal risk profile and the composition of the external data.

[100] I.e. a house which normally worth Y TL can be sold by a bank at a value of Y*(1-x), x>0. There are many reasons behind this. One of these reasons is that banks portfolios have to be liquid and regulations force banks to sell their illiquid assets such as real estate in a given period of time.

(IRB). In order to be eligible for the IRB approach, a bank needs to show that it meets certain minimum requirements both at the application for model approval and later on, on a continuous basis. These requirements include not only qualitative ones but also quantitative ones. The Committee states that the focus is on the capabilities of the banks to rank order and quantify risk consistently and reliably (BCBS, 2006: Para 388). In other words, banks should be able to show that the internal rating process provides a meaningful differentiation of risk, for a grouping of sufficiently homogenous exposures, and allows for accurate and consistent estimation of loss characteristics. Based on the information provided by each applicant bank, their supervisors need to develop detailed assessment procedures to guarantee that banks' systems and controls are sufficient.

Henderson and Jagtiani (2010) argued that Basel II is not totally prescriptive and allows financial institutions to have some flexibility in developing models. One such flexibility is provided in the segmentation area (risk bucketing)[101]. Authors highlighted that Basel II requires financial institutions to group their retail exposures into segments with homogenous risk character but allows for a high degree of flexibility for segmentation by means of number of segments and sub-segments. Consequently, it is noted that within the context of Basel II, there are no standard for allocating retail credits into risk buckets and banks have the discretion to choose very granular segmentation approach.

4.2 Current Regulatory Framework in Turkey

Regarding capital adequacy, current regulatory framework in Turkey is compliant with Basel-II. In 2011, Banking Regulation and Supervision Board decided a parallel run of Basel-II compliant regulations for one year and started full implementation of Basel-II in July 2012.

[101] Laurent (2004) indicated to direct characteristics such as maturity, size and indirect characteristics such as scoring as the main ways of segmentation that is being used by the industry.

Basel-II framework and related EU regulations which are constructed based on Basel-II (2006/48/EC and 2006/49/EC) includes several national discretions allowing national authorities to choose most appropriate approaches by taking into account the market based characteristics and riskiness. In paragraph 73 of the Basel-II framework, national supervisors are asked to evaluate whether 35% risk weight for fully secured mortgages on residential property is appropriate and increase this risk weight as appropriate. According to BRSA's regulation on Basel-II[102], 50% risk weight is applied to these exposures. However, national authorities have not disclosed any information on how the 50% risk weight is determined. The volatility in Turkish markets may indicate a need for a higher or lower risk weight for residential mortgage credits. In Basel context, as a general rule, banks should have enough capital to cover their unexpected losses and provisioning to cover expected losses. Therefore, appropriateness of these risk weights in covering unexpected losses should be a major concern[103]. Recently, the BRSA announced its IRB regulations, which allows banks to apply for using IRB approaches to measuring credit risk[104].

On the provisioning side, the Regulation on Classification of Bank's Exposures and Provisioning[105] (Provisioning Regulation) sets the rules. Provisioning Regulation requires banks to categorize their exposures in five groups. The main indicator for categorizing loans is past due date. Nevertheless, banks need to use all other relevant indicators in their categorization that might indicate the health of an exposure.

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[102]http://www.bddk.org.tr/WebSitesi/turkce/Mevzuat/Bankacilik_Kanununa_Iliskin_Duzenlemeler/1691syr_yon.pdf

[103] Powell (2004) and Ward (2002) draw attention to this issue.

[104] As of end-2014 IRB application pack has not been announced by the BRSA. Therefore, currently no banks use IRB for their capital adequacy calculations. BCBS (2014:3) noted that Basel II and Basel III standards are designed primarily for large international banks operating in BCBS member jurisdictions. Hence, national authorities need to carefully assess the appropriateness of the IRB approach for medium to small sized banks.

[105] http://www.bddk.org.tr/WebSitesi/turkce/Mevzuat/Bankacilik_Kanununa_Iliskin_Duzenlemeler/1707karsilik_yonetmeligi_7_2_2014.pdf

Exposures that are categorized under groups 3-5 are called non-performing loans. For these loans banks need to set aside specific provisions.

Table 34: Provisioning Rate by Exposure Category

	Category	**Main Indicator**	**Provisioning**	**Rate**
1	Standard	-	General	1%
2	Close Watch/Special Mention	Past Due < 30 Days	General	2%
3	Substandard	Past Due < 90 Days	Specific	20%
4	Doubtful	Past Due < 180 Days	Specific	50%
5	Loss	Past Due ≥ 180 Days	Specific	100%

However for category 1 and 2 loans, the BRSA applies a flat general[106] provisioning rate for all exposures regardless of their riskiness (i.e. the same provisioning rate applies to all exposures such as mortgages and corporates). This is 1% for all standard loans and 2% for loans that are closely monitored but not at default (this is called the category 2 loans where a delinquency up to 90 days is observed).

Additionally, from a macro-prudential point of view, the provisioning rates for consumer loans excluding mortgage loans were increased fourfold together with a significant increase in risk weights for these products after 2010 in order to limit fast growth in household indebtedness. This action had a significant impact on the growth rate of consumer loans. The annual rate of growth of these loans which were almost exceeding 40% decreased to under 10% following the effects of the actions indicated. This showed that in the Turkish market, provisioning rates are a quite influential element for taking actions about the macro-economy.

[106] General in the sense that these provisions are allocated for the pools, not directly linked to an exposure.

One other important regulatory requirement with respect to mortgage lending is the introduction of Loan to Value Ratio (LTV) by the BRSA[107]. Accordingly, all financial institutions extending mortgage loans need to check the value of the underlying collateral as of origination date and the amount of loans extended cannot exceed 75% of the appraisal value (i.e. the LTV ratio). There are similar requirements in different jurisdictions with respect to LTV. Main difference of the BRSA rule compared to the rules of other jurisdictions is the penalty applied to exceeding amounts. For example, if a banks extends credit beyond 75% limit, according to the BRSA rule, the exceeding amount needs to be deducted from banks own funds which has significant implications. Whereas in other jurisdictions the punishment is not that harsh, generally requiring the financial institutions to apply higher risk weights for such mortgages.

With respect to prepayments, Turkish regulatory system is quite unsophisticated. Law Amending the Laws Related to Housing Finance System (March 2007) introduced an upper limit on prepayment penalty for fixed rate contracts which cannot exceed 2% of the prepaid sum, calculated by making the necessary deductions of interest and fees. Additionally this Law states that a prepayment fee cannot be demanded from the consumer, in case the interest rate or lease payments are determined to be variable.

In 7 November 2013, Consumer Protection Act Nr: 6502 is published in the Official Gazette. This act has altered the prepayment penalty that is introduced by the Law Amending the Laws Related to Housing Finance System. According to Consumer Protection Act, for fixed rate mortgages prepayment penalty cannot exceed 1% of the remaining balance if the remaining maturity is less than 36 months and 2% if the remaining maturity is more than 36 months.

[107] http://www.bddk.org.tr/WebSitesi/turkce/Duyurular/Basin_Aciklamalari/8870basinaciklamasi1712.pdf

Recently, the BRSA announced the Regulation on Fees and Commission that could be Charged from Financial Consumers (dated 3 October 2014). According to the mentioned regulation when one or more of the installments are paid earlier or the mortgage loan is restructured for the advantage of the consumer no other fees or commissions can be charged except for the one stated in the Law. Moreover, these fees and commission cannot exceed the reduction in interest in case of restructuring.

4.3 Research Questions

In order to provide optimum amount of credit to the economy, financial institutions should optimize the amount of capital and provisions that is held. Underestimation of risks may lead to default of an institution which could even harm the financial stability. Reinhart and Rogoff (2010) noted the importance of closely monitoring the non-performing loans ratio (NPL) as this is an important indicator of the inception of a banking crisis. On the other hand, overestimating risks may result in creating credit less than the potential, which leads to less than expected profit and growth. For instance, Freedman and Click (2006:279) showed that extreme liquidity in developing countries restricts the growth rates. Excessive capital and provision could also create the same effect. Therefore, evaluating the regulatory requirements on the basis of risk is critical.

Excluding the last few years where Turkish authorities have started to use countercyclical macro-prudential tools, financial regulation can simply be described as convergence to the international standards in Turkey. However, taking into account the fact that most of the international standards are calibrated for developed countries, the need for paying more attention to this field becomes obvious. Otherwise, financial stability of the sector could be threatened by the risk accumulation. For instance, Ward (2002:4) indicated that Basel-II is not appropriate for developing countries because of high volatility in macro-economy (i.e. risk weight applied might not be appropriate), and greater vulnerability to external shocks, insufficiencies in the institutional capacities and scarce skills (i.e. being able

to build and supervise such models require significant amount of investment in human capital and IT infrastructure).

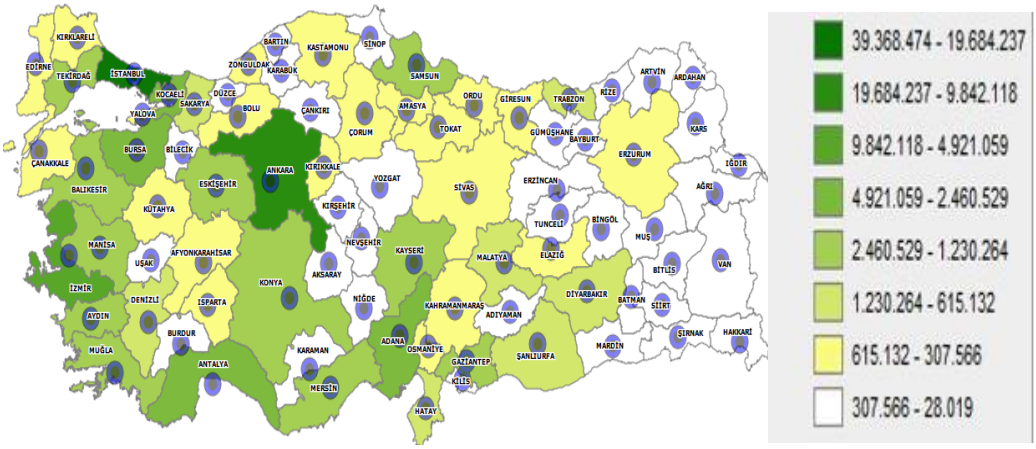
Wagner (2004:179) argued that by quantifying the credit risk in mortgage portfolios and using IRB approach, banks could significantly reduce their risk weights. Moreover, the capital arbitrage is higher residential mortgage portfolios compared to other portfolios. Therefore, evaluating the riskiness of mortgage products is important not only for the supervisory agencies but also for the financial institutions. For instance, by measuring the risks better, financial institutions can manage their economic capital management and pricing.

In the field of mortgage lending, the prepayment risk and the default risk are the most important risks that should be carefully measured and monitored. In that sense, answers are searched for the questions, a) what are the determinants of default risk and prepayment risk in the Turkish mortgage market, b) whether or not current regulations are sufficient for the effective functioning of the market. For the second question priority is given to capital adequacy and provisioning regulations. In that sense answers are searched for the questions; i) is the current 1% flat provisioning rate appropriate for residential mortgages, ii) is the current 50% risk weight for residential mortgage exposures appropriate under current macroeconomic environment. Therefore, appropriateness of risk weights applied in the Basel-II context and provisioning requirements coming from related BRSA regulation[108] are scrutinized. Additionally, appropriateness of the current prepayment penalty for mortgage loans is also assessed.

In recent years Turkish mortgage market has shown strong growth. The determinants of this growth is investigated in more detail in the micro level. Moreover, until today, no studies has been conducted which analyzed the characteristics of mortgage borrowers including their socio-economic status. For example, Figure 45 below

[108] Here, it should be noted that current BRSA regulation on provisioning is not compliant with IFRS 9 which will be implemented starting from 2017.

indicates that there are significant regional variations with respect to mortgage lending. This study will be the first one providing detailed borrower level characteristics of mortgage originations in Turkey.



Source: BRSA, June 2014

Figure 45: Mortgage Lending in Turkish Cities

4.4 Literature Review

In this section, some of the empirical studies that employ various econometric techniques to analyze mortgage termination risk in terms of default and prepayment are covered. Given the huge volume of literature in this issue, only brief information on major studies could be provided, with a focus on more recent ones. Moreover, given that many studies employed several models, it is not easy to discuss the significance of each variable in all these studies. Therefore, only the variables taken into account in these studies could be covered and the major conclusions of these studies are highlighted in this section.

History

In the last two decades, there has been a significant growth in the credit risk modeling literature and changes in the financial services sector and Basel capital frameworks have been the main determinant on this progress. Nonetheless, literature on Turkish market remained significantly underdeveloped.

According to Lacour-Little (2008), literature regarding the mortgage termination risk can be categorized under theoretical field and the empirical field. In the theoretical literature, the focus is mainly on asset pricing in a frictionless market where homogenous group of wealth maximizing borrowers who are driven by financial considerations borrow. Lacour-Little (2008) argued that, level of borrower sophistication, credit position, institutional constraints and transaction costs are ignored in those models. On the other hand, empirical research is more diverse both in terms of focus and methodology. Lacour-Little (2008) indicated that the commercial mortgage market is closer to this ideal market of the theoretical models than the residential segment.

Yılmaz (2009)[109] provided a comprehensive literature review on structural models and reduced form models[110] that are used for modeling mortgage credit and prepayment risk. Structural models are built on Black-Scholes-Merton methodology for option pricing. In the context of structural models, default is considered as a put option as the borrower has the option to put back the mortgage to the lender in case the value of the property is less than the present value of future payments required under the mortgage agreement (i.e. borrower has negative equity). Similarly, prepayment is modeled as a call option which allows the borrower to prepay the outstanding amount prior to maturity. For the default option to be in the money, equity of the borrower has to be negative. Also, the prepayment option is in the

[109] Similarly, Wallace (2005) covered some recent studies on structural models and reduced form models.

[110] Also called Equity Theory of Default and Ability to Pay Theory of Default in the literature.

money when the present value of all future payments discounted at the current interest rate is larger than the present value of these payments at the mortgage rate (Deng *et al.,* 1996:264).

The main idea of this option theoretic framework is using the structural variables of the borrowers, such as house and debt values, to determine the probability of default and prepayment (Donchev, 2009:8). In other words, as long as the market value of the home is higher than that of the mortgage, the borrowers have the motivation to sell the asset and payback the loan instead of defaulting on the loan which has serious consequences. Following Modigliani and Millers' irrelevance of financial structure theory, one can expect that borrowers can increase their wealth by defaulting on their mortgages when the market value of the mortgage exceeds the value of the house. Nevertheless, negative equity is shown not to be the sole factor effecting default, especially for the EU market where default is not costless (see Kau *et al.,* 1994). Gyourko and Tracy (2014) indicated that even in the USA case, 85% of households with a mortgage were current on their payments who had negative equity. Donchev (2009:9) indicated that in contrast to the US, a defaulting borrower loses his/her collateral in most European residential mortgage systems. Additionally the difference between the value of the property and present value of the remaining installments has to be covered by the borrower. In such a case, the approach of modeling default behavior as a put option on the house value becomes quite unrealistic[111]. In the literature, the approach generally accepted in Europe is called recourse lending and the approach followed by many of the US states is called non-recourse lending[112]. Ghent and Kudlyak (2010) showed that recourse decreases the probability of default.

[111] "Option based theories and triggering event theories" (see. Avery *et al.* (1996) for a detailed discussion on this approach) responds to this criticism where default is not only linked to negative equity but also linked to triggering events. In this case negative equity is not a sufficient but a necessary condition for default.

[112] See, Harris, R. (2010) for a detailed discussion on recourse and non-recourse US States. The author also noted that US residential mortgages are non-recourse in practice due to US bankruptcy regime.

Moreover, Lacour-Little (2008) noted that the values generated through option-theoretic approach generally do not match the observed market prices for the mortgage assets. Studies such as Vandell (1995) and Elmer and Seelig (1999) discussed this non-rational behavior of the borrowers in detail. Furthermore, Lacour-Little (2008) emphasized that default is not an explicit put option for mortgages. The reasoning behind this explanation is that default represents a violation of contract not the exercise of an option. Using this explanation, Lacour-Little (2008) argued that lender heterogeneity may be as significant as borrower heterogeneity in explaining the timing of default[113].

Reduced form models respond to most of the shortcomings described above. Reduced form models[114], also called intensity based models assume that default is governed by externally specified intensity process that may or may not be related to the asset value (Zhang, 2009:9). In other words, in contrast to structural form models where default and prepayment are endogenous, in reduced form models default and prepayment are exogenous events having their own arrival processes. The more flexible nature of the reduced-form approach also allows it to incorporate various exogenous variables into the pricing model, thus making it more amenable to empirical analysis compared to the tighter structural approach (Smurov, 2004:12). These models incorporated variables such as income and borrower level characteristics (age, education, occupation, change in marital status, etc.) in addition to the macroeconomic variables like interest rates (some of the studies also incorporated property related factors such as floor area[115]). Logistic regression is the industry standard in modeling default and prepayment risk. However, in the last

[113] There are many studies in the literature which focuses on filling the gap between theoretical and empirical approaches. For instance, Kau *et al.* (1993) included transaction costs in order to provide an explanation but noted additional research is needed in this field. Other studies include Jones (1993), Kau and Kim (1994).

[114] On other important difference between structural and reduced form models is that structural models are applied to pool level data whereas reduced form models are applied to loan level data (Wallace, 2005).

[115] For a detailed discussion of these studies, see Tam *et al.* (2010)

decade survival analysis has become the one of the most popular techniques employed in modeling these risks. Some prominent studies in the literature regarding reduced form models for mortgage risks are provided below.

Default

Credit scoring models have become increasingly important for banks whose primary role is to extend credit. These models have significantly increased the speed of decision making process. Today, many banks have such systems that allow them to have automatic decision making processes for retail loan portfolios.

With the introduction of Basel-II capital accord, banks have started to use the modeling outcomes not only for decision making processes but also for capital allocation and capital planning purposes.

Previous literature has shown that trigger events, underwriting issues[116], economic factors, and interest rate changes impact the probability and timing of default (Goodman and Smith, 2010). In this subsection some of the major studies on default modeling is covered.

Quercia and Stegman (1992)[117,118] provided an inclusive background regarding the empirical residential mortgage default literature. Authors analyzed mortgage default

[116] These variables are directly related to the US related studies and therefore cannot be included in the analyses.

[117] In their paper which is analyzing the US mortgage market, Avery *et al.* (1996) provided an alternative categorization; option based theories and option based and triggering event theories. Option based theories correspond to the second generation studies explained by Quercia and Stegman (1992). Whereas, option based and triggering Events theories combine the former theories with triggering events where delinquencies are not explicitly linked to default but can lead to default if triggering events are sufficiently severe. The author believes that the categorization provided in Quercia and Stegman is more appropriate for the US market as the role of equity related factors are far less relevant compared to the non-US markets.

[118] Vandell (1993) also gives a survey on mortgage default literature.

literature in three generations[119]. The first generation covers the period as early as 1960s where empirical studies attempted to identify the mortgage and borrower characteristics that are associated with mortgage default (such as Jung, 1962; Page, 1964). Beaver (1967) and Altman (1968) were the first studies to include multivariate discriminant analysis for the purpose of categorizing credit as good or bad without any focus on mortgage. Later on, Ohlson (1980) used logistic regression in order to model default using financial ratios.

The second generation studies examined the default decision as an option (structural models) where the net equity constitute the central role in default studies (i.e. Findley and Capozza, 1977; Dunn and McConnell, 1981; Epperson *et al.*, 1985; Vandell and Thibodeau, 1985; Zorn and Lea, 1989; Kau *et al.*, 1992, 1994; Kau and Keenan, 1999).

The contribution of the third generation, on the other hand, is related to estimating the probability that a partial fraction of a large pool will default using sophisticated reduced form models such as proportional hazard estimation (i.e. Van Order, 1990; Kau *et al.*, 1994). These models have also incorporated the triggering events approach where the default is linked to significant adverse changes in the financial and private stance of the borrowers such as changes in employment, marital status, etc.[120] Narain's study (1992) was the first study on survival analysis for building credit scoring models and this methodology is then improved by Thomas *et al.* (1999). Thomas *et al.* (1999) showed that the performance of reliability modeling approaches (i.e. survival models) can be superior to traditional logistic regression approach to modeling default. They also used the competing risks concept which allows both the default and prepayment to be taken into account at the same time.

[119] In this section categorization of Quercia and Stegman (1992) is used but additional references are provided.

[120] For a detailed discussion of triggering events theories, see Avery *et al.* (1996)

There are also hybrid approaches in the literature which combines option theoretic variables into the competing risks framework (See, Deng *et al.,* 1996, 2000[121]).

Thanks to high quality and sufficient data, there are several studies in the literature focusing on the US market. Using a two period optimization model of consumer choice, Vandell and Thibodeau (1985) investigated the default behavior in the 30 year fixed rate mortgages in the US. They concluded that payment levels relative to income, current and expected housing market conditions, economic conditions, wealth, crisis events (i.e. trigger events such as unemployment) and transactions costs could influence the default decision.

Epperson *et al.* (1985) was one of the first studies to incorporate the option theory with the mortgage default literature. Authors noted the volatility of house prices and volatility of spot interest rates as the main determinants of asset values and specifically indicated to the need for a complete model that would allow the interaction between prepayment and default. Later on, Kau *et al.* (1992) built an option-theoretic model for pricing residential mortgages, by taking into account both the prepayment risk and default risk.

Hendershott and Schultz (1993) modeled Federal Home Loan Mortgage Corporation insured loans (single family mortgages) which were insured during 1975-87. Authors developed a time series of conditional claim rate for the insured loans and summarized default and foreclosure risk for specific pools of mortgages. Using a semi-log probability model, they found that both unemployment and negative equity variables have significant effect on default. Additionally, authors noted that default risk decreases with the loan size and origination year could significantly affect the default rate.

[121] Lacour-Little (2008) indicated that this paper is unquestionably the most widely cited paper in the mortgage termination literature.

Deng *et al.* (1996) provided a unified option based approach to default and prepayment behavior by employing proportional hazard framework using a loan data of around 1.5 million fixed rate level payment mortgages that are originated between 1976 and 1983. Authors introduced the option variables into modeling; the present value of the unpaid mortgage balance at the current market interest rate divided by the value discounted at the contract interest rate (*poption*) and the likelihood that borrower's home equity ratio is negative, which is calculated as taking the difference between the present value of the unpaid loan balance and the purchasing house price at the time of loan origination divided by the estimated volatility of the housing price index (*pneq*). Authors highlighted the importance of initial LTV ratio and negative equity in default modeling.

Deng *et al.* (2000) used call and put option indicators, together with their squared terms, state unemployment rate and state divorce rate to model prepayment and default in a competing risks framework. They noted that there is significant amount of heterogeneity among borrowers and option theoretic models are not sufficient for modeling these risks and lead to serious errors in estimating prepayment risk. Authors showed that paying no attention to the interdependence between prepayment and default could lead to serious errors in estimating default risk. Moreover, they also indicated that both prepayment and default risk is higher in high initial LTV loans and prepayment and default behavior varies significantly across regions.

In an attempt to fill the gap between theoretical and empirical studies, Capozza, Kazarian and Thomson (1998) introduced the conditional probability of default concept. Authors noted that the unconditional probabilities (which depends on the origination values) are secondary in importance compared to the conditional probabilities (which depends on the current values as of time t). Similarly, Kau *et al.* (2003) investigated the effect of transaction costs on default. However, they determined that transaction costs are not providing the necessary information to fill this gap. Similarly, Vandell (1995) noted the lack of precision regarding the option-theoretic models.

Goodman and Smith (2010) analyzed the determinants of mortgage loan default in the US using a raw dataset of 34 million raw mortgages in the US by employing maximum likelihood methods. Authors argued that after controlling for loan and local conditions, significant variation is observed in the default rate across states. The authors therefore highlighted the importance of a national level policy for regulating predatory lending and foreclosure activities related to financial institutions.

Similarly, Capozza and Order (2011) examined the relative roles of underwriting, moral hazard and local economic conditions in the in hike in mortgage default rates during global financial crisis period by using US loan level data originated between 2000 and 2007 using survival analysis techniques. Authors showed that original term, origination year log balance, credit score, purpose (purchase), documentation, owner occupancy, region, loan age and current LTV as significant variables in the model[122]. Moreover, they indicated that favorable economic conditions in 1990s made mortgage lending look better than it was (Capozza and Order, 2011:150).

Glennon and Nigro (2011) indicated that the static models to credit default do not take into account the seasoning effect, change in leverage of the lender and change in collateralization of the loan. Therefore, dynamic models such as survival analysis serve the purposes of the modelling better. For model development, authors chose 20000 loans with original maturity of 15 years and evaluated the performance of parametric survival, discrete time hazard and split population survival model. They showed that the static model performs relatively well against the dynamic models over only very short time horizons but the loss estimates from the static model are consistently lower than actual losses (under-prediction by 20-50%). Additionally, the authors argued that discrete time hazard model have the best forecast accuracy over longer time horizons. Finally, the authors concluded that banks should consider

[122] Authors have also included some interaction terms (origination year*limited doc, origination year*LTV, origination year*limited doc*LTV), but the reason for selecting these interactions were not explained in the paper.

developing capital adequacy, loan loss provisioning and securitized loan valuation models with a dynamic sample and model design.

Krainer and Laderman (2011) investigated the interaction between mortgage prepayment and mortgage default between the years 2001 and 2010 with the use of 770000 first lien, 1-4 family, owner occupied, conventional mortgages obtained from LPS Applied Analytics database. Using competing risks hazard model with static and dynamic covariates they concluded that both the house price dynamics (i.e. decline in house prices) and tighter lending standards (observed by investigating the periods where the general interest rates declined but mortgage prepayment activity did not increase) led to weak prepayment activity by affecting mortgage demand and mortgage supply respectively.

Archer and Smith (2011) explained that in an the environment of limited information and limited liquidity, higher rates of appreciation generate an irrational expectation of continued high appreciation which results in a euphoria effect in mortgage default. Euphoria causes both borrowers and lenders to commit to mortgage loans with potentially more burdensome and risky future payments. Authors used Florida county level house price appreciation levels as euphoria proxies and variables such as loan underwriting variables, FICO score, LTV ratio and DTI ratio as control variables in a logistic regression setting. The authors concluded that high levels of historical house price increases could create euphoria, causing a greater tendency to risky loans which in turn reduces the value of the put option. Whereas, during the periods of house prices declines, the reverse happens. In all cases, it is noted that the effect of the put option dominates.

Quercia *et al.* (2012) studied the tendency of very low to low income groups to terminate a mortgage contract by employing a competing risks framework. They used a sample of 16 thousand loans from the US that are originated between 1990s and 2007. Main findings of this study are; in line with previous studies, credit score, loan to value ratio and local unemployment rate are important indicators of default and prepayment, loans with higher originating amounts and higher refinance values

have higher default and prepayment probabilities and finally, debt to income ratios are important for estimating default.

Using a data set of mortgages and employing OLS and two stage least squares procedures, Chiang *et al.* (2002) investigated the relationship between mortgage lending spreads and individual borrower, property and loan characteristics in Hong Kong. In this article, authors tested the validity of two hypotheses for Hong Kong. The sorting-by-observed-risk hypothesis and the information asymmetry hypothesis. According to the sorting-by-observed-risk hypothesis, prepayment and default risks are observable via credit analysis and therefore riskier borrowers need to assign more collateral and could borrow less, meaning that larger mortgage and smaller LTV is associated with riskier borrowers. On the other hand, asymmetric information hypothesis assumes that borrower risks are unobservable. Knowing that they have high default risk, these borrowers tend to pledge less collateral. Regressing mortgage spreads on various explanatory variables, the authors concluded that lenders in Hong Kong can observe the risk type of individual borrowers and charge a mortgage spread accordingly which is consistent with the sorting-by-observed-risk paradigm.

With data from a major Chinese Residential Mortgage Lender, Deng *et al.* (2005) evaluated the prepayment risk and default risk in the China residential mortgage market. In order to do that, authors used data of 75000 single family mortgages originated between 1998 and 2002 and estimated prepayment and default using Cox proportional hazard model. They found that borrowers liquidity constraints (measured in terms of equity to market value ratio), macroeconomic developments (unemployment rate) and alternative investment opportunities (i.e. the slope of the yield curve) has significant effects on both the prepayment rates and default rates. Other significant variables in the models include, original LTV ratio, log loan amount, origination year, income groups, age, marital status, education, occupation, and some interaction terms between age group and marital status with macroeconomic variables. Call option related factors are excluded from this research as the mortgage interest rates are determined by bank of China and all mortgages are variable rate.

Donchev (2009) used Cox proportional hazard rate model to estimate probability of default for mortgages in Netherlands using 92 thousand mortgage records originated between 2002 and 2008. He found original debt to income ratio, 3 month Euribor interest rate and unemployment rate as the determinants of the mortgage default. Additionally, the author modeled the loss given default and obtained the expected loss distribution for mortgages which he used in determining the effect on RMBS tranches.

McDonald *et al.* (2010) used survival analysis and Monte Carlo simulation in order to conceptually show how to forecast future cash-flows from mortgage products with the data of a UK mortgage lender. Authors indicated that the 2007-2008 mortgage crisis had shown the importance of accurately assessing and pricing the risks in mortgage lending. Using discounted cash flow forecasts under various macroeconomic scenarios, the authors estimated the profit distribution of the mortgage lender which can be employed in pricing new portfolios of loans.

On Spanish bank data, Cao *et al.* (2009) used survival analysis technique to model credit risk of consumer credit loans. Also there are many studies applying survival methods to commercial mortgage backed securities segment. Ciochetti *et al.* (2003), Deng *et al.* (2006), Ambrose and Sanders (2003) and Archer *et al.* (2002) are particular examples of such studies. For example, using CMBS data between 1996 and 2001 Deng *et al.* (2006) employed competing risks methodology and included loan to value ratio, debt servicing ratio, rate spread at origination, various prepayment protection indicators as the time invariant covariates and state unemployment rate as time variant covariate.

Survival analysis have also been widely used for modeling risks in other credit segments. Bellotti and Crook (2009) used survival analysis for predicting credit card defaults using macroeconomic variables such as unemployment and interest rates as time varying covariates (which cannot be readily included in logistic regression models). Authors noted that survival analysis provide improvement in comparison with logistic regression and pointed to other loan segments as future lines of research.

Prepayment

Analyzing major studies in the literature revealed that there is an important literature on prepayment modeling. Many earlier studies in the field of prepayment used pooled level data for prepayment analysis. Lacour-Little (2008) explained the studies that use aggregate pool performance as Wall Street prepayment models where authors qualitatively describe the factors used in the prepayment model and the predictive power is depicted graphically (i.e. Peters *et al.*, 1984; Patruno, 1994; Hayre, 2001). Housing turnover rates, seasonality, refinance incentive, loan age and burnout have been the main that are taken into account in Wall Street prepayment models. In a recent study, Park *et al.* (2011) analyzed the pool level mortgage prepayment rates in Korea and developed a model similar to the US PSA model. Authors concluded that Korean mortgages season fast and reach to a high level of prepayment before leveling off. They also noted that spread between MBS coupon interest rate and current interest rate, loan age and house prices increase the prepayment rate.

Hall (1985) introduced the option theoretic setting for the prepayment. Later on, given the limitations of pool-level data (i.e. directly effect of borrower characteristics on prepayment) the research on prepayment shifted to loan level data. Earlier studies found that LTV and prepayment are negatively associated (Peristiani *et al*,. 1997). Cunningham and Capone (1990) used multinomial logistic regression. Hakim (1997) estimated prepayment probability using borrower level characteristics, loan level characteristics and macroeconomic variables. Similar to the discussions with respect to default modeling, many studies examine the under-exercise behavior in the prepayment option (Quigley and Van Order, 1990; Archer and Ling, 1993; Archer *et al.,* 1996; Caplin *et al.,* 1997).

Green and Shoven (1986) is one of the first studies that applied Cox proportional hazard model to residential mortgage data in order to model prepayments. In many of the studies, methods used for default modeling are also generalized to prepayment modeling or a competing risks approach is used (i.e. Deng *et al.,* 1996, 2000, 2005;

Green and Shoven, 1986; Krainer and Laderman, 2011 and Quercia *et al.*, 2012). As noted in the default risk subsection, Deng *et al.* (1996, 2000 and 2005) are the influential papers modeling prepayment together with default using a competing risks framework.

Similarly, Ambrose and Lacour Little (2001) analyzed the prepayment behavior of the adjustable rate mortgages (ARM) via a competing risks model. The data consisted of 2699 conventional ARMs that were originated between 1992 and 1994. Authors used the dynamic ratio of current contract interest rate minus 30 year conventional fixed rate (r_f) divided by r_f as a proxy for the option variables. They argued that actual levels of house prices is unobservable and the extent that call option is in the money put option is out of the money, meaning that prepayment and default are substitutes. They also incorporated the probability of negative equity (*pneq*) variable in their models. Additionally, authors clearly stated that the prepayment risk in ARMs are significantly higher compared to FRMs and concluded that in contrast to the fixed rate mortgages loan age has a negative effect on prepayment risk.

Danis and Pennington-Cross (2005) analyzed the prepayment and default behavior of 30 year fixed rate loans originated between 1996 and 2003 (a total of 22,799 loans) using double-hurdle Tobit model. They concluded that default and prepayment risk increases due to long-run delinquency of a loan (where the effect on prepayment is higher). The authors interpret such prepayments as distressed prepayments (i.e. due to triggered prepayment penalties).

Lacour-Little and Holmes (2010) analyzed the prepayment penalties in the residential mortgage contracts for the US. Authors noted that regarding prepayment penalties, regulations differ considerably across different states. For instance in Colorado prepayment penalties could be applied within three years and at an amount of six months interest, whereas Georgia limits prepayment penalties to 2% of the loan amount in the first year and 1% in the second year and a total of 28 states restricts prepayment penalties as of 2008. Authors also noted that prepayment

penalty issue was neglected in the literature[123] and concluded that prepayment penalties bring along a measurable economic benefit via reduction of mortgage rates and should not be banned but regulated.

Kishimoto and Kim (2014) investigated the prepayment in Japanese market using Poisson regression. Noting that the volatility of interest rates were very low during the analyses period, the authors concluded that short-term interest rates have a to some extent greater explanatory power than long-term interest rates. In addition, they indicated that prepayment is sensitive to the loan age, slope of yield curve and interest rate volatility in Japan.

Lacour-Little (2008) explains the more recent discussion on the prepayment side is mainly on disentangling the prepayments arising from mobility from those due to refinancing (i.e. Clapp *et al.*, 2001) and effects of house prices on prepayments (i.e. Greenspan and Kennedy, 2007).

Cangur (2009) summarized the main outcomes of the recent prepayment literature indicating that; option theoretic framework can be used for assessing the default and prepayment behavior but it may not be sufficient due to sub-optimal prepayment decisions of the borrowers; factors such as interest rate, LTV, house prices, regional mobility rates, seasonal variations, refinancing incentive and loan age have been the main components of the empirical models; the interaction between default and prepayment behavior is important and incorporated into the theoretic framework via competing risks models and household income, interest rates and house prices are the key stochastic variables in explaining the prepayment behavior.

[123] Research on prepayment penalties in the US include; (DeMong and Burroughs, 2005; Pennington-Cross, 2003; Elliehausen *et al.*, 2008).

Case of Turkey

Some important studies focusing on Turkish mortgage market are as follows. Erol and Patel (2005ii) analyzed the default of wage indexed payment mortgage in Turkey and concluded that this contract performs better in terms of protecting borrowers compared to adjustable rate contracts. Çetinkaya (2009) formed a structural model and estimates default and prepayment risk for Turkish mortgage market. Karacula (2009) estimated the default probabilities of mortgage credits of a certain bank in Turkey by employing logistic regression and using data of 65 thousand mortgage borrowers' over 2005-2008 that is obtained from a single bank. The dataset included mortgage amount, marital status, payment to income, loan to value ratio, credit limit, time to maturity, credit extension date, interest rate, installment amount, income, gender, expertise value, education, and age variables. Analysis showed that time to maturity, payment to income ratio, mortgage amount, LTV ratio, interest rate, installment amount, income and education variables have significant effects on mortgage default for the specific bank[124]. Given the scarcity of papers regarding Turkish mortgage market, this study will be the first rigorous empirical study on Turkish residential mortgage market with a comprehensive loan level data collected from three important lenders in Turkey.

Models based on only macro-level data

According to Glennon *et al.* (2008), although there has been substantial progress in credit scoring, an agreement has not been reached on best practices. There is another line of research where only macro level data sets are used in order to investigate the sectoral level indicators such as non-performing loan ratios, interest rates, unemployment, etc. As an example, Tam *et al.* (2010) studied the residential default behavior from 1998 to 2007 in Hong Kong via autoregressive multiple linear regression. Authors concluded that lag term of the default rate, gross mortgage

[124] This is a Masters' thesis which includes only simple analysis.

interest rate, current loan to value ratio, change in debt to income ratio and consumer price index are positively correlated with default rate. Whereas, property price appreciation and local stock market index are negatively associated with default rate.

Other studies modeling the non-performing loans amount using macro-level variables such as unemployment, growth and inflation are; Rinaldi and Sanchis-Arellano (2006), Louzis *et al.* (2011) and Jakubik and Reininger (2013).

Default modeling and capital requirements

There are also few studies in the literature focusing on the relationship between mortgage related credit risk and regulatory capital requirements. Calem *et al.* (2004) analyzed the appropriateness of capital requirements (Basel-I) based on the 47 thousand single family 30-year fixed conforming loans data. They employed simulation methods (house prices, unemployment rates and interest rates are simulated over a specified horizon from the empirical distribution of these variables) and hazard models to conclude that the Basel-I (the international capital framework that was in effect at the time of the research) risk weights for some mortgage loans such as subprime loans require significantly higher capital. Moreover, Basel-I standards were punishing financial institutions with high capital requirements for other loan types and leading them to take these positions out of their balance sheets which explains the high degree of securitization in the market. Hence the authors concluded that appropriate capital charge for credit risk should vary with loan and borrower characteristics.

Using survival analysis techniques Ambrose *et al.* (2006) found evidence of regulatory capital arbitrage in mortgage related securitization. Ward (2002) focused on the issue that the Basel-II framework is calibrated for rich and developed countries and states that it may be inappropriate for the developing countries to apply it without their own variants. Powell (2004) supported the same claim and argued that Basel-II standards will yield little in terms of risk management and proposes a centralized rating based approach.

Land and Santomero (2003) analyzed the practices in the US banks regarding retail portfolios. Authors concluded that the logistic regression based scoring methods that are widely used by US banks did not provide reliable approach for setting regulatory requirements as the output of these models are basically a rank ordering measure instead of one-year probability of default. Authors suggested directly estimating parameters such as probability of default for determining capital requirements. They also indicated that Basel-II risk weight function is concave in PD, therefore more granular segmentations are associated with lower risk weights. Laurent (2004) investigated the effect of segmentation on capital requirements based on auto lease financing and found that capital requirements can be reduced by 7% if a segmentation based on scoring is used. Henderson and Jagtiani (2010) investigated the effect of mortgage portfolio segmentation on Basel-II capital requirements and concluded that Basel-II capital varies considerably across default prediction models and segmentation schemes (the more granular the segmentation the higher the capital arbitrage) which enables banks to choose the approach which requires minimum capital for their portfolios.

Provisioning

Regarding the provisioning issue, the Spanish regulation has been shown to be the best practice which related level of credit provisions to the expected losses and cyclicality in the economy (Sarina, 2009). Lis *et al*. (2000) provided a good coverage of Spanish statistical provisioning system. Moreover, Basel-II capital standard and IFRS 9 standard provides the basis for dynamic provisioning.

Main Outcomes from the Literature Review

Critical analysis of the literature reveals some important aspects about default and prepayment modeling. Firstly, recent literature regarding mortgage terminations literature heavily relies on reduced form models which incorporate call and put options. Many studies in the literature focused on inappropriateness of structural models for modeling mortgage termination risk, especially in the Europe region.

Therefore, in this thesis a similar approach is followed and both options are calculated and included in the models. Additionally, it is observed that works of Deng *et al.* about mortgage risk modeling has been the most cited works in this field. Therefore, in the modeling a similar approach is chosen when including variables to the models and presenting results.

In the recent years survival models which are taking into account competing risk aspects are the most widely used models in the mortgage termination risks field. Some studies also considered unobserved borrower heterogeneity. However, this effect is minimized when consumer characteristics could be included in the analysis and as argued by Smurov (2004) models with unobserved heterogeneity are not easy to implement and often produce no or very modest levels of such heterogeneity. Given that there are many variables for consumer characteristics (trigger events, regions, income aspects), for simplicity, a competing risks framework is chosen without taking into account the unobserved heterogeneity. Smurov (2004) also noted that despite their conceptual differences, different empirical models often produce similar estimates, which was shown by studies using more than one empirical technique.

4.5 Data

A rich, loan-level data set is obtained from three private commercial banks. Among these banks two are large scale deposit banks (one is one of the largest banks in Turkey and the other one is a comparatively smaller one) and the third one is a participation bank. The reasoning behind this selection is that banks policies and aggressiveness in mortgage lending (i.e. the cut-off value as explained in the sections above) could hamper robustness of the results and therefore heterogeneity among banks is taken into account by using this selection approach. The data set constructed for the present study corresponds to approximately one-third of the all mortgages originated in Turkey in 2013.

As indicated in Quercia and Stegman (1992), lenders generally collect data at the time of the origination (ex-ante) related to residential mortgages. This disables us to use many of the variables as time-varying covariates. Given that there is no national/international level standard on banks data collection requirements, the depth and coverage of data that is obtained by different banks vary considerably.

Banks that are contacted for this study[125] are requested to provide all mortgage default and prepayment related data in a pre-specified format (template). In that template, mortgages with maturities less than two years, mortgages denominated in currencies other than Turkish lira and variable rate mortgages are excluded. The reason for excluding short term mortgages is that default modeling necessitates at least 12 months observation period.[126] Also extending consumer loans to individuals other than Turkish Lira is prohibited in 2009 with Decree Law # 32 on Protecting the Value of Turkish Lira. Therefore, measuring the riskiness of foreign exchange denominated mortgage loans whose share is negligible in bank-portfolios is not relevant today. Lastly, Law #5582 which was published in the Official Gazette on March 6th, 2007 introduced strict requirements for banks while extending variable rate loans. Today, fixed rate loans dominate the Turkish mortgage market.

Table 35 shows the number of mortgages and relevant origination periods for the data obtained from three banks. It is seen that our data base includes more than 710 thousand individual mortgages and that there is a common data period starting from January 2007 and ending in March 2014.

[125] Four banks are contacted for gathering information and three of them provided data.

[126] More specifically, logistic regression based models require at least two-year maturity for the default modeling. Additionally, in Turkey, the maximum maturity for mortgage loans is 120 months for most of the banks. Therefore, mortgages with longer than 10-year maturities are excluded. Among the three banks in the sample, only one of them has extended mortgage loans exceeding 10-year maturity and the share of such mortgages is stated to be negligible by the relevant bank personnel.

Table 35: Data Obtained from Banks

	# of Mortgages Reported	Starting date	End date	Quality of Data
Bank 1	393,451	1/1/2005	31/3/2014	+
Bank 2	267,732	1/1/2007	31/5/2014	+
Bank 3	51,488	07/02/2002	31/4/2014	-

Initial analysis revealed that the default and prepayment data submitted by Bank 3 is not reliable[127]. Therefore, the third bank's data set is excluded from the modeling. On the other hand, in obtaining some descriptive statistics such as gender and age distribution of mortgage borrowers, data of this bank is also used.

The table below categorizes the variables included in this thesis (both the descriptive analysis and the modeling) according to i) loan related variables, and ii) borrower related variables, iii) housing property or collateral related variables and iv) option indicators.

[127] I.e. any early payment of an installment is reported as prepayment and default data are not provided.

Table 36: Categorization of Variables

Category	Variables
Loan related	Credit Date/Credit Year Credit Amount Installment Amount Maturity/Remaining Maturity Interest Rate Status LTV/CLTV Default Date Prepayment Date
Borrower related	Age Gender Initial Marital Status Married/Divorced Education Income/Payment to Income Occupation Score Delinquency Purpose Restructuring First House
Housing property or collateral related variables	City Appraisal Value Area Collateral Age Lien
Option Indicators	-Call Option (Poption) -Put Option (CEMV)

The following list describes the data in more detail and provides links with the default and prepayment modeling literature.

Code:

In order to identify each customer of each banks, a bank specific code is given to borrowers (such as A1, A2,… for the first bank and B1, B2,… for the second bank, etc.).

Credit Date (Credit_Date/Credit_Year) [128]:

Credit extension date is available for all data points. This data helps identifying the various cohorts according to origination. Capozza and Order (2011), Deng *et al.* (2005) and Calem *et al.* (2004) used origination year dummies (Credit_Year) in their models.

Credit Amount (Credit_Amount):

Changes in macroeconomic conditions are likely to affect the default behavior more, when the loan sizes are becoming larger (Lin, 2004). In many studies in the literature (Deng *et al.* (2005), Calem *et al.* (2004), Krainer and Laderman (2011)) loan amount is taken into account in the mortgage termination models after log transforming the data. In this thesis, a similar approach is followed.

Instalment Amount (Installment_Amount):

Installment amount is the monthly payment for the mortgage loans and it is used in calculating Poption variable. It is not included in the prepayment and default models as the other variables, namely, maturity and loan size compensate for it.

Maturity:

An increase in mortgage term brings along additional factors regarding the mortgage termination risk. In credit risk context, longer maturity lending is accepted as more risky (Basel-II IRB approach introduces a maturity adjustment according to maturity for the calculation of capital requirements). Capozza and Order (2011) and Karacula (2009) used maturity as an explanatory variable in their default models.

Interest Rate (Interest_Rate):

Mortgage interest rate at the origination is provided for all banks and all loans. Karacula (2009) used mortgage interest rate as an independent variable. Assuming that banks use risk based pricing approaches, it might be expected that borrowers

[128] Variable names in parenthesis are the ones used in modeling.

borrowing at higher rates are riskier. Literature suggests that prepayment increases with origination interest rates (Adelman *et al.* (2009), Kujpers and Shotman (2007)).

Status:
At every calculation date, the status of the loan is set to;
D: for default
P: for prepayment
M: for matured loans and
O: open account.

Default Date (Default_Date):
The date of default is provided in this field. For non-defaulting mortgages the value is set to "NA". Default dummy is calculated based on this date.

Prepayment Date (Prepayment_Date):
The date of prepayment is provided in this field. For non-prepaying mortgages the value is set to "NA". Prepayment dummy is calculated based on this date.

Loan to value ratio (LTV):
Related literature on mortgage termination showed that LTV is one of the most important indicators of default and prepayment (current LTV: Calem *et al.,* 2004; Goodman and Smith, 2010; Krainer and Laderman, 2011; initial LTV: Deng *et al.,* 1996, 2000, 2005; Van Order, 2007; Donchev, 2009). As the LTV ratio at the initiation increases, the possibility that the value of the collateral go below the present value of the remaining payments increases. On the other hand, high LTV values might mean low prepayment.

Age:
The age of the borrower at the loan origination is provided. Deng *et al.* (1996) used Age>40 and Age>40 as dummies. Karacula (2009) used Age as a continuous variable. Age is used as a continuous variable in order not to lose any information.

Gender:

Gender of the borrower is provided by the banks. This categorical variable is set to zero for females and 1 for males. Wu and Deng (2010) used gender as an explanatory variable in their prepayment model.

Initial Marital Status (Initial_Marital_Status):

The marital status of the borrower is categorized as 1 for married and 0 for others. Deng *et al.* (2005) and Calem *et al.* (2004) used marital status in default and prepayment modeling.

Marital Status Change (Marital_Status_Change – Married/Divorced):

Within the term of the mortgage loan, if there is a change in marital status then this dummy is set to one, otherwise it is set to zero. Deng *et al.* (2000) used state level divorce rate as an explanatory variable. In the modeling the Married/Divorced dummy is used which is set to 0 for no change, 1 for marriage and 2 for divorce.

Education:

This variable is set to 1 for Primary education, 2 for Secondary education and 3 for Undergraduate or higher education level. Calem *et al.* (2004) and Deng *et al.* (2005) used education level as an explanatory variable for mortgage termination risk.

Income:

Monthly income variable is used as a continuous variable. Wu and Deng (2010) and Deng *et al.* (1996) used income variable in prepayment and default modeling.

Occupation:

Based on different grouping provided by the banks, occupation data are allocated to three main groups; governmental job, private sector job and self-employment. Occupation is used as an explanatory variable in Deng *et al.* (2005).

Score:

Credit scores given by banks internal models are obtained and the scales of these scores is adjusted so that max score becomes 100 and minimum score becomes 0. During the analysis of the data, it is observed that the scoring system has changed in the banks. Therefore, this variable is not included in the default and prepayment modeling.

Purpose:

Normally, mortgage loans are the loans that are extended with the purpose of buying a house. However, in Turkey and in many other jurisdictions mortgage loans can also be used as a source of cheaper finance for other financing needs. Consequently, loans obtained for the purchase of a house are categorized as 1, loans for all other purposes are categorized as 0. Capozza and Order (2011) included Purpose variable in their models. However, due to high number of missing values, this variable could not be integrated into modeling.

City:

Traffic license plate codes are used for categorizing cities in the data provided by the banks. Goodman and Smith, Calem *et al.* (2004) and Krainer and Laderman (2011) used state dummies in modeling mortgage termination risk depending on the location of the collateral. In the modeling 7 cities, for which house price appreciation rates are available, are included as city dummies. Other cities are coded as 0.

Appraisal Value (Appraisal_Value):

Appraisal value of all the loans are requested from the banks which gives the value of the collateral at the origination. Used for calculating the LTV value.

Area:

Floor area of the collateral. Only available for Bank 1 and Bank 3 for a small number of observations. Wu and Deng (2010) noted that house specific attributes are useful in estimating prepayment.

Collateral Age (Collateral_Age):

Age of the collateral as of origination. Only available for Bank 3. Wu and Deng (2010) noted that house specific attributes are useful in estimating prepayment.

Payment to Income (PaymenttoIncome):

By dividing monthly mortgage payments by monthly income, payment to income ratio is obtained. Van Order (2007), Donchev (2009) and Karacula (2009) used this as an explanatory variable. Following Deng *et al.* (2005) log (Income) variable is used in the modeling.

Lien:

Lacour-Little (2004) indicated that junior liens might affect mortgage loan performance arguing that in theoretical models the main assumption is that all borrowers has only one loan that is collateralized by the underlying property. However, this data could not be provided by two of the banks.

Restructuring Date / Restructuring Interest Rate (Restructuring_Date/ Restructuring_Interest_Rate)

Only available in Bank 1. If the mortgage loan is restructured before the maturity then its restructuring date is provided together with the restructuring interest rate.

Delinquency:

When the delay in monthly payments is between 30 days and 90 days, then these are recorded as delinquency. In banks credit scoring models delinquency is an important indicator of default. Danis and Pennington-Cross (2005) used delinquency data in modeling prepayment and default. Moreover, both Basel-II and the IFRS 9 standard indicates to delinquency status as an important indicator.

First House (First_House):

This variable could only be provided by Bank 1 for limited number of data points. The variable takes the value 1 if this is the first house of the mortgage user. Otherwise, it is set to 0.

Macroeconomic variables

In some studies macroeconomic variables such as Unemployment[129] (Deng *et al.*, 2000) and Interest Rate (Donchev, 2009 used 3-month LIBOR rate) variables are taken into account. These variables are obtained from Turkish Statistical Agency (TUIK) and Central Bank of Republic of Turkey (CBRT) databases respectively.

Option Predictors:

Prepayment option (Poption):

Deng *et al.* (1996, 2000), Archer and Smith (2011) used the poption variable as an indicator of prepayment. It is calculated as the present value of the unpaid mortgage balance at the current market interest rate minus the value discounted at the contract interest rate divided by present value of the unpaid mortgage balance at the current market interest rate. The possibility of prepayment is expected to increase with this indicator.

$$poption = \frac{\sum_{t=1}^{\tau} \frac{Installment_t}{\left(1+\text{market rate}_q\right)^t} - \sum_{t=1}^{\tau} \frac{Installment_t}{(1+\text{interest rate})^t}}{\sum_{t=1}^{\tau} \frac{Installment_t}{\left(1+\text{market rate}_q\right)^t}} \qquad (39)$$

where; τ is the number of remaining installments at period *q*,

q is the calculation quarter,

Installment is the installment amount,

Interest rate is the origination interest rate.

Default Option (Current Equity to Market Value- CEMV):

Deng (2005) employed the current equity to market value approach as a proxy for put option. In this approach;

[129] Results are mixed on the effect of unemployment on prepayment (see, Deng *et al.* (2005))

$$E_{i,k_i} = \frac{M_{i,k_i} - V_{i,m,\tau_i+k_i}}{M_{i,k_i}} \quad (40)$$

$$M_{i,k_i} = C_i \left(\frac{I_{\tau_i+k_i}}{I_{\tau_i}} \right) \quad (41)$$

$$V_{i,m,\tau_i+k_i} = \sum_{t=1}^{TM_i-k_i} \frac{P_i}{(1+m_{\tau_i+k_i})^t} \quad (42)$$

where C is the purchasing value of the property at the origination (time τ), M is the current market value of the underlying property, $I_{\tau_i+k_i}$ and I_{τ_i} are house price indices at corresponding time points, V is the current value of the mortgage, TM is the contract term, P is the mortgage installment amount and m is the current market rate for mortgages.

Other variables for which data could not be obtained:
For some variables, no reliable data could be provided by banks. For instance, if the collateral is revalued during the maturity of the mortgage, then the revaluation value is requested. However, this variable could not be provided. Additionally, prepayment penalty is also another variable requested, however, all banks indicated that fixed 2% prepayment penalty is applied.

Table 37 provides the variables covered in some of the important studies that modeled prepayment and default together with the availability of that data for the analyses in this thesis.

Some additional details about the data and manual changes applied to the data are given in Appendix E.

Table 37: Variables Used in Some Major Studies

Deng *et al.* (2000)	**Deng et.al. (2005)**	**Karacula (2009)**	**Calem *et al.* (2004)**	**Krainer and Laderman (2011)**	**Donchev (2009)**	**The Present Study**
Call Option and squared term						+
Put Option and squared term (Probability that there is negative equity).	Current Equity to Market Value (CEMV)					CEMV: +
	Slope of Yield Curve					Not common practice, will not be investigated
LTV(as categorical variable) <0.6 0.6-0.75 0.75-0.8 0.8-0.9 >0.9	LTV>60	Loan to value ratio	Current LTV	Current LTV and Current LTV squared	Initial LTV	Current LTV: +
	Log value of original amount	Mortgage amount	Loan Amount	Log loan size		+
State Unemployment	Local Unemployment Rate		Change in Local Unemployment	Local Unemployment	Local Unemployment Rate	-
	Origination year	Credit extension date	Period dummy			+
	Income Group	Income			Payment to Income	Income/PTI: +
	Age<40	Age				+
State Divorce Rate	Married	Marital status				Initial Marital Status: + Married/Divorced: +
	Education	Education				+
	Occupation					+
	Stock Exchange					Not common practice, will not be investigated,
		Credit limit				-
		Time to maturity				+
		Expertise value				Not common practice, will not be investigated.
		Interest rate			3-month Euribor rate	Mortgage Interest Rate: +
		Installment amount				Not common practice, will not be investigated
		Gender				+
			Burnout			-

Table 37: Variables Used in Some Major Studies (continued)

	Spread	Mortgage Spread and Mortgage Spread Sq	Not common practice, will not be investigated
	Score	FICO	+
	State dummy	State fixed effects	City Dummy: +
		Penalty	In Turkey a fixed penalty of 2% is applied. Therefore, mortgage loans cannot be differentiated based on penalty.
		Subprime	-
		Jumbo	-
		Full documentation	-
		Conforming	-
		Private label	-
		Interest Rate Volatility index	-
			Delinquency Dummy: +
			Lien: +

"+" Available, "-"Not Available

4.6 Methodology and Analysis

This section covers the methodology used in assessing the riskiness in the Turkish mortgage market. Additionally, both qualitative and quantitative analyses are also given in this section.

4.6.1 Methodology

There are various analytical techniques regarding default and prepayment modeling including ordinary least squares, logistic regression, discriminant analysis and survival methods. A more detailed discussion on relevant literature is provided in literature review section. Following the discussion in that section survival analysis is employed in this thesis.

The sufficiency of national regulations such as general credit provisions and capital requirements is evaluated based on the output of the models that will be constructed using loan level data. Typical steps in developing models using loan level data are provided in the Figure below.

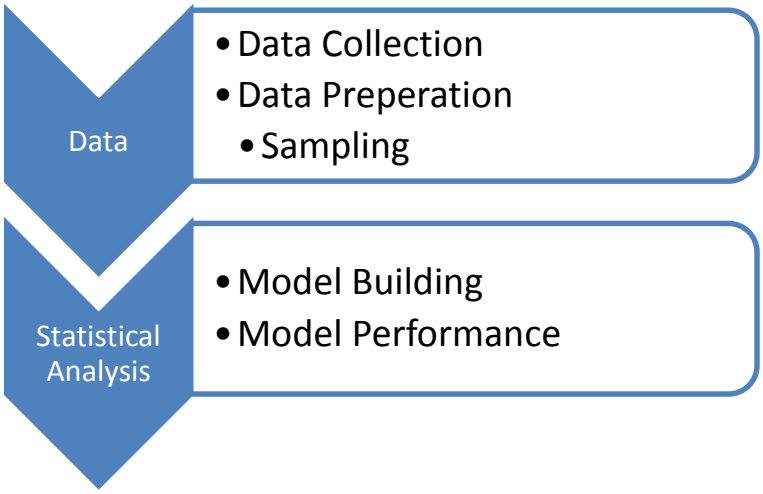


Figure 46: Developing Models Using Loan Level Data

As mentioned above, even though Basel-II implementation has recently started in Turkey, progress by the banks since 2006 enabled banks to have significant amount of loan level data[130].

Kau *et al.* (1994) indicated that except for the cases where initial LTV or the house price volatility is high, the effect of prepayments is greater compared to the effect of defaults on the mortgage valuation. Consequently, significant attention is also paid to prepayment models in this thesis.

Common modeling practice regarding default and prepayment is based on cross sectional sampling designs where a selection of customer histories is observed at

[130] Modeling credit risk requires a comprehensive database including loss experiences, lender characteristics (current and past), value of the underlying property and so on.

time t and payment behavior is tracked over some future time periods (Normally between 12 to 24 months). Models are used to predict the performance over the interval [t, t+k] depending on the observed characteristics at time t. On the other hand, in dynamic modeling, observations over multiple periods of time for fixed set of units is used. (Glennon *et al.*, 2008).

In this thesis, performance period is used as one year as suggested by the Basel-II framework. However, in order to calculate provisioning rate for the loans with delinquency, expected loss during the remaining life of the loan is calculated by following the approach suggested by the IFRS 9 standard.

A distinction should be made between delinquency and default for the aims of this work. Delinquency occurs when the borrower misses at least one of the payments but no more than three payments. There could be several reasons behind this failing to pay condition such as a temporary disruption in income. In practice and also in international standards the borrower is considered to be in default state when three consecutive payments are delinquent. Default is "the transfer of legal ownership of the property from the borrower to the lender either through the execution of foreclosure proceedings or the lender's acceptance of a deed in lieu of foreclosure" (Giliberto and Houston, 1989:56). This definition is somewhat different from the term technical default where any breech of mortgage contract is a technical default.

4.6.1.1 Survival Analysis Theory

According to Lacour-Little (2008:314) although there are many methodological approaches for default modeling in the literature, survival models such as proportional and non-proportional hazards are generally the preferred choice. The survival modeling approach was originated from the medical statistics field and there is a simple analogy with respect to the mortgage finance field: as a result of default and prepayment, mortgage contract might terminate/expire due to time-invariant characteristics and external events.

Both mortgage prepayment and default causes right censoring in the data. Some mortgages mature during the observation period and for those mortgages actual durations to default and prepayment cannot be observed. Secondly, if a mortgage is defaulted, it cannot be prepaid and vice versa. As a result defaulted loans are considered as censored data for prepayment function and prepaid loans are considered censored for the default function (Deng *et al.*, 1996:266).

The Competing Risks Model

Pavlov (2001) argued that the widely used non-competing risks estimation of the mortgage termination risk could be misleading. The competing risks model, on the other hand, can simultaneously examine two or more events. In the special case of mortgages the competing risks model take into account both the default and the prepayment.

In the survival model the time for the event occurrence, *T*, is a random variable with a continuous distribution function $f(t)$ of, and *t* is the time that the event occurs. In this setting, the cumulative distribution function (cdf) of the event occurrence can be shown as:

$$F(t)=\int_0^t f(s)ds=\Pr\{T\le t\}. \qquad (43)$$

The survival function, which indicates that the time to prepayment will be of a time period of at least t is given by:

$$S(t)=\Pr(T>t)=1-F(t). \qquad (44)$$

and the probability density function is:

$$f(t)=\frac{dF(t)}{dt}=-\frac{dS(t)}{dt}. \qquad (45)$$

The hazard function, the probability that the default will occur in the short interval of Δt can be defined as:

$$H(t) = \lim_{\Delta t \to 0^+} \frac{\Pr(t \le T < t + \Delta t | T \ge t)}{\Delta t} = \frac{f(t)}{S(t)}. \quad (46)$$

When there are k covariates, the hazard function can be written as:

$$H_i(t) = h_0(t)\exp(\beta_1 X_{i1}(t) + \beta_2 X_{i2}(t) + ... + \beta_l X_{il}(t)) \quad (47)$$

Where $h_0(t)$ is the baseline hazard function, indicating the probability of default or prepayment under homogeneous conditions. The coefficients of independent variables affecting default or prepayment, X_i are $\beta = (\beta_1, \beta_2, \cdots, \beta_l)$. Cox (1972) proved that β can be estimated without knowing the exact baseline hazard function. Taking logs of both sides, the Cox partial likelihood model is obtained.

$$\log H_i(t) = \log(h_0(t)) + \beta_1 X_{i1}(t) + \beta_2 X_{i2}(t) + ... + \beta_l X_{il}(t) \quad (48)$$

In this setting, the probability that s^{th} mortgage in a portfolio will default at time t_k is given by:

$$P(t_s = t_k | R(t_k)) = \frac{\exp(\beta' X_k)}{\sum_{s \in R(t_k)} \exp(\beta' X_s)} \quad (49)$$

since baseline hazard is fixed for all mortgages. In this equation, $R(t_k)$ is the number of mortgages that are at risk of defaulting/prepayment at time t_k.

By taking the product of these probabilities; the partial likelihood function can be written as:

$$L = \prod_{k=1}^{K} \frac{\exp(\beta' X_k)}{\sum_{s \in R(t_k)} \exp(\beta' X_s)} \quad (50)$$

The competing risk model can analyze two events simultaneously (default and prepayment). This estimation technique eliminated the problems that occur due to separate estimation of these risks and assuming that default and prepayment are independent risks. Deng *et al.* (2000:303) indicated that forecasts that pay no attention to the interdependence between prepayment and default risk leads to significant errors while estimating the default risk. The competing risks model overcomes this limitation by providing a unified model which allows dependence between prepayment and default risks to be taken into account (Lacour-Little, 2008).

The cumulative incidence function (CIF) which indicates the probability that an event of type j has occurred by time t can be given as;

$$F_j(t) = \int_0^t f_j(s)ds = \Pr\{T \le t \text{ and } J = j\} \qquad (51)$$

Competing risk models can be classified under two main categories, namely, the latent failure time models and informative censoring models (Busschers, 2011: 34). In the latent failure time models competing risks are modeled in a multivariate failure time context where it is assumed that only the earliest of failures is observed and all other failure times are latent. In these models, it is assumed that competing risks are independent which clearly does not hold for the case of mortgages. Informative censoring models include cause specific hazard rate model and subdistribution hazard rate model.

Cause Specific Hazard Rate Model (Kalbeisch and Prentice):

In the context of prepayment and default modeling, cause specific hazard rate for cause j can be characterized as;

$$H_j(t \mid X) = \lim_{\Delta t \to 0^+} \frac{\Pr(t \le T < t + \Delta t, \varepsilon = j \mid T \ge t, X)}{\Delta t} \text{ for j=1,2} \qquad (52)$$

where ε is the failure type; prepayment or default. In this setting observations that has a termination except j are considered as censored observations.

Subdistribution Hazard Rate (Fine and Gray):

The hazard rate for subdistribution hazard rate model for prepayment and default modeling is characterized by;

$$H_j(t \mid X) = \lim_{\Delta t \to 0^+} \frac{\Pr\left(t \le T < t + \Delta t, \varepsilon = j \middle| T \ge t \cup (T \le t \cap \varepsilon \ne j), X\right)}{\Delta t}$$

for j = 1,2 (53)

where ε is the failure type; prepayment or default. Here, observations that terminates due to the other cause (i.e. prepayment when the hazard rate for default is taken into account) are included in the risk set at time t (i.e. they are not censored).

(Busschers, 2011: 38) noted that Fine and Gray methodology creates biased results when the frequency of competing events is significantly different and this methodology is not appropriate for time varying covariates. Since default frequency in the dataset is significantly lower compared to prepayment frequency and time varying covariates are included, cause specific hazard rate is employed in this thesis.

The competing risks proportional hazard model is estimated by maximizing the following partial likelihood function [131]:

$$L(\beta) = \prod_{j=1}^{m} \prod_{i=1}^{k_j} \frac{\exp(x_{ji}(t_{ji})\beta_j)}{\sum_{l \in R(t_{ji})} \exp(x_l(t_{ji})\beta_j)} \quad (54)$$

where

i is a history,

j=1,…,m is the types of termination (i.e. prepayment, default),

k_j is the number of subjects in the data with termination type j,

and $R(t_{ji})$ denotes the set of observations exposed to risk *j* after *t* periods of history.

Finally, estimated one year probability of default (or prepayment) that is of interest in this thesis is[132];

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[131] Notation is taken from Krainer and Laderman (2011)

[132] See Bushers (2011) for a more detailed theoretical discussion.

$$P(T = t, \varepsilon = j | T > t - 1) \text{ for j=1,2.} \quad (55)$$

$$P(T = t, \varepsilon = j | T > t - 1) = \frac{P\left((T=t, \varepsilon=j) \cap (T>t-1)\right)}{P(T>t-1)} \quad (56)$$

$$= \frac{P(T=t, \varepsilon=j)}{P(T>t-1)} \quad (57)$$

$$= \frac{P(T \leq t, \varepsilon=j) - P(T \leq t-1, \varepsilon=j)}{P(T>t-1)} \quad (58)$$

$$= \frac{F_j(t) - F_j(t-1)}{S(t-1)} \quad (59)$$

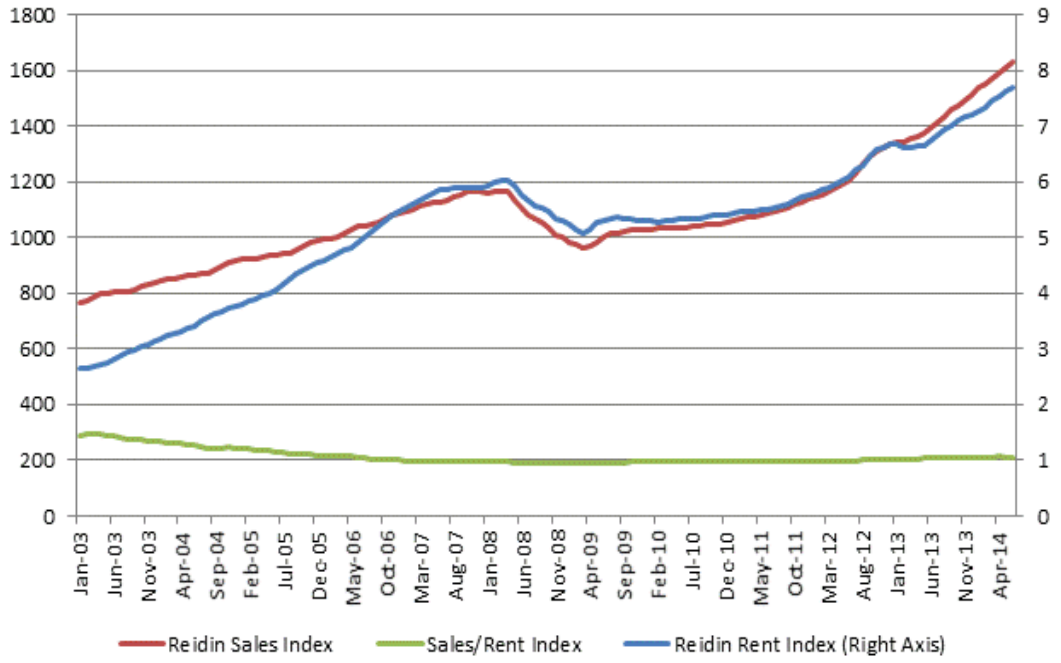
4.6.2 Analysis

In this section, descriptive analysis on both the mortgage originations in Turkey and mortgage termination risks are provided.

4.6.2.1 Descriptive Analysis of Mortgage Termination Risks

In this subsection the housing price dynamics and changes in unemployment rate over the past decade are discussed first. After this discussion, descriptive analysis of mortgage originations is covered.

Figure 47 displays the house price changes and changes in rental income between 2003 and 2014 in Turkey and shows that house prices in Turkey has almost doubled in the last 10 years. We also observe a similar trend in rent index. Finally, the sales/rent index which is a popular indicator to observe housing bubbles is at quite reasonable levels, which does not indicate extremely high house prices compared to rent.

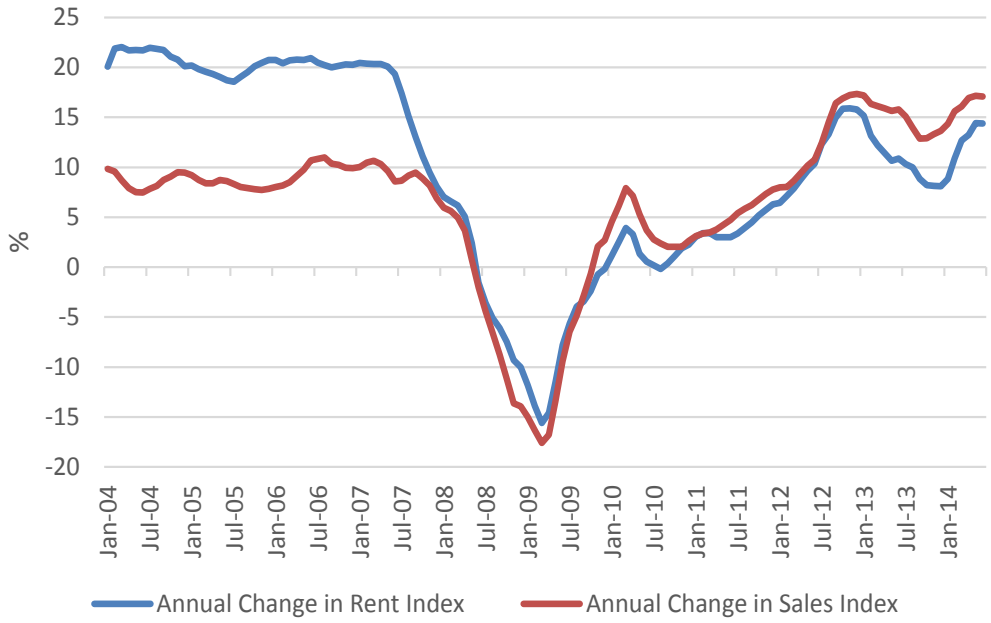


Data Source: REIDIN[133]

Figure 47: REIDIN Rent and Sales Indices

Annual change in the REIDIN rent and sales indices are presented in Figure 48. The effect of global financial crisis on the Turkish housing market can be better analyzed via this figure. During global financial crisis period, house prices in Turkey decreased more than 15%. House prices returned back to pre-crisis levels in around two-year time period. Also, the increase in sales prices exceed the increase in rent prices after the crisis period.

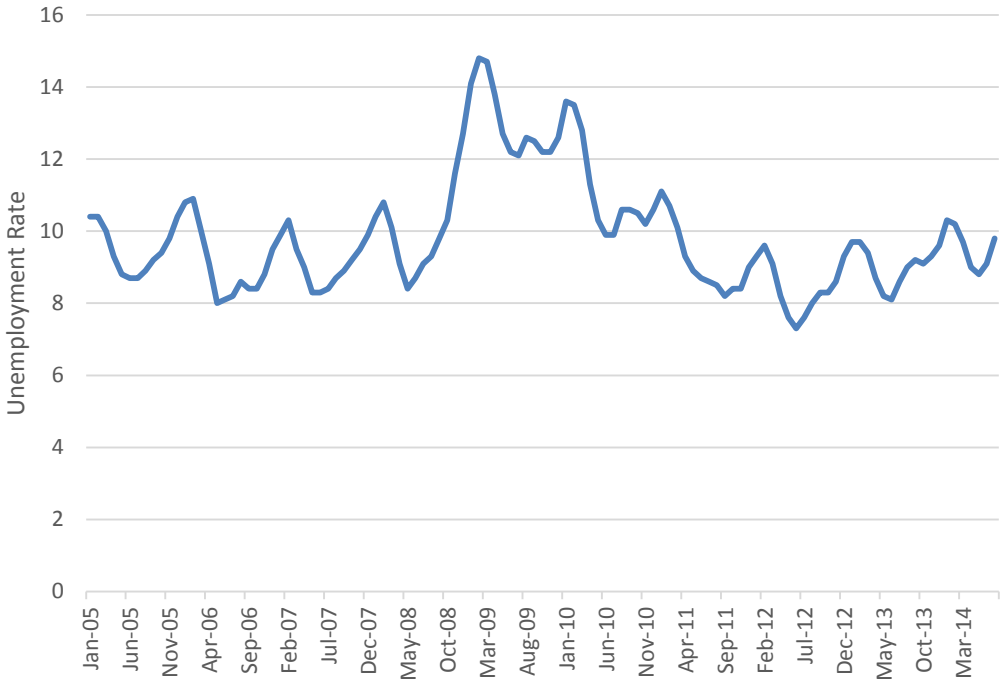
[133] REIDIN Index can be criticized due to its methodology. On the other hand, the only other available data source on this issue is CBRT database, but it starts from 2010 and does not cover the time period included in this thesis.



Data Source: REIDIN

Figure 48: REIDIN Rent and Sales Indices – Annual Change

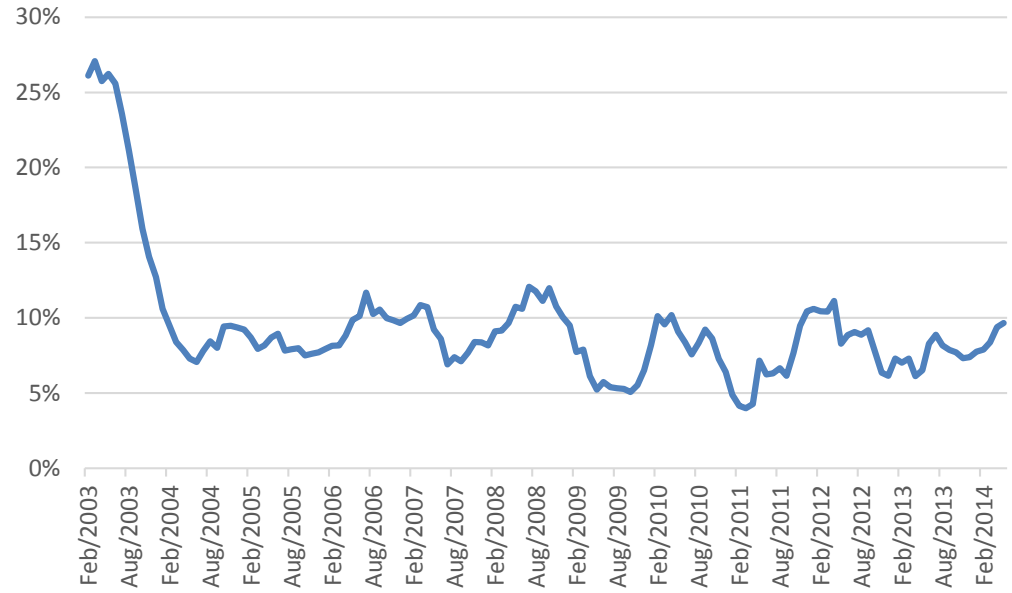
Another macroeconomic indicator related to housing market is unemployment rate. In Turkey unemployment rate has been fluctuating around 8-10% for many years (Figure 49). Similar to the pattern in house prices, unemployment rate was severely affected by the global financial crisis and exceed 14% level during early-2009.



Data Source: Thomson Reuters

Figure 49: Unemployment Rate

Lastly, Figure 50 illustrates the development in CPI inflation. Inflation rate which was exceeding 25% as of January 2003, decreased to 7% level in 2004 and after 2008 inflation rate fluctuated between 5-10%. While it can be argued that decreasing inflation was a significant achievement, current rate of inflation is still very high compared to the developed countries.



Datasource: Turkstat

Figure 50: CPI Inflation – Yearly Basis

Microsoft Excel 2013 is used in order to prepare the raw data for statistical analysis. As the size of data set is huge, the data is exported to Microsoft Access 2013 in order to carry out the analyses and obtain the results presented in this section. After the results are obtained through more than a hundred and seventy simple and crosstab SQL queries, they are turned into graphs in Microsoft Excel 2013.

As indicated in the previous sections, there is no comprehensive information in the literature analyzing the main features of the mortgage originations in the Turkish banking sector. Given that sampled banks are quite similar in terms of many characteristics, it can be argued that most of the analyses in this section can be generalized to the sector.

Brief results from the following descriptive analyses can be summarized as follows;

i. Mortgage loan maturities are lengthening in the Turkish mortgage market on average from 5.7 years in 2007 to 7.6 years in 2013,
ii. Mortgage interest rates are falling and the rates are not differentiating significantly among the three lenders in our sample,

iii. The share of less than 100,000 TRY loans in banks' mortgage portfolios are increasing while housing prices are increasing,

iv. On average, property appraisal values of the newly originated mortgages are decreasing. In addition, both the average floor area of the houses and the average age of mortgage borrowers are decreasing. This implies that, there has been a positive improvement towards the accessibility of mortgage products,

v. At the mortgage origination, approximately 80% of the borrowers are married and nearly 25% of them are females,

vi. Banks have different portfolios regarding the education level of the borrowers, interestingly the mortgage borrowers of the participation bank has the highest education level,

vii. Analyzing the occupational profile of borrowers, it is observed that whilst the share of public officials has been decreasing, the share of private sector workers and self-employed workers has been increasing,

As noted earlier in the data section, data set is obtained from three banks in Turkey. For the first bank data set goes back to 2005, whereas for the second bank, data history goes back to 2007. For the participation bank (Bank 3), data set is available starting from 2002. Figure 51 indicates that the number of mortgage exposures increased along with recent developments in Turkish mortgage market. Within the overall sample, the largest number of mortgages were originated in 2013. This is totally aligned with the analyses presented in Chapter 3 (i.e. growing residential mortgage market).

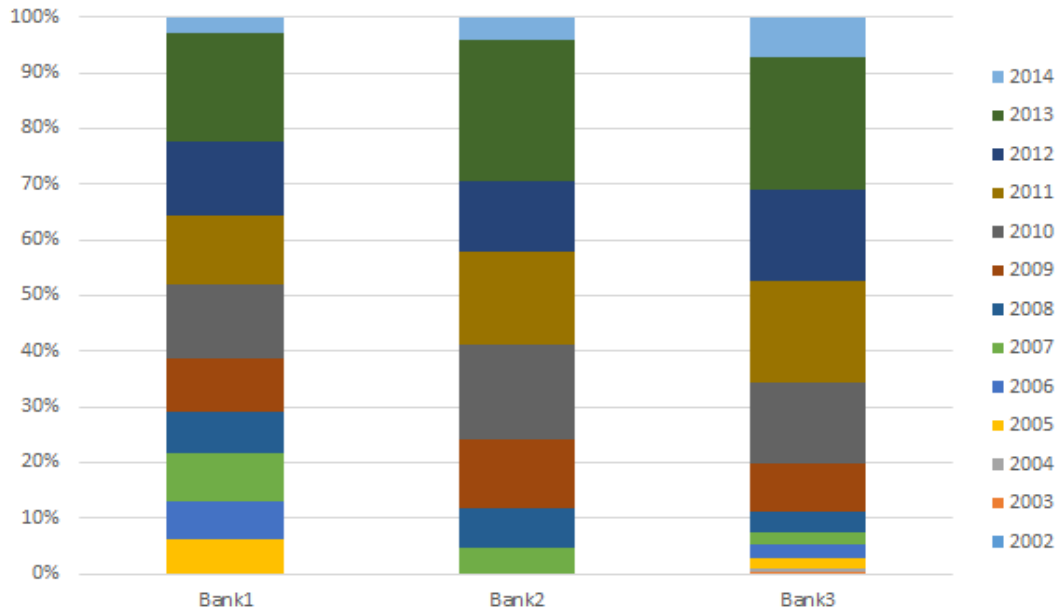


Figure 51: Origination Year of Mortgage Exposures

Figure 52 provides a maturity breakdown of mortgage originations for the sample. The left hand side graphs provide a detailed analysis of the loan maturity whereas the right hand side graphs display the aggregated figures for the mortgage origination year. Clearly, for all three banks the 10-year maturity, i.e. 120-month maturity is one of the most preferred maturity (for Bank 3 it is the 60-month maturity). It can be observed that Bank 2 and Bank 3, mostly originated products such as 48- and 60-month maturity mortgages. On the other hand, for Bank 1, there is no such concentration in terms of specific maturities (i.e. maturity distribution is uniform). This indicates that maturity selection is mostly dependent on the orientation of banks towards certain products. Additionally, the graphs on the right hand side show that the share of ten year-maturity loans has increased notably during the past years for all three banks. We see that in the two large scale banks, share of 120-month maturity mortgages reached 50% of the new originations, whereas this level remained around 25% in Bank 3.

There is significant demand for longer term mortgages from the consumers but banks need to adjust their funding sources in order to respond to that demand. In that sense, small scale banks are disadvantageous compared to large scale banks.

It is also important to note that for Bank 3 (where data set was available back to 2002) until 2004 the most popular mortgage product has been under 36-month maturity mortgage loans. However, under the relatively stable macroeconomic conditions in Turkey the share of longer term mortgage products have increased significantly, especially after 2005.

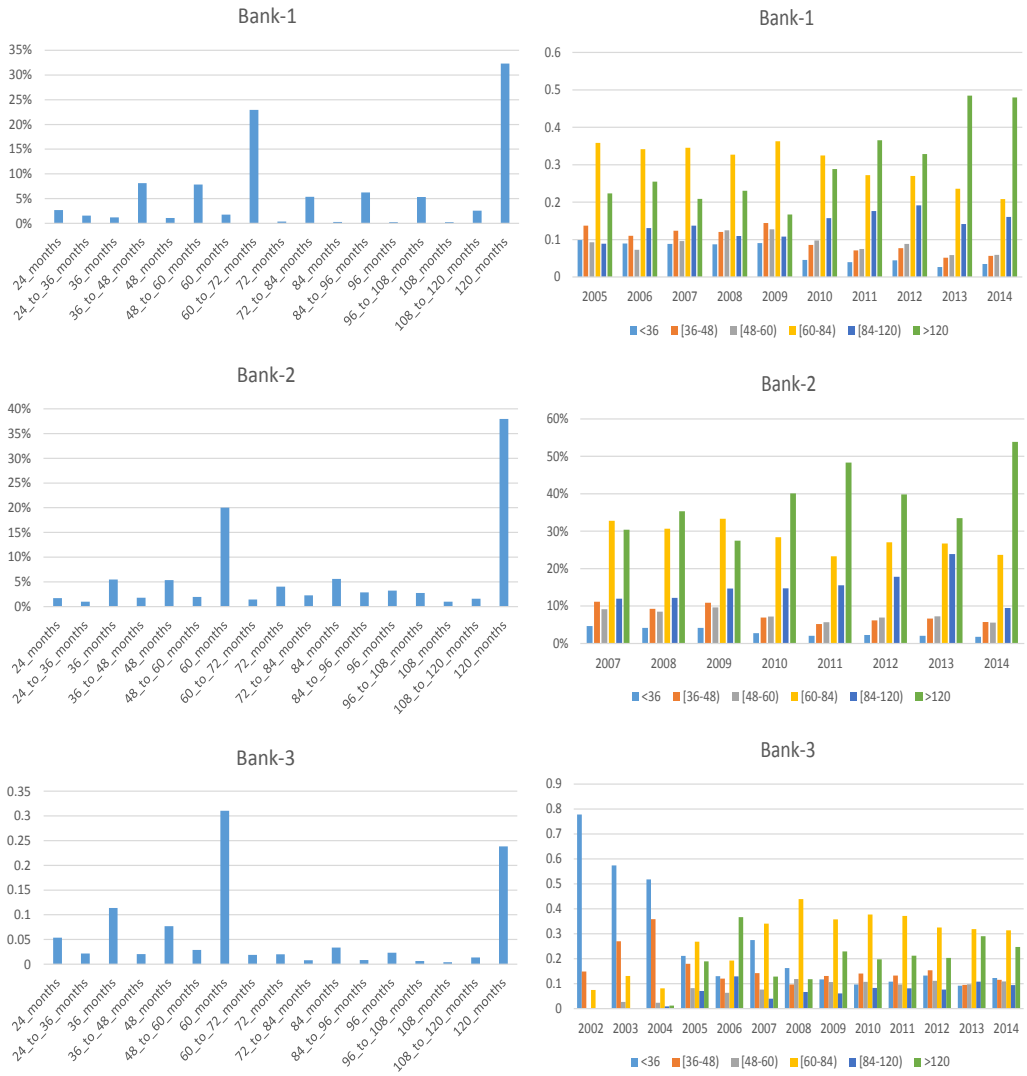


Figure 52: Maturity Breakdown

Figure 53 presents the average interest rate by the origination year and shows that average monthly interest rates in the mortgage origination has been decreasing in the in the observation period.

Elliott (2010:43) rightfully indicate that, the problem about Turkish housing market is not related to expensive homes but related to expensive home loans. Average interest rate for Bank 3, was more than 2.5% per month in 2002 (corresponds to almost 35% annual interest rate). After 2010, the origination interest rate decreased below 1% level which is very positive for the development of the market. Moreover, during 2014, there was a significant increase compared to the previous year. Last but not least, this figure shows that average mortgage interest rates are very close in all three banks, showing that bank size is not a direct indicator of advantageous mortgage interest rates in Turkey.

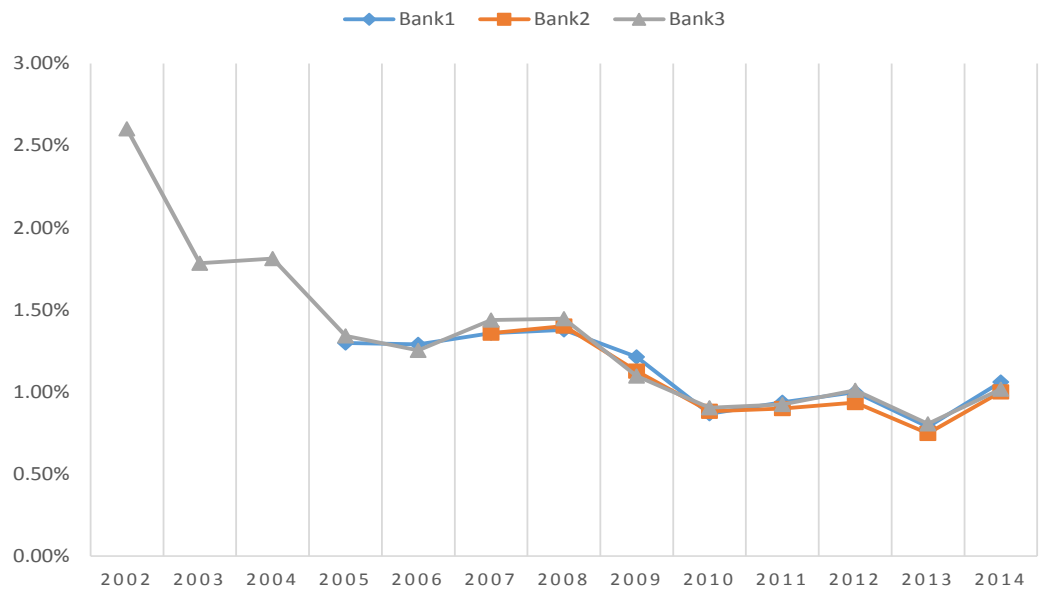


Figure 53: Average Interest Rates by Origination Year

Figure 54 illustrates the distribution of mortgage interest rates according to origination years. More specifically, mortgage interest rates above 1.2% per month almost disappeared from the market after 2010. Additionally, when we look back to

2002, although average rates applied were very high, for some customers Bank-3 provided mortgage loans as low as 0.8% interest rate per month. Lastly, during the short observation period in 2014, we observe that the mortgages were split between under 0.8% category and 0.8% to 1% category and the share of other categories are minimal.

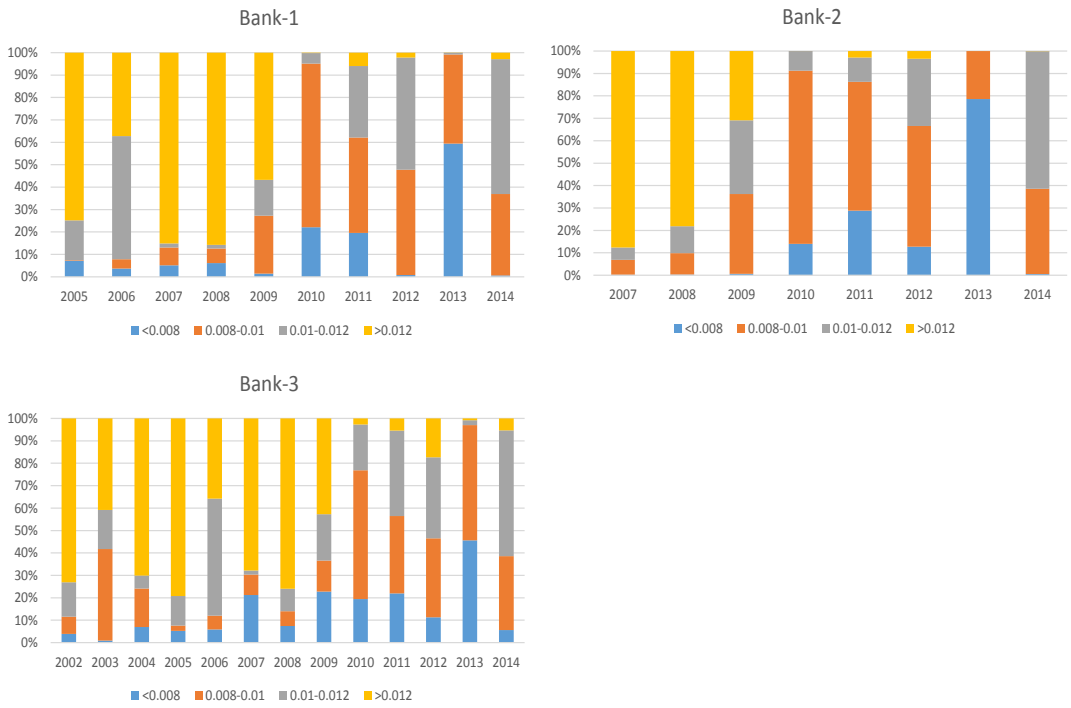


Figure 54: Interest Rate Distribution According to Origination Year

Figure 55 shows that for both of the banks, in contrast to the mortgage pricing theory, which states that longer maturity loans are riskier and should be originated at higher interest rates, the interest rates at the mortgage origination have been lower for longer maturities until 2009. This was mainly due to the expectation that general level of interest rates will decrease in the coming years. After 2009, the pricing mechanism turned back to normal where banks asked for higher interest rates on average for longer term mortgages.

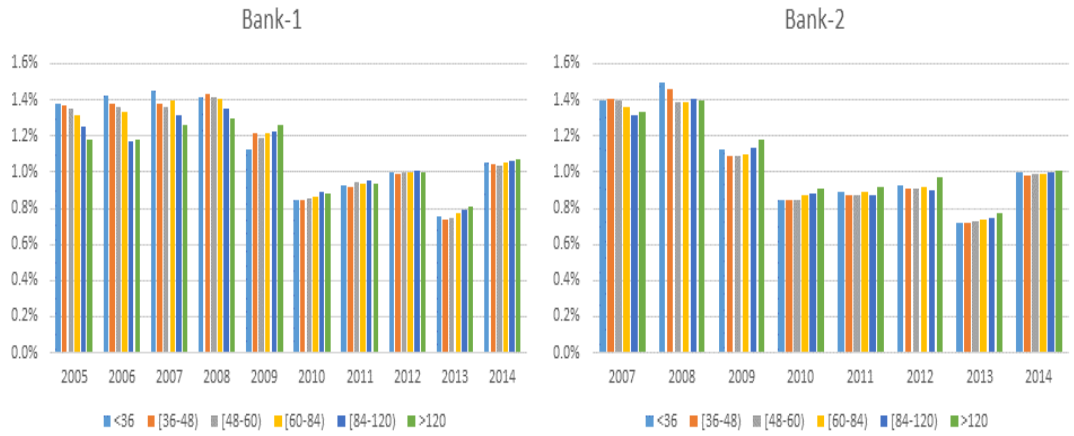


Figure 55: Average Interest Rate According to Origination Year and Maturity

Figure 56 shows the credit amount distribution in the three banks. It indicates that in all banks mortgage loan amount concentrate in the 50 thousand to 100 thousand Turkish Lira bucket. Additionally, over 200 thousand Turkish Lira bucket comprises less than 5 percent of all mortgage loans.

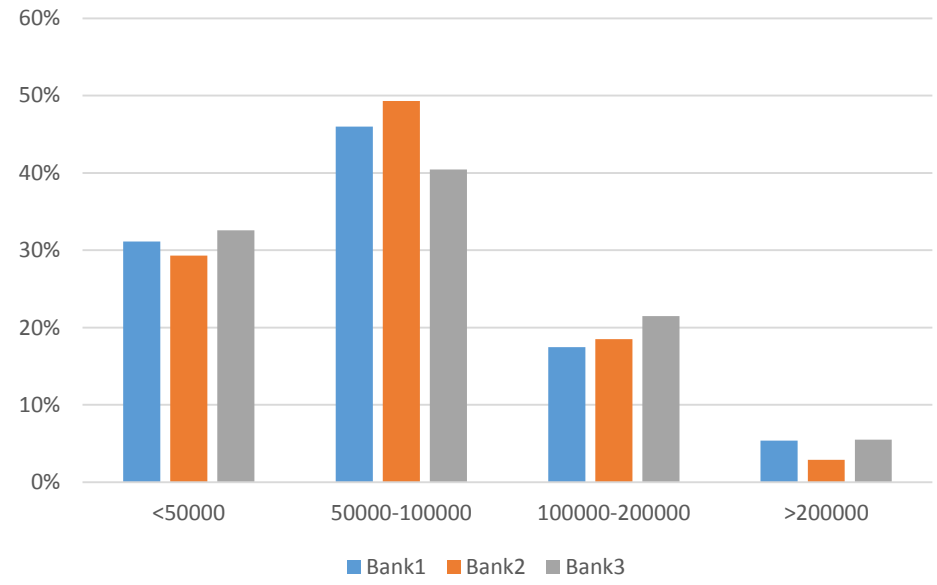


Figure 56: Credit Amount

Figure 57 provides the distribution of inflation adjusted credit amount. It is observed that changes in the shares of buckets are negligible when compared to Figure 56.

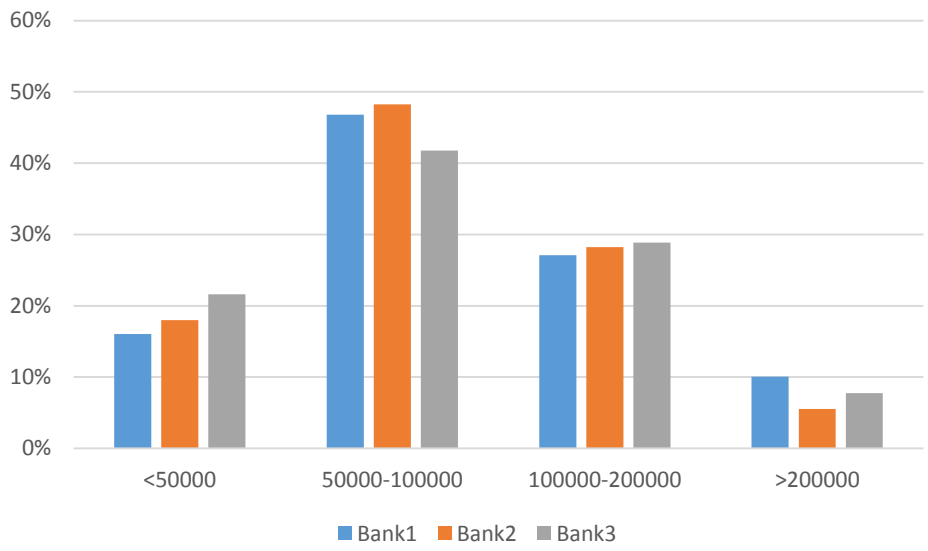


Figure 57: Credit Amount – Inflation Adjusted

In Figure 58 the change in the shares of credit amount buckets are given for each bank. It is seen that, the share of under 50 thousand Turkish Lira bucket has decreased and the share of 50 thousand to 100 thousand bucket has increased in the recent past when measured in nominal terms.

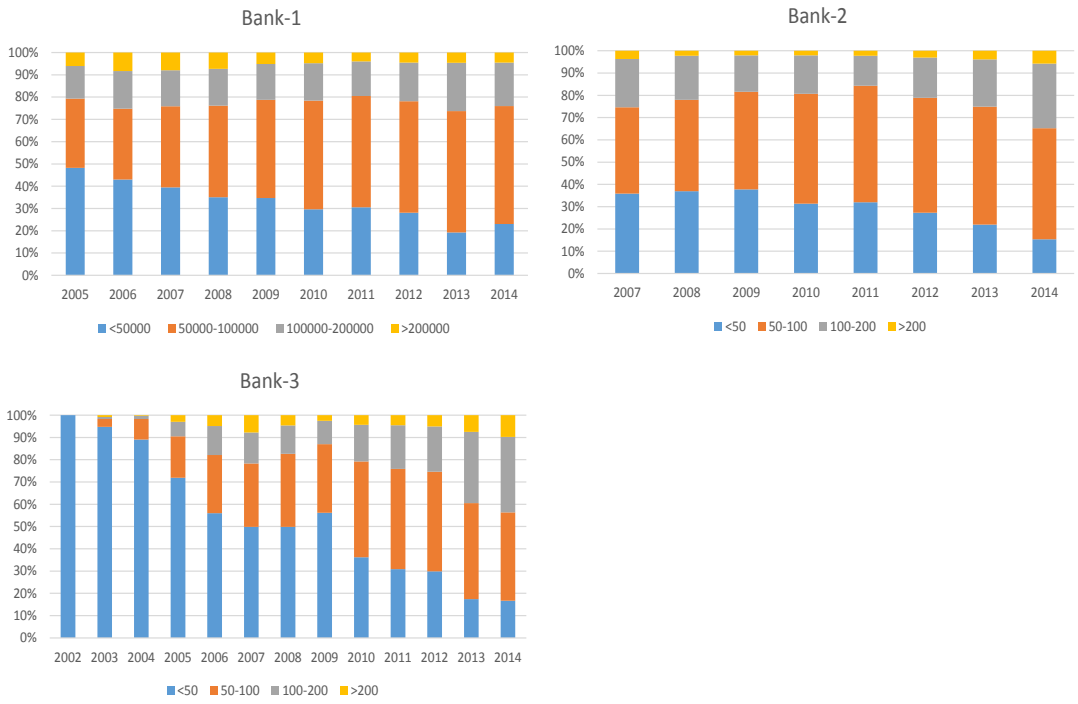


Figure 58: Origination Year vs Credit Amount

In addition to the previous analysis, the following graph depicts the distribution of inflation adjusted figures. These graphs show that the decrease in the share of less than 50 thousand TRY bucket is mainly due to the inflation effect. These graphs also indicate that the distribution of credit amount has become closer after 2007 in all three banks.

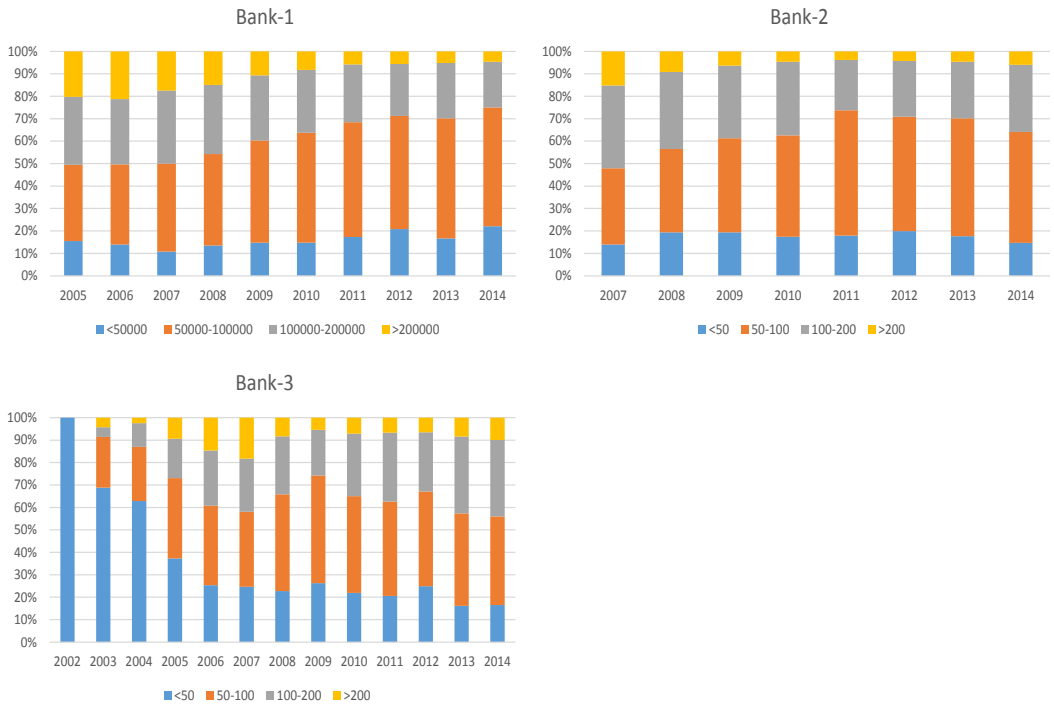


Figure 59: Origination Year vs Credit Amount – Inflation Adjusted

Figure 60 illustrates the development of average credit amount for all banks in the sample. In these banks average credit amount ranges between 80 thousand and 110 thousand TRY. It is interesting to note that in the small scale bank average credit amount is higher during the last three years.

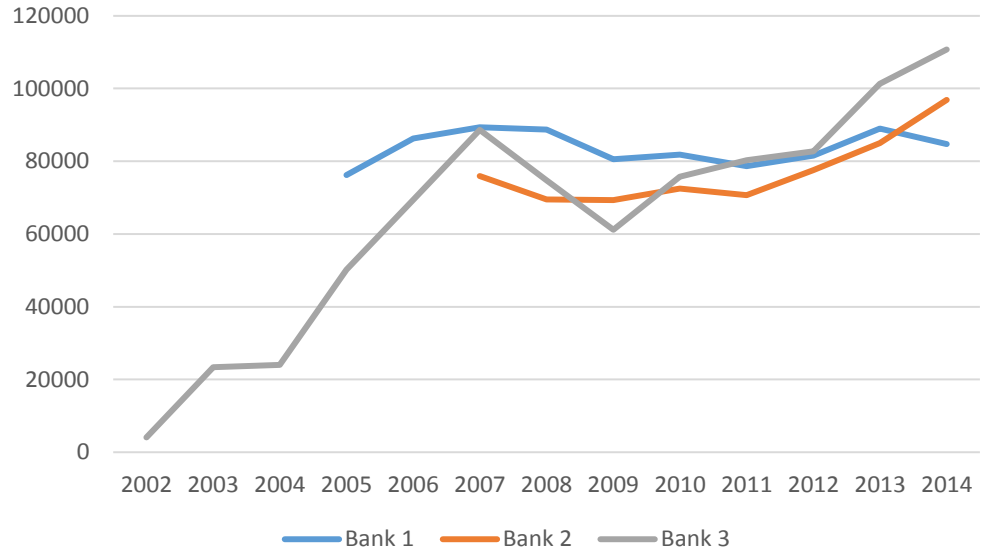


Figure 60: Development of Average Credit Amount

Figure 61 provides information about average credit amount which is corrected for inflation effect. It is seen that, average credit amount in all there banks have declined considerably after 2007 (in real terms) which is a positive development with respect to accessibility of the mortgage market.

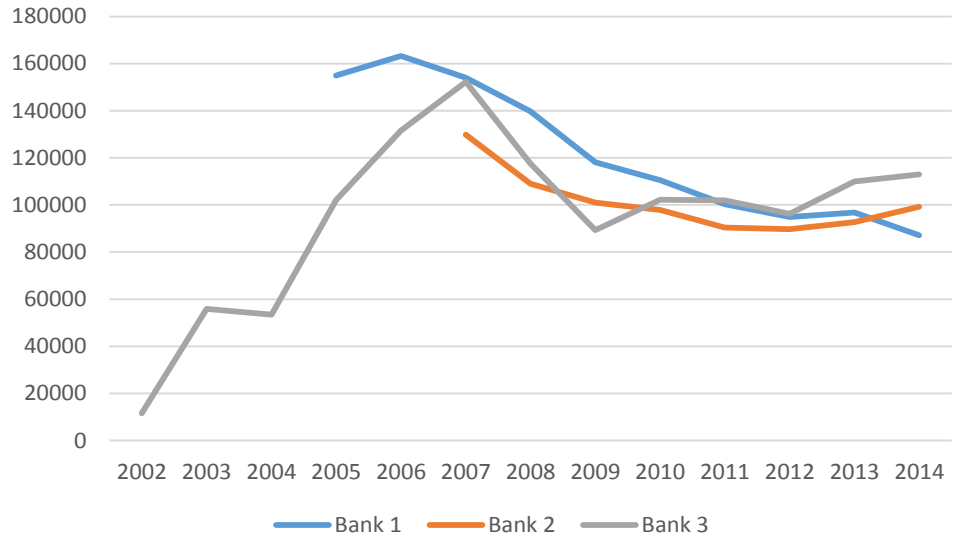


Figure 61: Development of Average Credit Amount – Inflation Adjusted

As indicated in the Literature Review section, Loan to Value Ratio (LTV) is an important indicator regarding the mortgage termination risk[134]. Figure 62 provides change in the LTV buckets. The share of under-50% LTV bucket and 50-75% LTV bucket has not changed substantially in the portfolio of Bank 1. Whereas, in Bank 2 portfolio, there has been important changes where, the share of 50-75% LTV bucket has increased significantly during the last four years. There is also a similar trend in the portfolio of Bank 3. In 2002 almost all loans had an LTV of less than 50%. However, loans having less than 50% LTV is under 40% of the portfolio originated in 2014.

One other important aspect about these graphs is the intervention of the BRSA in 2011 by restricting loans exceeding 75% LTV level. Consequently, the share of more than 75% LTV bucket has declined significantly for all three banks. This is a good example showing the effect of the BRSA's intervention. National authorities need to carefully investigate the riskiness of this credit segments and take macro-prudential measures as required.

[134] Although current LTV is a more relevant indicator, the information on initial LTV is provided for illustrative purposes.

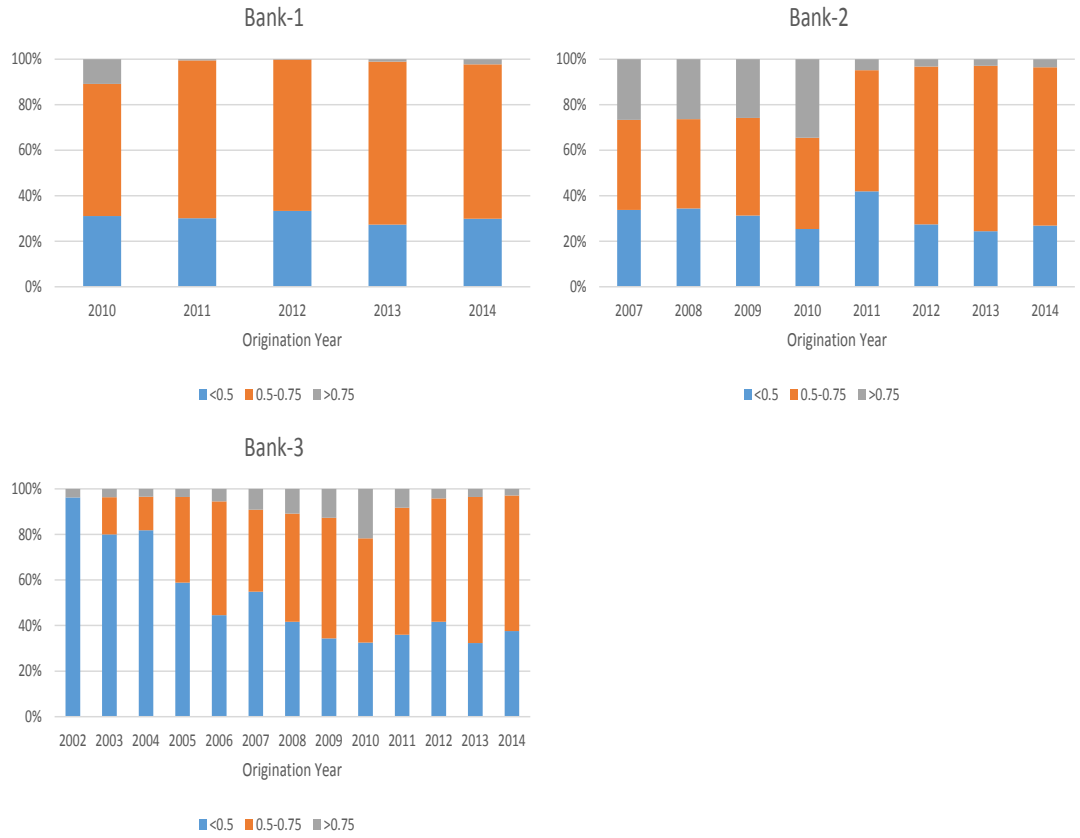
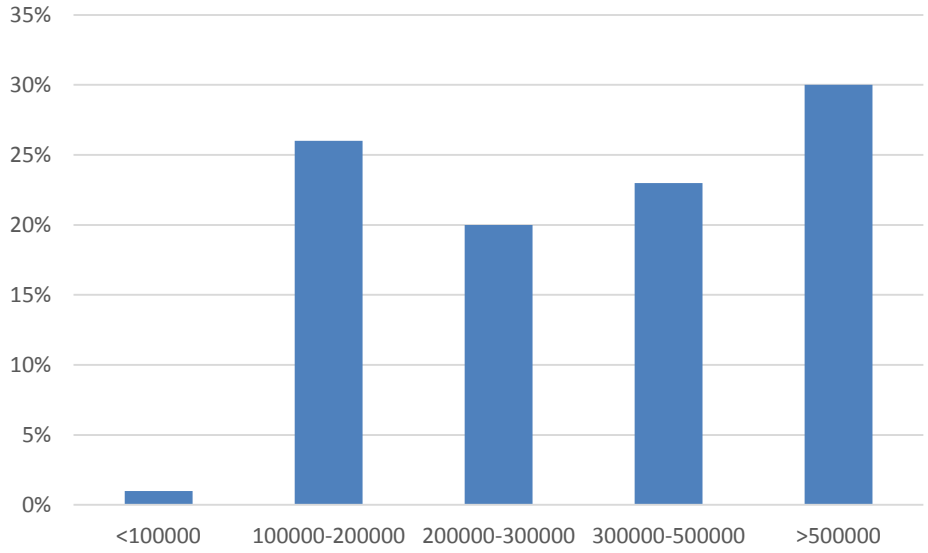


Figure 62: Loan to Value Ratio

The distribution of house prices that is obtained from REIDIN is provided in Figure 63. Consistent with the LTV values above, house prices are higher compared to average loan amounts[135].

[135] Due to its data collection technique (i.e. ask prices are collected instead of sales prices), REIDIN house prices could be overestimating the house prices.



Source: REIDIN, 2014-3rd Quarter

Figure 63: Distribution of House Prices

Although house prices have been steadily increasing in Turkey, Figure 64 shows that inflation adjusted appraisal values for newly originated mortgages have been decreasing (or at least not increasing). This is another factor which supports the assessment that accessibility is increasing for mortgage products in Turkey.

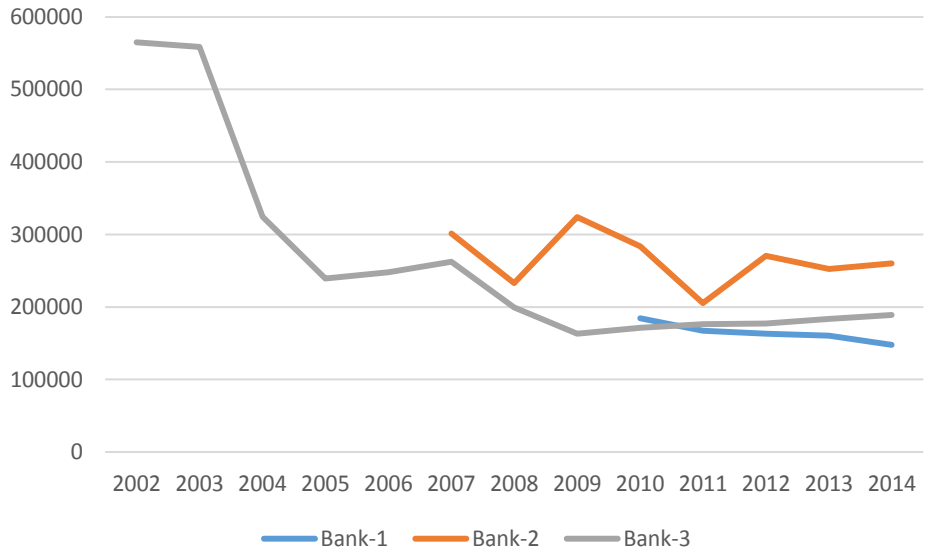


Figure 64: Average Appraisal Value – Inflation Adjusted

Distribution of mortgage loan installment amounts in provided in Figure 65. Buckets under 2500 TRY constitute the bulk of the data and for all banks total share of installments exceeding 2500 TRY is less than 20%.

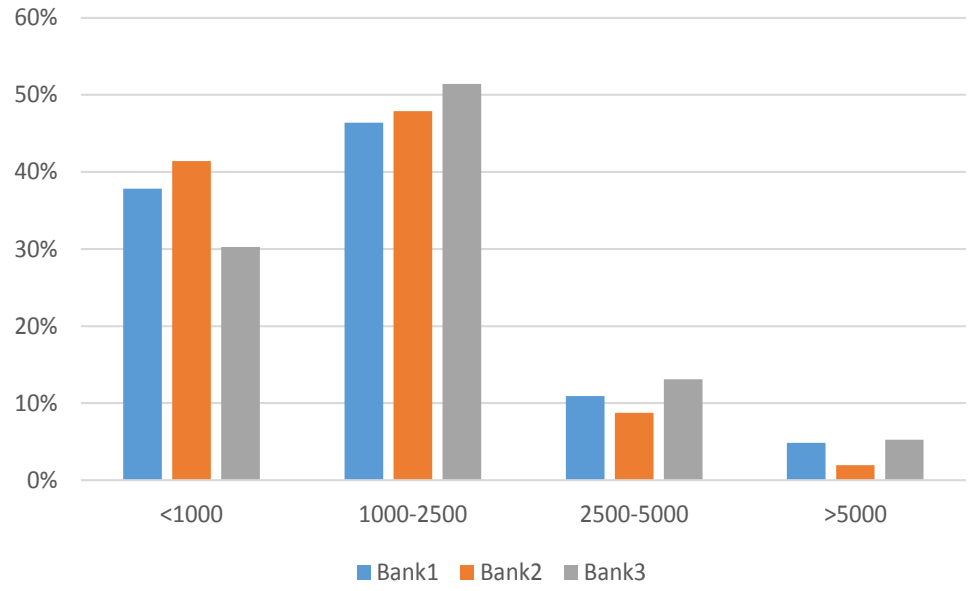


Figure 65: Installment Amount

Figure 66 provides the same figure after inflation adjustment. This figure shows that 1000-2500 TRY mortgages bucket comprises more than 50% of all loans.

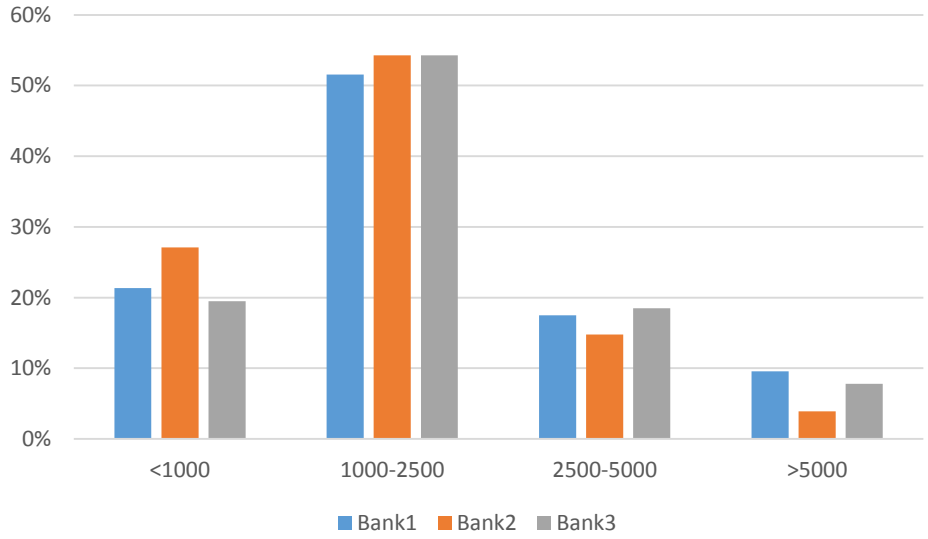


Figure 66: Installment Amount – Inflation Adjusted

Figure 67 illustrates that while average mortgage loan amounts (measured in nominal terms) have been increasing, the average installment amounts have been decreasing (between 2007 and 2014). This is consistent with increasing maturities in the mortgage loans and decreasing interest rates, which is a positive development with respect to accessibility of mortgage products by a wider population segments.

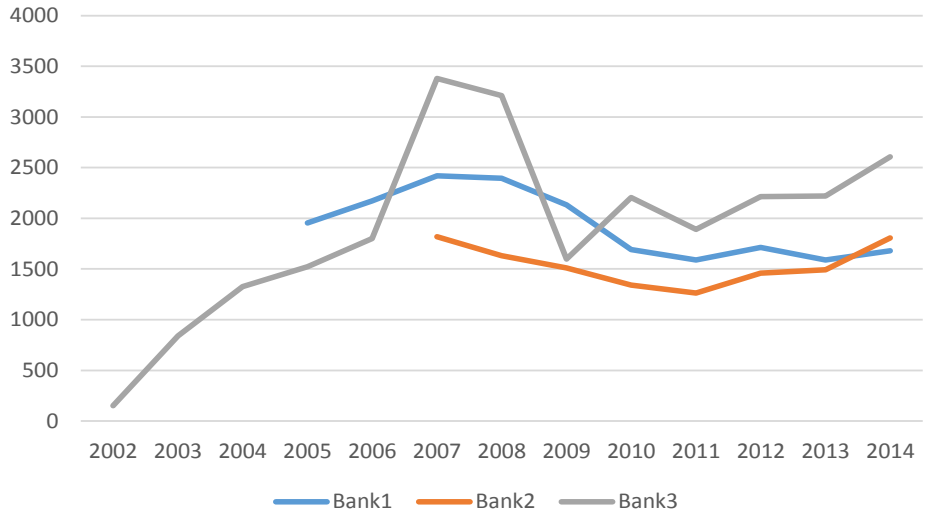


Figure 67: Development of Average Installment Amount

Figure 68 shows the development of average installment amounts in real terms. Similar to the average credit amounts (in real terms), average installment amounts have also been decreasing after 2007.

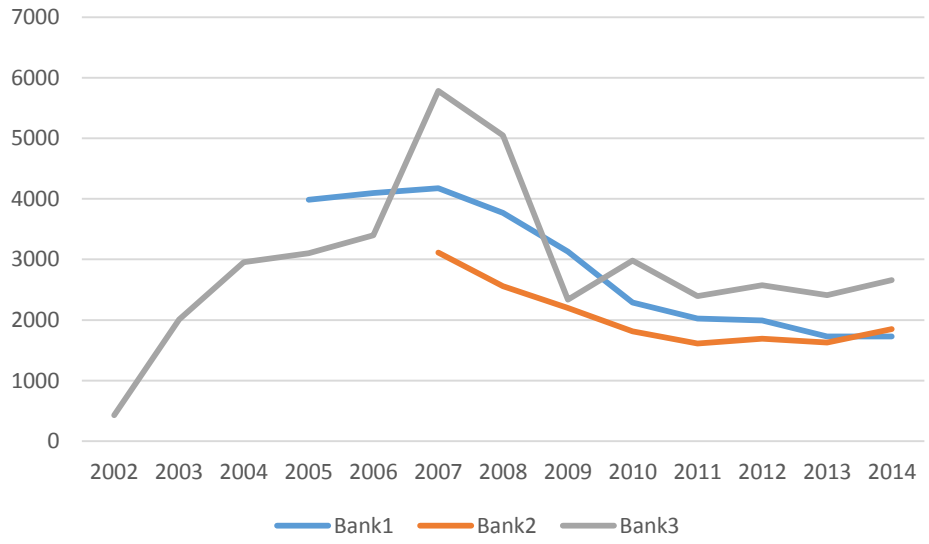


Figure 68: Development of Average Installment Amount – Inflation Adjusted

Figure 69 below provides a simple illustration of default rate in two of the sampled banks categorized by origination and default years. In both banks, a sharp increase was observed in default rates during the global financial crisis period. This indicates that the residential mortgage segment is vulnerable to adverse developments in the national economy. When the bucket "total" is analyzed, it is seen that in both Bank 1 and Bank 2, default was highest in the 2008 vintage. Total default rate remained under 1% in the vintages after the global financial crisis. This might be an indication of stricter lending standards after the global financial crisis period.

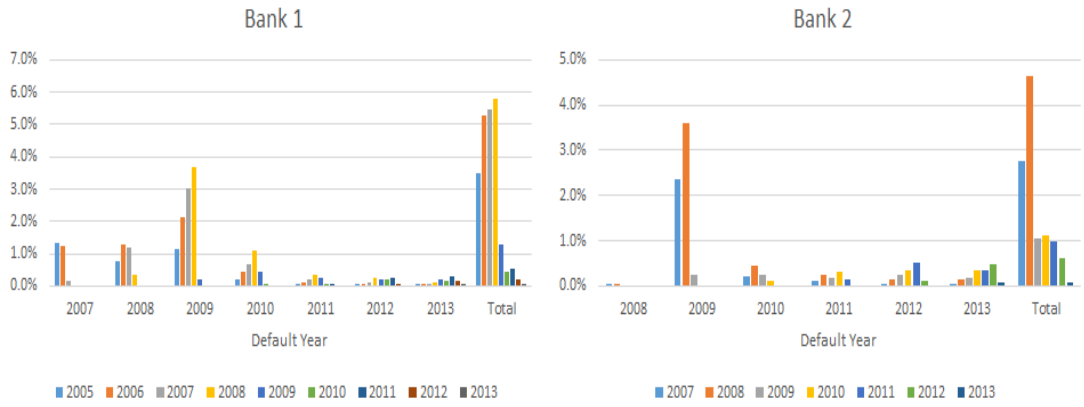


Figure 69: Default Rate by Origination Year

In the figures above, we have shown that these banks are quite similar in terms of certain properties such as average loan amounts, interest rates and maturities of the mortgage portfolios. Although, these two banks are also quite similar with respect to the default observations, there is a striking difference with respect to prepayment behavior.

Figure 70 shows that total prepayment rate increase up to 40% for Bank 1 whereas this indicator exceeds 70% for Bank 2. Also, the volatility of prepayment behavior in Bank 2 is considerably higher compared to Bank 1. Additionally, these graphs also indicate that prepayment risk is very important in Turkish banking sector which should be carefully measured, monitored and managed.

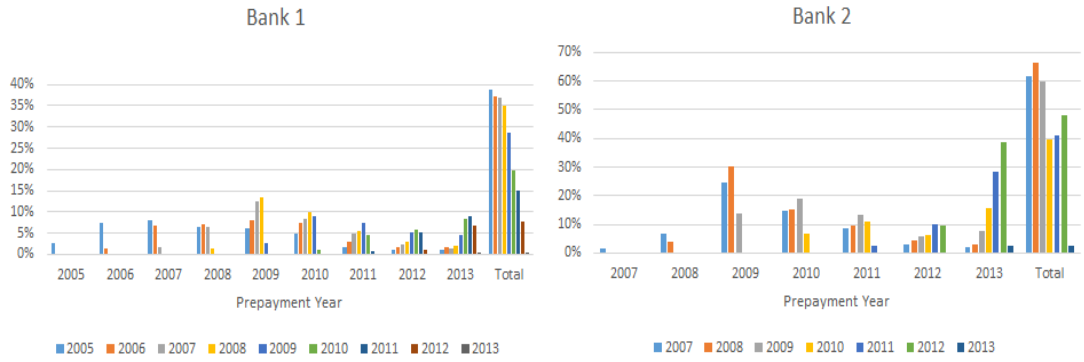


Figure 70: Prepayment by Origination Year

Age distribution of mortgage borrowers also indicate positive developments regarding the accessibility of mortgages in Turkey. According to Figure 71, while the share of younger population in mortgage loans has been increasing, the share of older population is decreasing. In all three banks, share of under-30-years old group, which was under 5% as of 2007, exceeded 15% as of 2014. These figures also show that mortgage loans concentrate around 30-50 years old age groups.

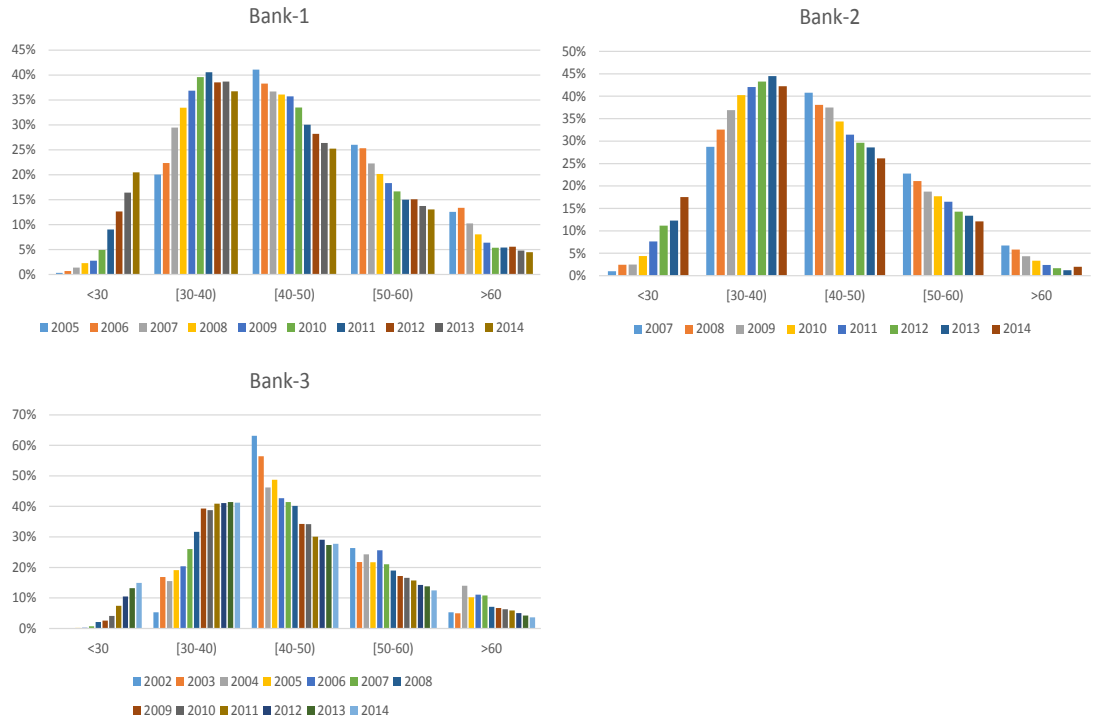


Figure 71: Age Distribution of Borrowers

Figure 72 also supports the above mentioned assessment. Average age of mortgage borrowers which was more than 45 in 2007 decreased to around 40 as of 2014. The decreasing trend in the average age of borrowers is quite clear indicating that younger generations are accessing to the mortgage products more frequently compared to the past.

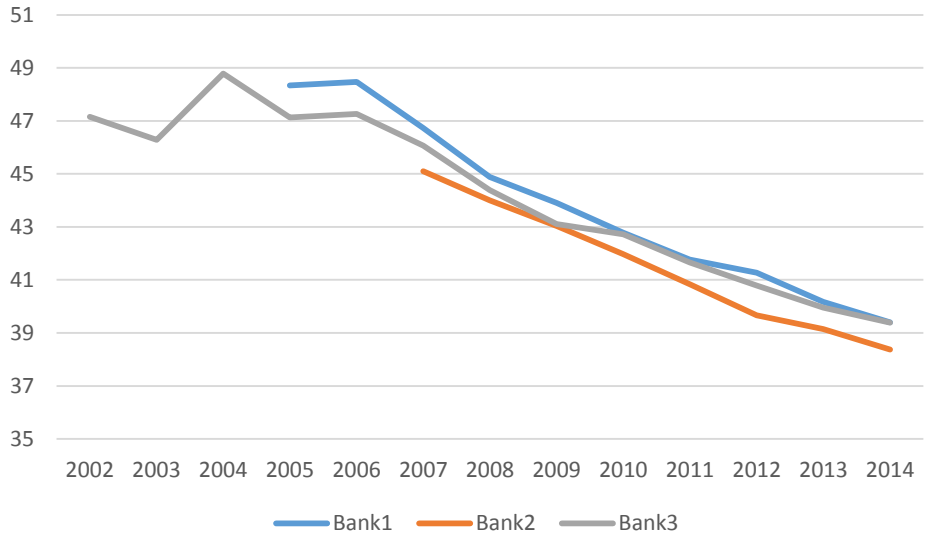


Figure 72: Average Age by Bank

Figure 73 illustrates the share of female borrowers. The share of female borrowers is in 20-25% range for all three banks. It should be highlighted that for Bank 3, this ratio was as high as 35% as of 2002. Although there has been a mildly positive trend, accessibility of woman to mortgage products is still at very low levels but this figure is in line with the woman workforce participation rate.

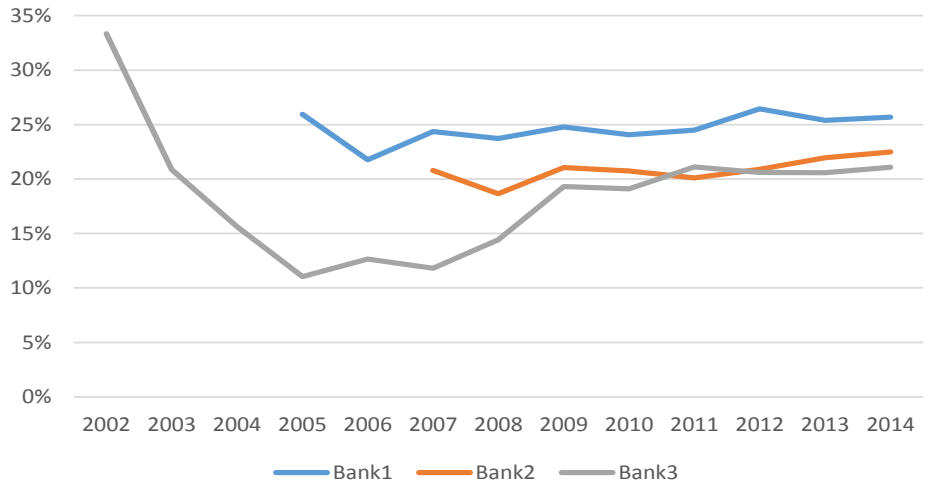


Figure 73: Percentage of Female Borrowers

Marital status variable is available for Bank 1 and Bank 2. Figure 74 demonstrates that the percentage of married borrowers is around 80% for both banks. The main difference across these banks is the trend of this indicator. This ratio has decreased from 88% level to 80% level in the last 5 years for Bank 1, whereas for Bank 2, this ratio has increased from 70% level to 80% level. This figure clearly illustrates the difference in bank's policies and strategies.

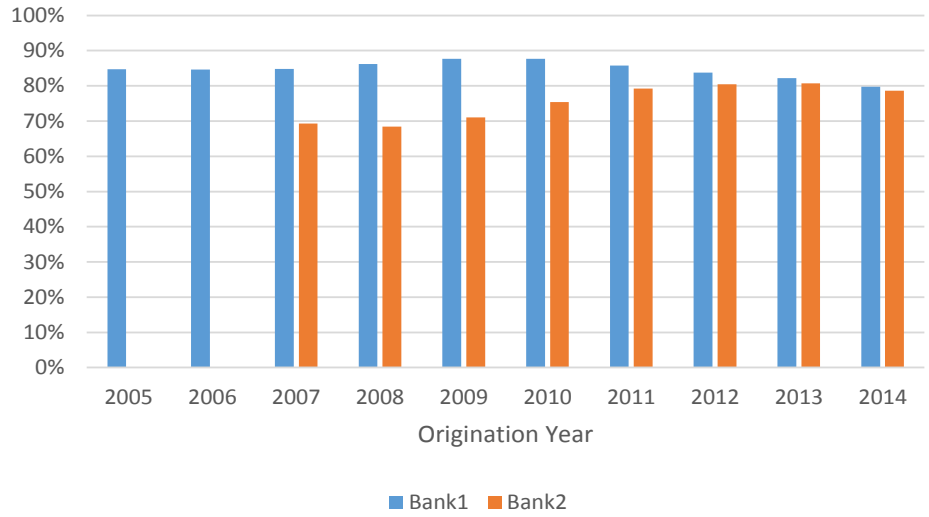


Figure 74: Percentage of Married Borrowers

Figure 75 indicates to differences in bank's data collection practices. Bank 1 reported that change in marital status of its borrowers has remained under 5% in the past. Whereas, according to Bank 2 data, this indicator reached up to 25% level. The author believes that this difference is mainly due to data collection practices of these banks.

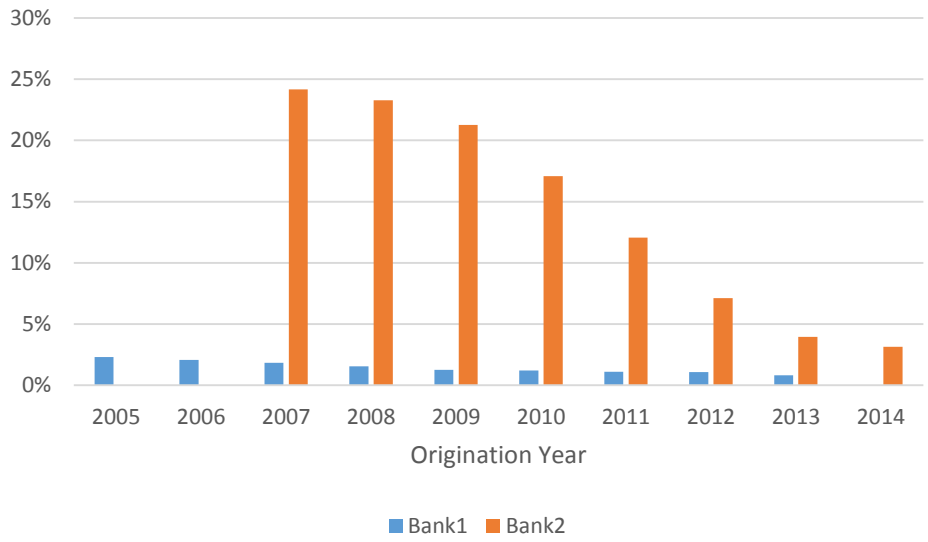


Figure 75: Marital Status Change

The distribution of education of the mortgage borrowers according to origination year is given in Figure 76. While Bank 1 and Bank 2 mortgage portfolios have similar characteristics regarding education level of borrowers, Bank 3 portfolio is quite different. The percentage of mortgage borrowers with a university degree is more than 80% for Bank-3, however, this ratio is around 40% for Bank 2 and 25% for Bank 1. These graphs indicate that in recent years while Bank 3 has been focusing on consumers with at least a university degree, Bank 1 has been focusing more on secondary and high school education segment. Additionally, the portfolio of Bank 2 is fairly stable, showing only smaller changes from one year to another. The results of such policies/choices will be reflected in these banks profit and loss statements. If higher education is an important factor that reduce the default and prepayment probabilities, Bank 3 will be more profitable in the future (assuming that average interest rate applied is the same). This example shows the interaction between bank policies and the default and prepayment modeling.

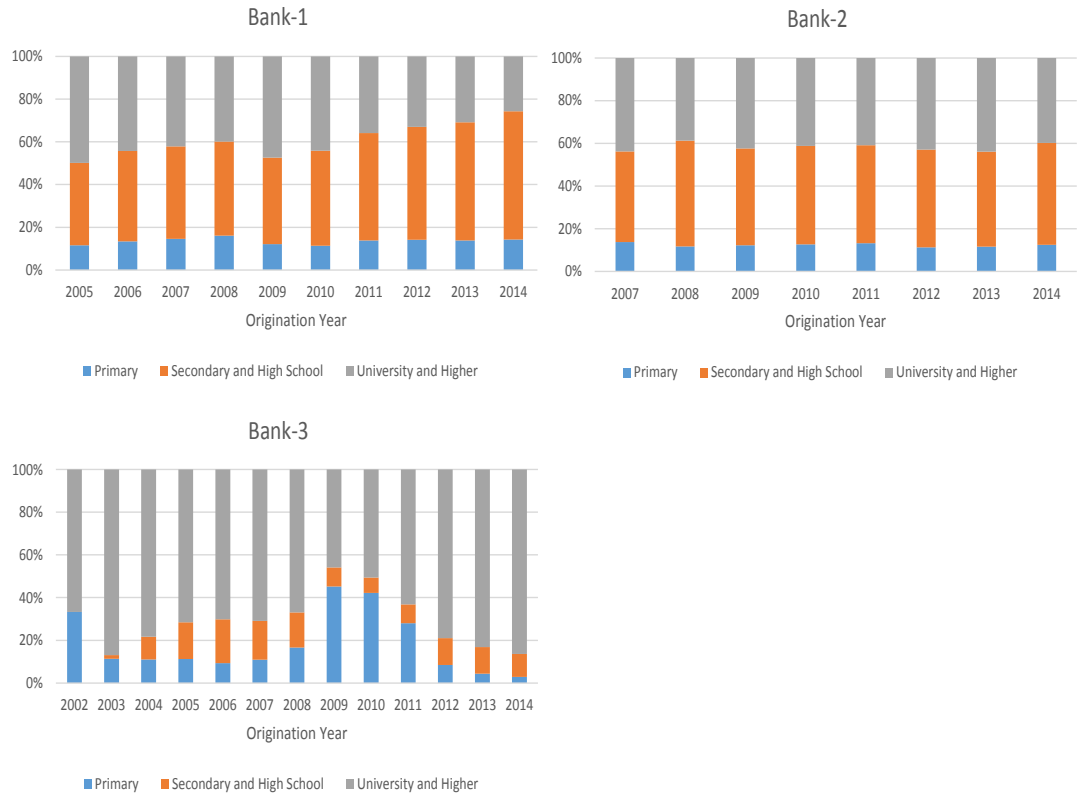


Figure 76: Education Level of Mortgage Borrowers

According to Figure 77, the share of the population segment with less than 2,000 TRY monthly income is noticeably small. The share of this group is relatively large for Bank 1 (around 30% as of 2014) compared to Bank 2 (less than 10%). These graphs illustrate that, Bank 1 has been focusing on lower income segments. The share of over 10000 TRY monthly income group has decreased from 35% level in 2005 to 10% level in 2014. It should be noted that income data are not available for all consumers. Therefore, missing values could have some effect on income distribution and payment to income ratio analyses.

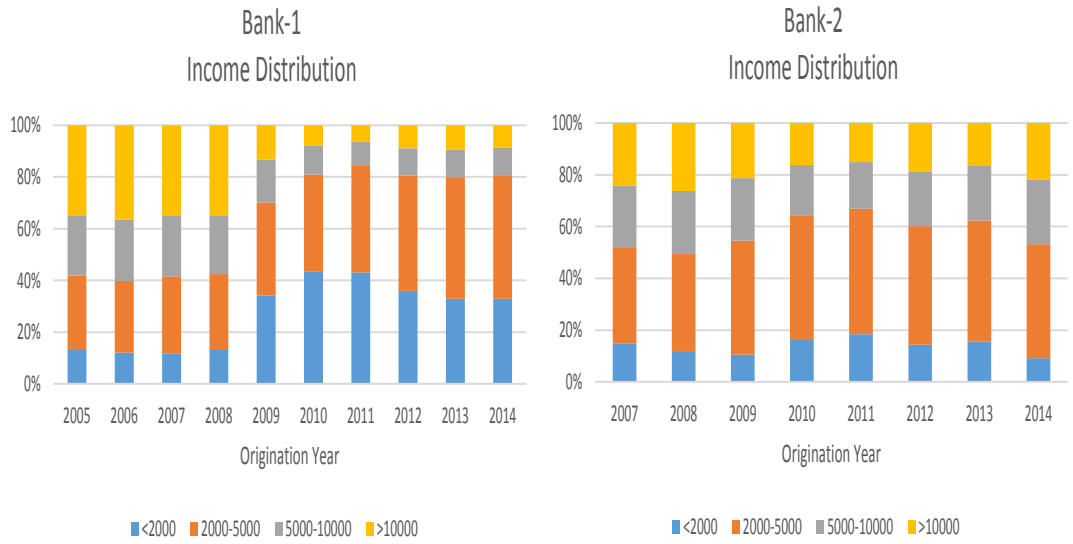


Figure 77: Income Distribution by Origination Year

Figure 78 provides the distribution of inflation adjusted income. Here it is clear that in the portfolio of Bank-1 the share of lower income group has been steadily increasing. Moreover, in the last 5 years, bank's portfolios have stabilized in terms of the distribution of income.

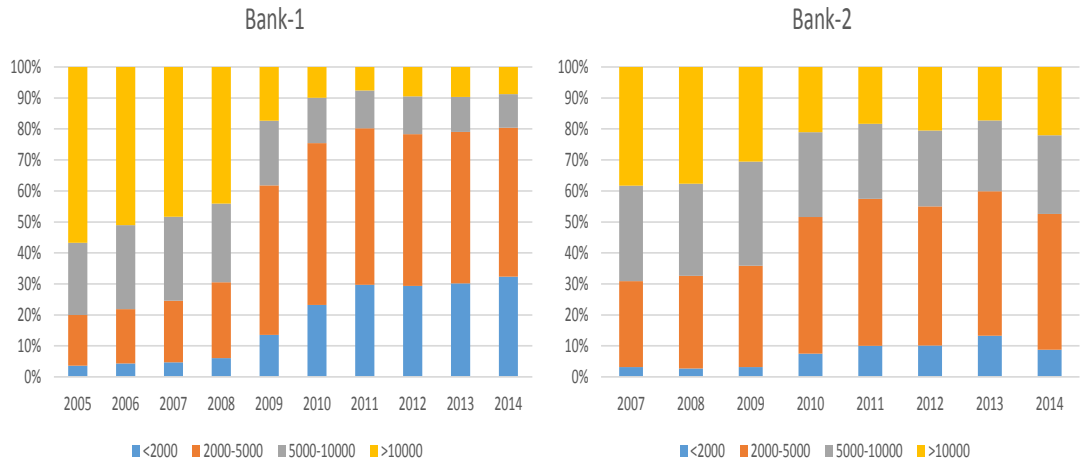


Figure 78: Income Distribution by Origination Year – Inflation Adjusted

The distribution of payment to income ratio (PTI) is given in Figure 79. Supporting the above assessments, Bank 1 has been focusing more on lower income segments and as a result share of mortgage installments to monthly income has been higher for this bank. Bank 2 is much more conservative compared to Bank 1 where PTI exceeds 50% only for 15% of the loans as of 2014.

Another important point that should be mentioned here is that for significant number of borrowers, PTI is higher than 100%. Technically, this is not possible as borrowers cannot pay back mortgage installments that is higher than their monthly income. However, in Turkey obtaining income data is problematic. Therefore, actual payment capacity of the borrowers might be much higher than what formal figures show due to the high share of informal economy, and the reliability of income data is questionable.

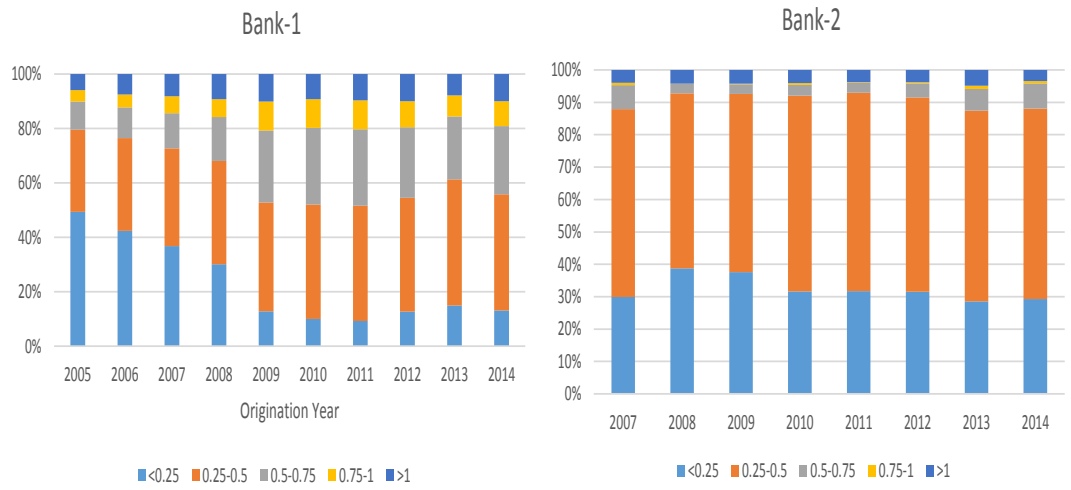


Figure 79: Payment to Income Ratio by Origination Year

In the figures below, mortgage originations in a given year is categorized according to the occupation of the borrower. Here it should be noted that all the banks in the sample have different data collection practices and the corresponding categorization of each bank is matched to three occupation groups, namely; public, private and self-employed. Since, Bank 3 has a longer historical data, related figure better depicts the

developments in the past. During 2002-2004 period, public sector workers compromised a significant portion of the mortgage loans. However, this share has decreased drastically over time. It is important to highlight that before 2000-2001 crisis, banks were not conducting traditional banking business in Turkey where the main activity was to collect deposit and lend the government who was offering significant spread over inflation. After the restructuring in the Turkish banking sector, banks have started to move towards financing companies and individuals. This graph is a good example of this development, where banks initially focused on public employees that have guaranteed salaries. In the meantime, as Turkish banks have learned doing banking, their orientation towards private sector and self-employed categories has increased.

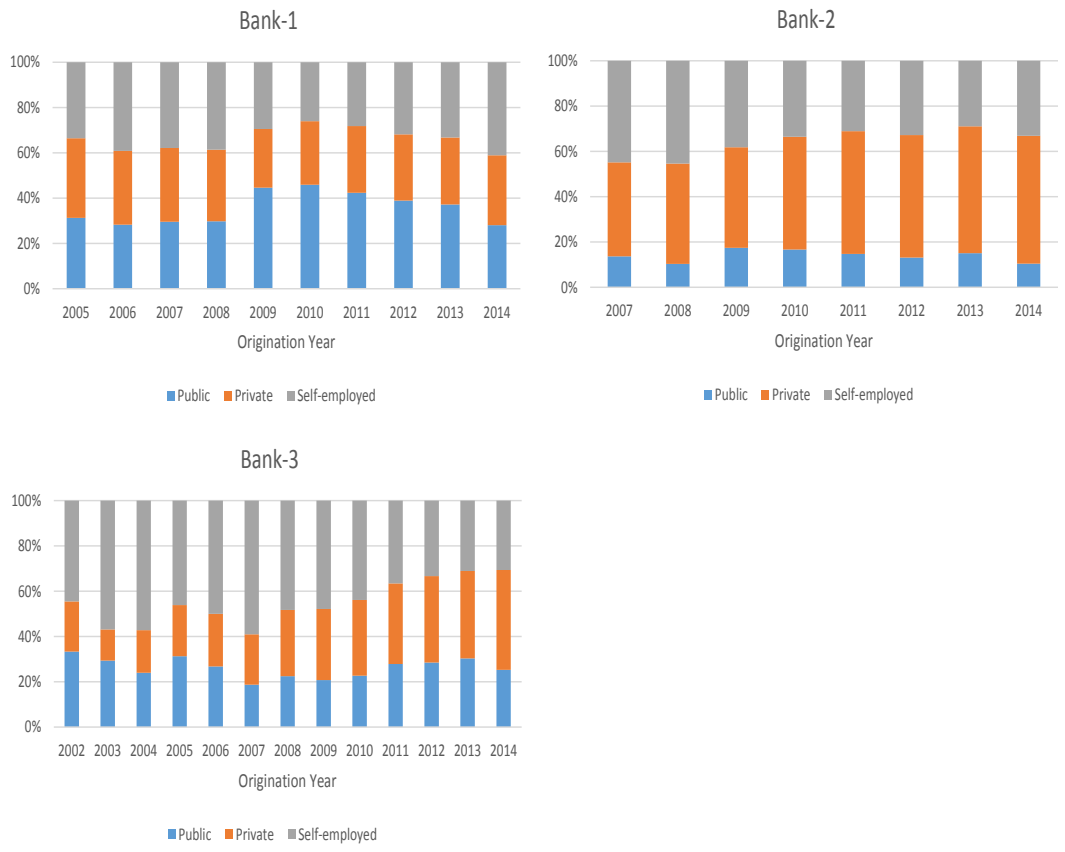


Figure 80: Occupation by Origination Year

Figure 81 illustrates the share of three metropolitan cities in the mortgage originations. Share of these cities and remaining cities is quite similar in all three banks. As expected, Istanbul has the lion's share with around 25-30% of the number of mortgage loans. Share of Ankara ranges between 8-16% and Izmir has a much lower share around 3-5%. In contrast to the presumption that bank's mortgage loans are focusing only on large cities, other cities have a share of more than 50%.

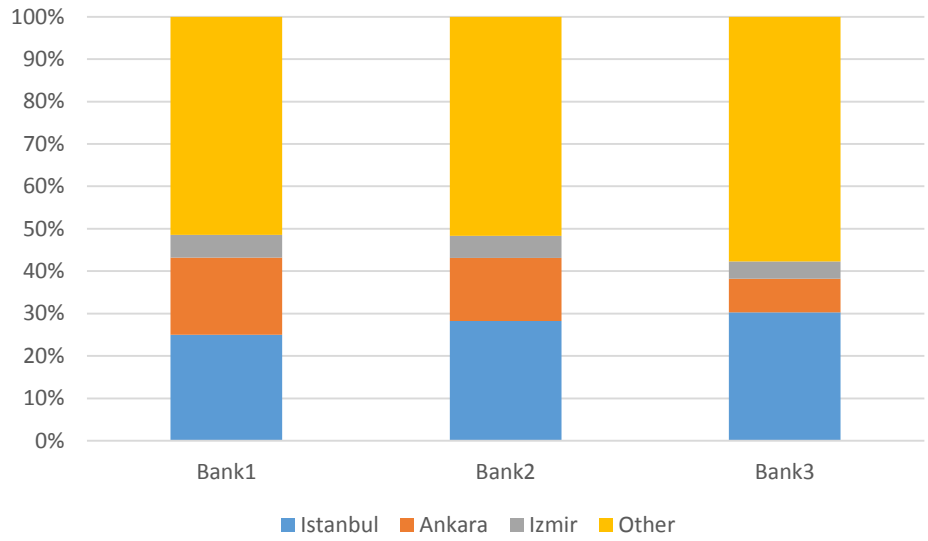


Figure 81: Mortgage Loans by Regions

According to Table 38, total number of house sales in 2013 was around 1.15 million, approximately 40% of which was sales in the form of mortgages. Regional analysis show that share of mortgages in total sales do not change dramatically from one city to another but except for the three largest cities (Ankara, İstanbul and İzmir), share of mortgages is considerably lower. Additionally, in Table 38 we see that share of mortgages in total sales decreased dramatically in 2014 compared to 2013. This can be explained with the increase in mortgage interest rates in 2014, showing that Turkish home buyers are reacting significantly to mortgage interest rates. Lastly, the mortgages / population indicator is highest in Ankara both in 2013 and 2014.

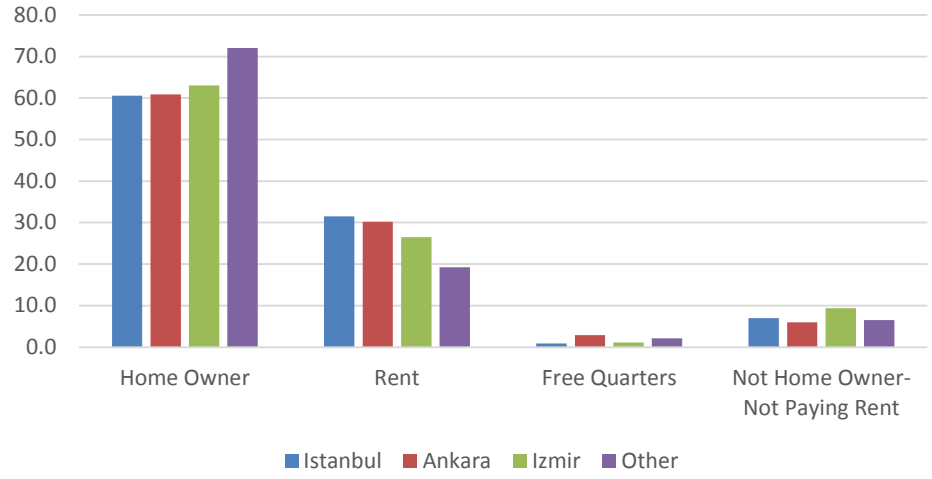
It is important to note that among more than 700 thousand mortgages that was reported by the banks for this study, the ones originated in 2013 was 156,213. This corresponds to approximately one-third of the total mortgages originated in Turkey during 2013 which shows that the three banks included in this thesis provide a good fraction of the all mortgages and is representative of the sector in many respects.

Table 38: Total House Sales and Mortgages

		Ankara	Istanbul	Izmir	Other	Total
2014 (January to October)	Total Sales	105,336	179,190	56,675	585,731	926,932
	Mortgages	39,809	70,193	21,060	178,589	309,651
	Share of Mortgages in Total Sales %	37.8	39.2	37.2	30.5	33.4
	Population	5,146,307	14,360,924	4,089,055	53,727,606	77,323,892
	Mortgages /Popn. (%)	0.8	0.5	0.5	0.3	0.4
2013	Total Sales	137,773	234,789	72,421	712,207	1,157,190
	Mortgages	61,994	106,977	32,207	258,934	460,112
	Share of Mortgages in Total Sales %	45.0	45.6	44.5	36.4	39.8
	Population	5,056,126	14,107,954	4,047,743	53,270,024	76,481,847
	Mortgages /Popn. (%)	1.2	0.8	0.8	0.5	0.6

Source: Turkish Statistical Agency

Regional homeownership rates that are given in Figure 82 also provide interesting results. Homeownership rate is significantly higher in regions excluding three metropolitan cities, namely; Ankara, İstanbul and Izmir. For these cities home ownership rate is very close, around 60%. Households paying rent is around 30% in Ankara and Istanbul, whereas this ratio is less than 20% in the other cities group.



Source: Turkish Statistical Agency – 2011 Survey

Figure 82: Home Ownership According to Region

Mortgages are generally extended with the purpose of buying a house. However, in Turkey and in many other jurisdictions mortgage loans can also be used as a source of cheaper finance for other financing needs. As these loans are collateralized, the interest rate applied by the banks are much lower compared to consumer loans. In the database reported by banks, around 90% is recorded as home purchase loans and the remaining 8-10% is recorded as loans for other purposes (Figure 83).

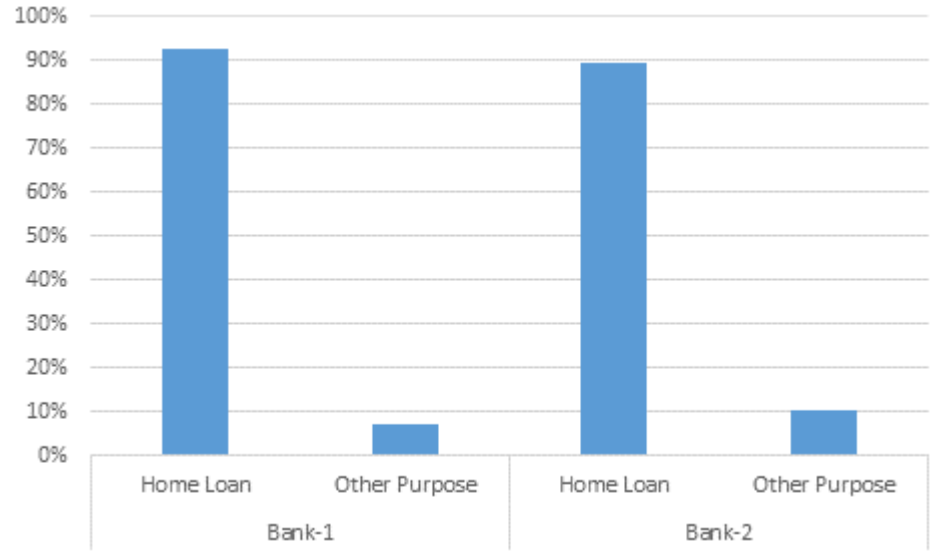


Figure 83: Purpose of the Loan

Figure 84 shows the percentage of first lien mortgages among all originations. The share of first lien is more than 90% for all three banks. In the last few years, there is a downward trend in this ratio that might indicate a decline in the overall quality of the collateral, which should be carefully monitored by supervisors and individual banks.

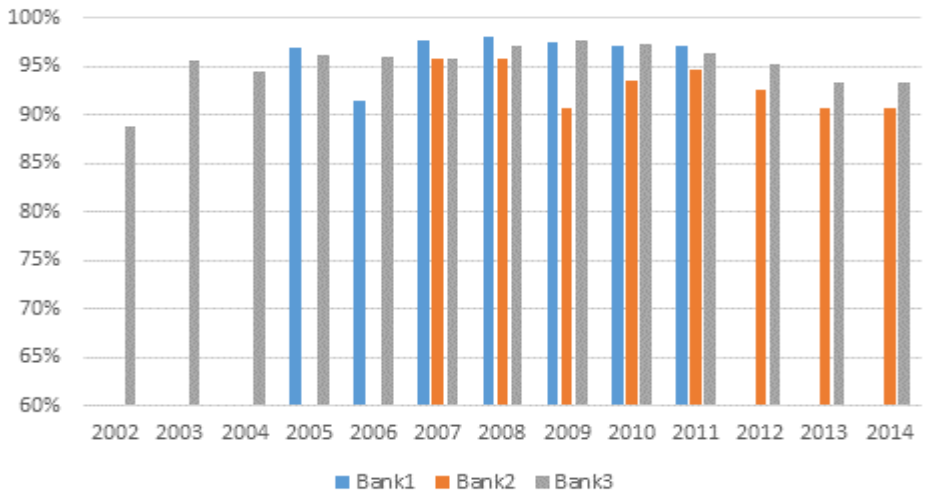


Figure 84: Percentage of First Lien Originations by Year

Figure 85 provides the information about the floor area of the underlying collateral. In the recent years borrowers prefer smaller floor areas. As smaller houses are more accessible by lower income groups, this development is considered positive regarding accessibility.

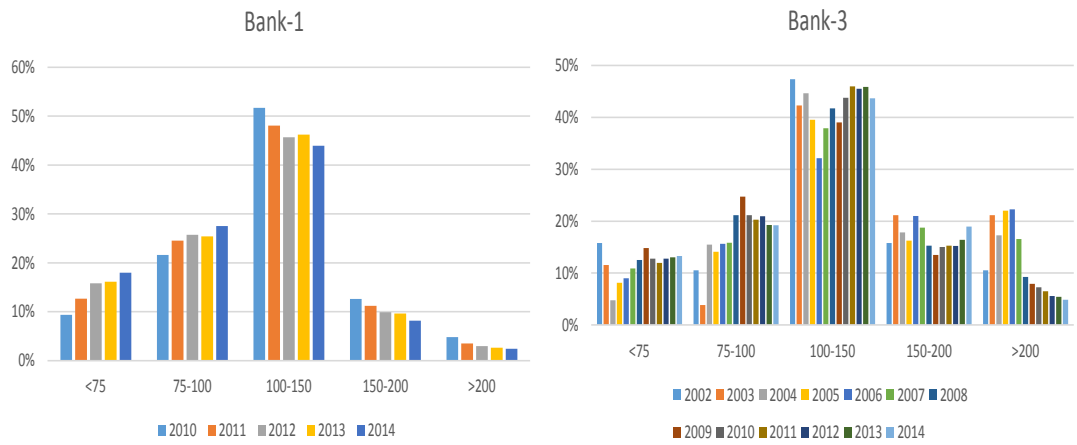


Figure 85: Floor Area by Origination Year

Figure 86 provides an important information about the demand for new houses[136]. Among the mortgage loans originated between 2002 and 2005, the share of under-5-years collateral age bucket comprised a significant portion. Moreover, in the last 5 years, the share of this group has steadily increased. Furthermore, during the global financial crisis period, the share of newer houses as collateral has increased whereas the share of older buildings has decreased.

[136] For this indicator, data was available for only Bank-3.

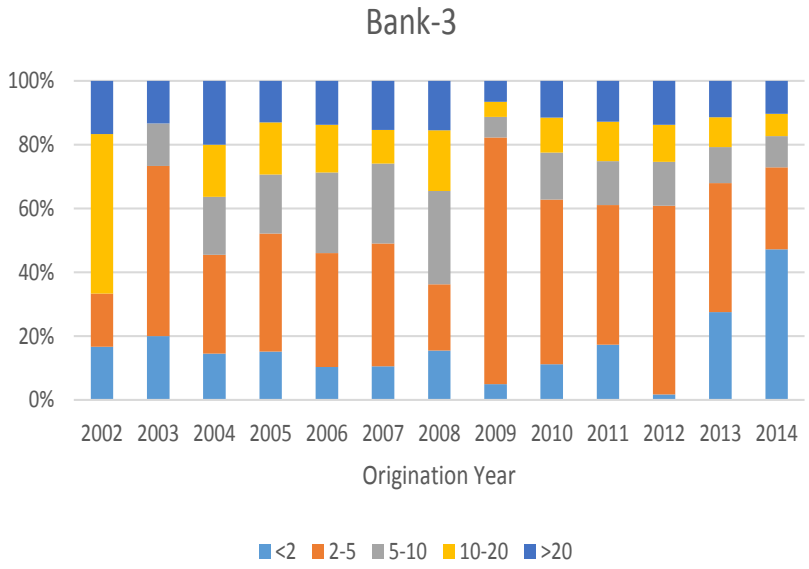


Figure 86: Collateral Age by Origination Year

Additional Analysis on Selected Variables

Figure 87 provides the income distribution in Bank 1 and Bank 2 according to age categories. The main finding regarding this graph is that, average income increases as the age increases. Additionally, in the under-30-years-old age bucket, Bank 1 has lower income borrowers compared to Bank 2, which is a significant indicator of riskiness.

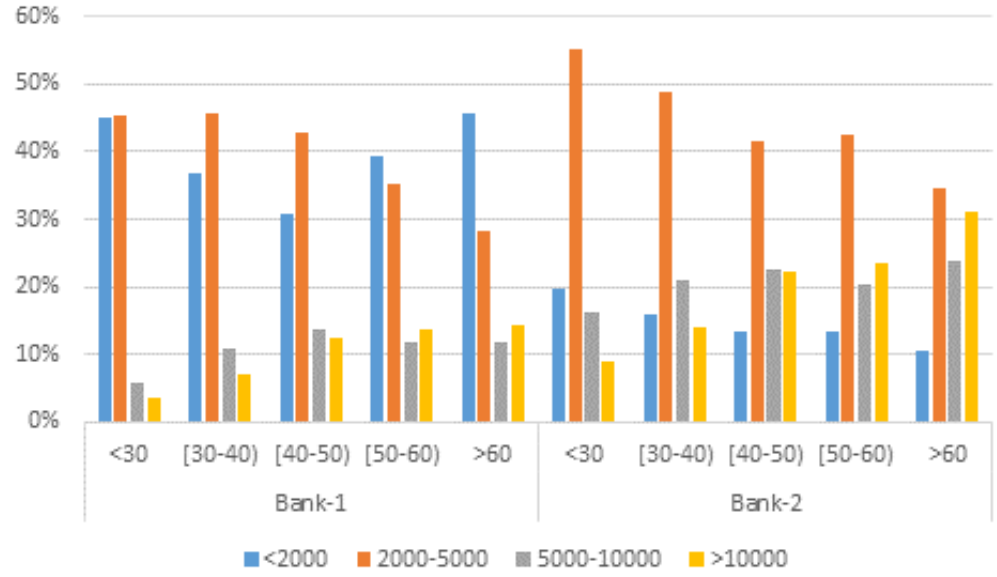


Figure 87: Income Distribution According to Age Categories

Consistent with the finding above, younger borrowers prefer longer maturities, since their payment capacities are generally lower. 120-month maturity is by far the most preferred product for youngest age bucket, whereas in the above-60-years old age bucket, the most preferred products ranged between 60-84 months maturities.

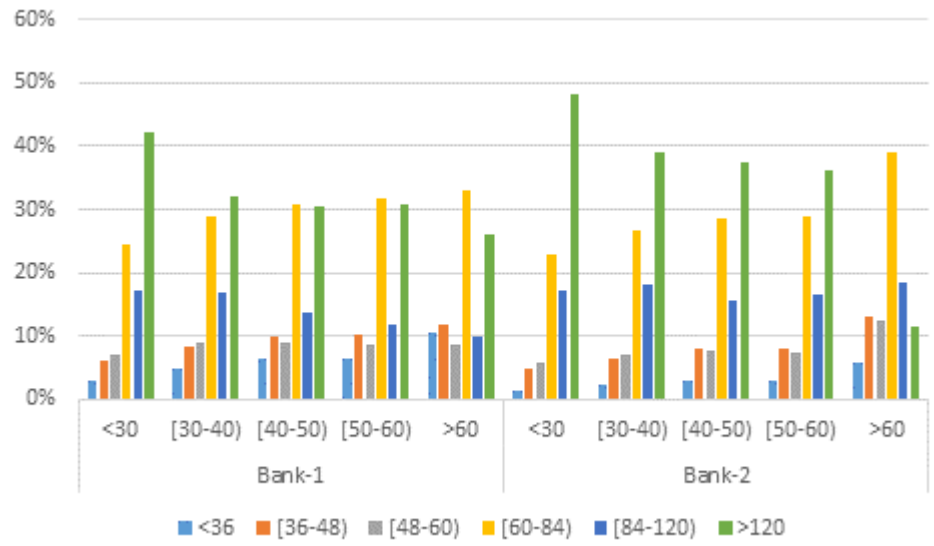


Figure 88: Maturity Distribution According to Age Categories

According to Figure 89, average installment amount decrease as the maturities increase. This means that consumers can afford paying higher amounts of installments in the short term. This is in line with consumption theory. People do not prefer to commit high installment amounts for longer terms taking into account possible shocks to their incomes.

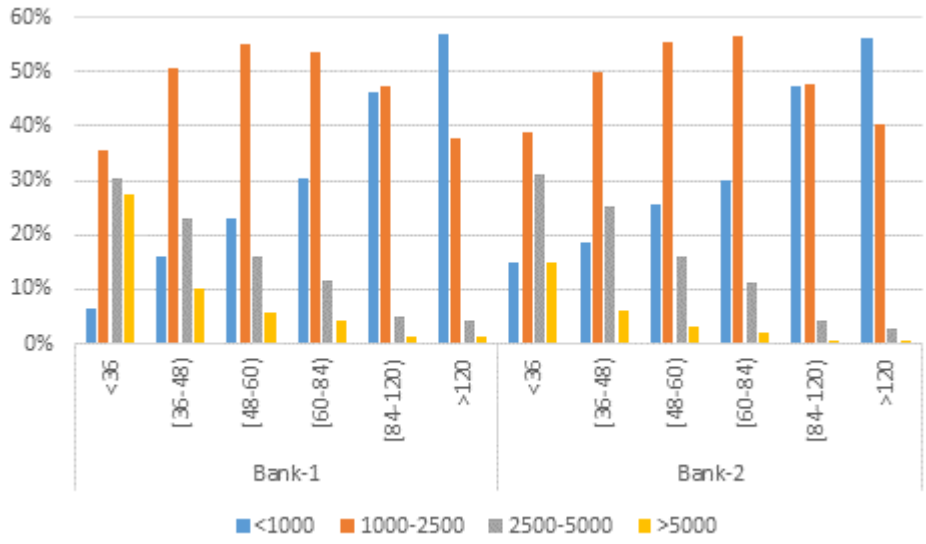


Figure 89: Maturity Distribution According to Installment Amount

Figure 90, which depicts payment to income ratio according to maturity, also supports the assessment given above. Payment to income ratio decreases as the maturity of the loan increases.

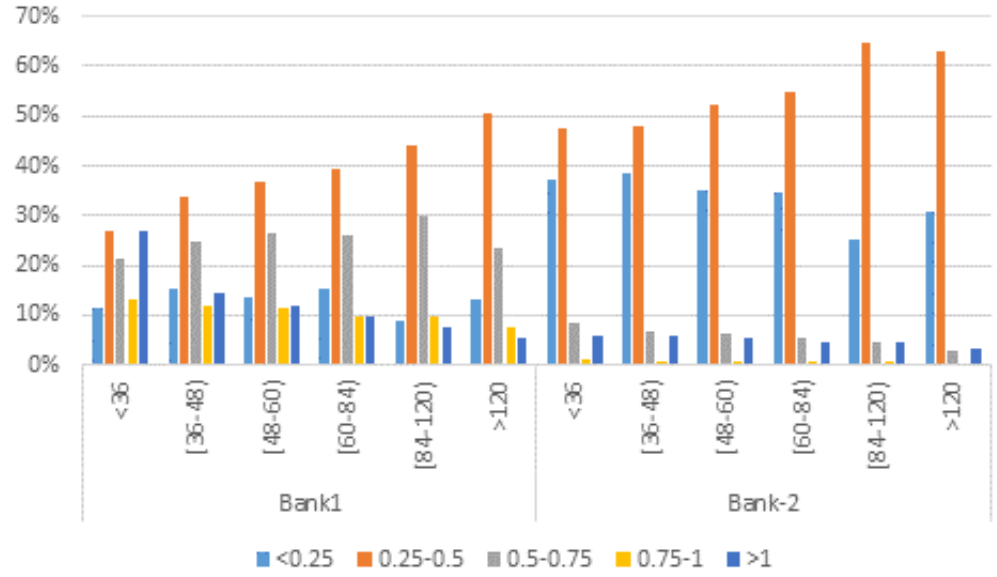


Figure 90: Payment to Income Distribution According to Maturity

The percentage of female borrowers according to marital status is illustrated in Figure 91. Here, it is observed that the percentage of female borrowers is the slightly higher for singles in Bank 2 but significantly higher for singles in Bank 1. This shows that for the married couples often male is the one who is registered for the mortgage.

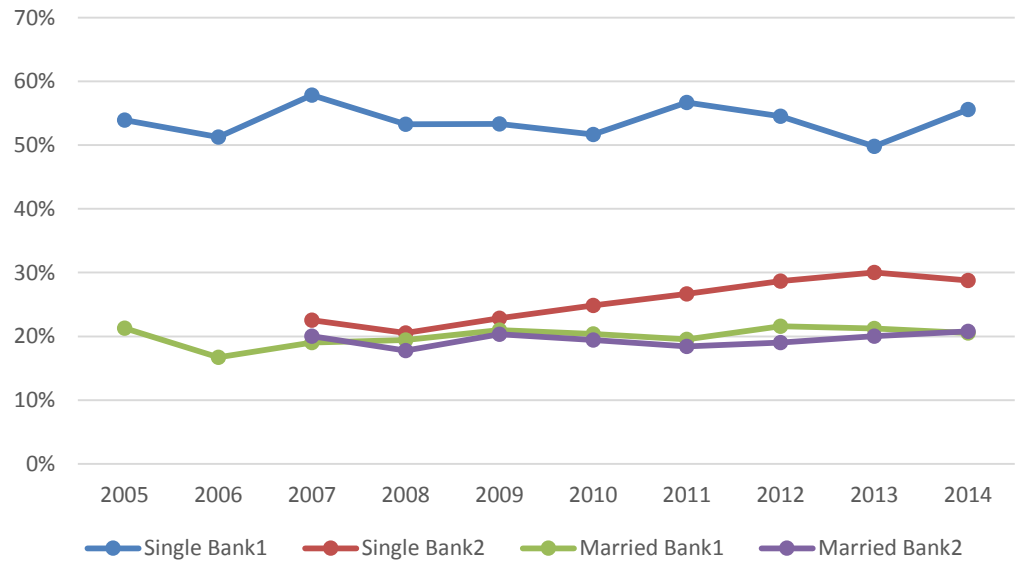


Figure 91: Percentage of Female Borrowers According to Marital Status

Figure 92 shows the distribution of education level of the mortgage borrowers according to occupation. It demonstrates that the self-employed bucket has the highest share of borrowers with primary and secondary level education whereas the public sector bucket has the highest share of borrowers with university or higher education.

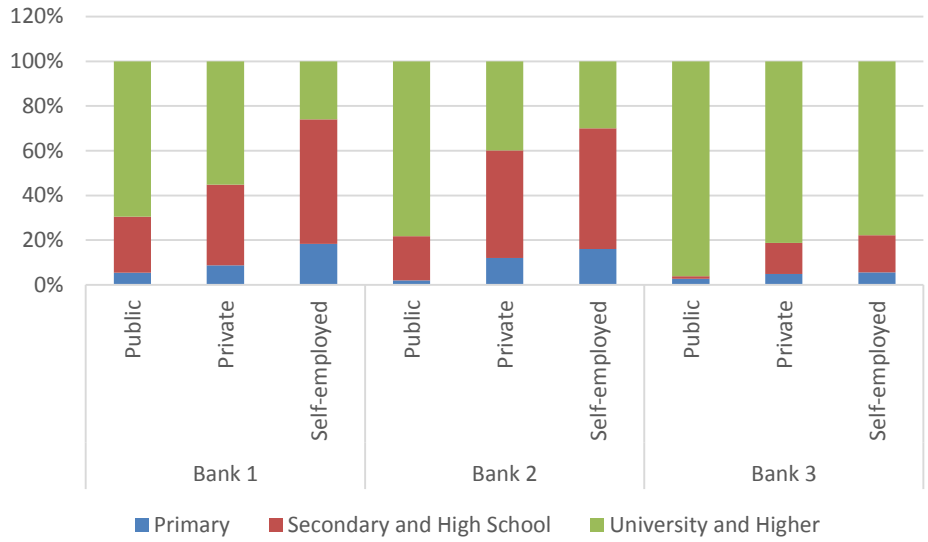


Figure 92: Education Level According to Occupation

Figure 93 depicts the inflation adjusted average credit amount according to the purpose of the loan. Here we observe that credit amount is slightly higher for the loans that are obtained with the purpose of home purchase.

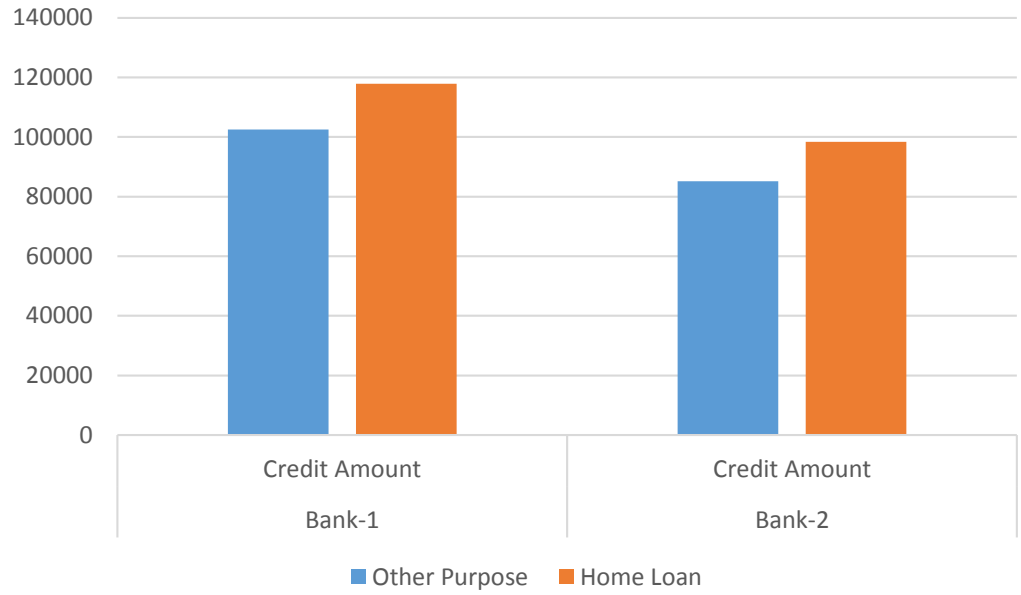


Figure 93: Credit Amount According to Purpose – Inflation Adjusted

4.6.2.2 Descriptive Analysis of Mortgage Termination Risks

In this subsection, descriptive analyses on mortgage termination risks in Turkey are provided. These analyses are based on the developments in the entire history of each mortgage loan. Therefore, results presented in this section may diverge from the results in the modeling section where one-year PDs are estimated.

Brief results regarding the analyses below can be summarized as follows;

i. There was a sharp increase in the default rates during the global financial crisis period (NPL rates which was less than 0.3% increased to 2.3%); however, default rates turned back to pre-crisis levels and the decrease in

NPL rates still continue (NPL rates decreased to less than 0.6% in 2014[137]),

ii. Two banks are different in terms of the realization of risks; i.e. default and prepayment risks were materialized earlier for Bank 2 portfolio compared to Bank 1,

iii. Delinquency history increases the default risks by 6-fold and 3-fold for Bank 1 and Bank 2 respectively. Similarly, it is observed that the default risk increases with the original maturity of the mortgage loan,

iv. Origination interest rate is a strong risk factor that is positively associated with both the default and prepayment risks,

v. Loan to Value ratio does not have a monotonic relationship with the default and prepayment and hence seems to be a weak risk factor,

vi. Similarly, factors such as age and gender appears to be weak risk factors for both risks,

vii. Default risk is lower for married borrowers

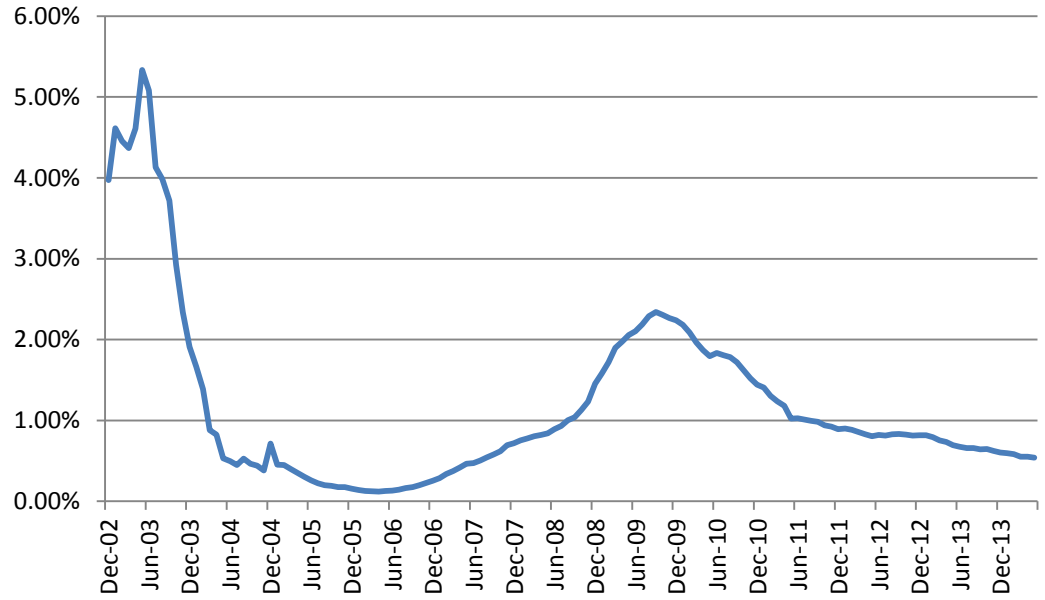
viii. Prepayment risk increases with income level and education level of the borrowers,

ix. The link between default and prepayment risks and the occupation level of the borrowers differ across banks; i.e. both prepayment and default risks are higher in the private and self-employed groups for Bank 1, whereas, prepayment risk is highest for the public employment category for Bank 2.

Figure 94 provides the development of non-performing loans (NPL) ratio of the bank's mortgage portfolio. The aggregated figures that are provided by the BRSA web site show that the NPL of the mortgage segment which exceeded 5% level after 2000-2001 crisis, gradually decreased until 2006. There was a significant increase in the NPL ratio of the sector during global financial crisis period, which then started

[137] It should be noted that NPL is a stock variable, and the effect of decreasing default rates are observed with a lag.

to decrease again. As of early 2014, NPL ratio of the mortgage segment reduced to around 0.6% level.



Data Source: BRSA

Figure 94: Non Performing Loans Ratio in Turkish Banking Sector – Mortgages

For the analyses in this section, all mortgages are categorized under 4 main groups, namely; defaulted, prepaid, matured and other. The other-group indicates to loans that are still being paid. As default and prepayment data are only available for Bank 1 and Bank 2, the analyses in this section excludes Bank 3. Additionally, it should be noted that all these figures are obtained in a decreasing interest rates environment and therefore very specific to the case of Turkey.

Figure 95 summarizes mortgage termination risks according to origination year. Here we observe a downward trend in default and prepayment rates but this does not mean that risks is getting lower. The observation period for newer vintages is shorter, and all risks have not been materialized for these vintages.

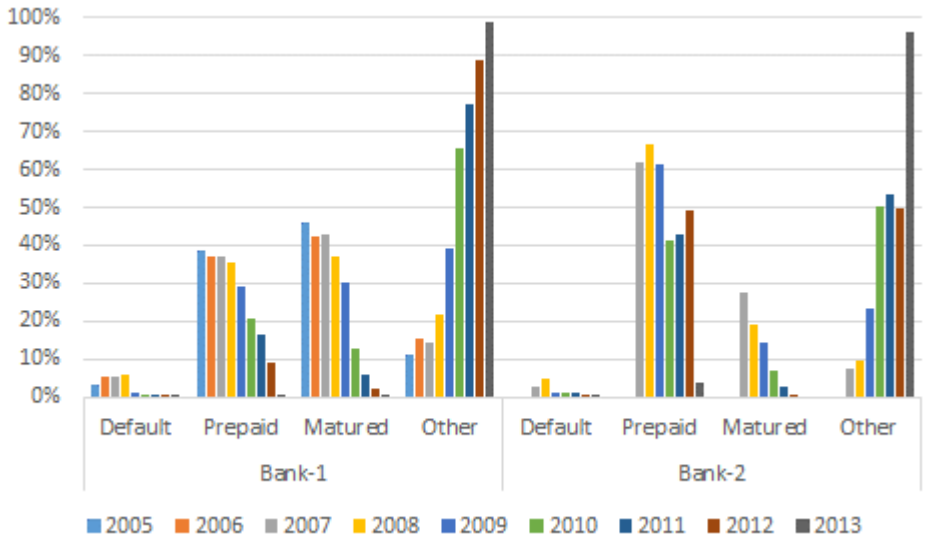


Figure 95: Mortgage Termination Risks According to Origination Year

Table 39 shows that most of the defaults occurred within the first 4 years after the origination. For Bank 1, 85% of all defaults of the 2005 vintage was observed within 4 years and this ratio increases to more than 90% between the years 2006-2009. Also for Bank 2, more than 95 percent of all defaults was observed within 4 years for the vintages 2007 to 2009.

Table 39: Defaults by Vintage

Bank 1	<1year	1-2 years	2-3 years	3-4 years	>4years	Total
2005	0	180	149	184	84	597
2006	116	296	367	352	72	1203
2007	123	556	483	66	53	1281
2008	214	529	88	45	45	921
2009	42	67	47	47	9	212
2010	14	59	82	23	0	178
2011	23	121	38	0	0	182
2012	22	24	0	0	0	46
Bank 2						
2007	1	207	73	12	7	300
2008	367	344	54	36	23	824
2009	42	63	75	64	10	254
2010	69	187	149	51	0	456
2011	92	200	82	2	0	376
2012	105	74	0	0	0	179

Figure 96 better illustrates the explanation given above. Additionally, this figure demonstrates that default risk is at its peak two years after the origination in both banks.

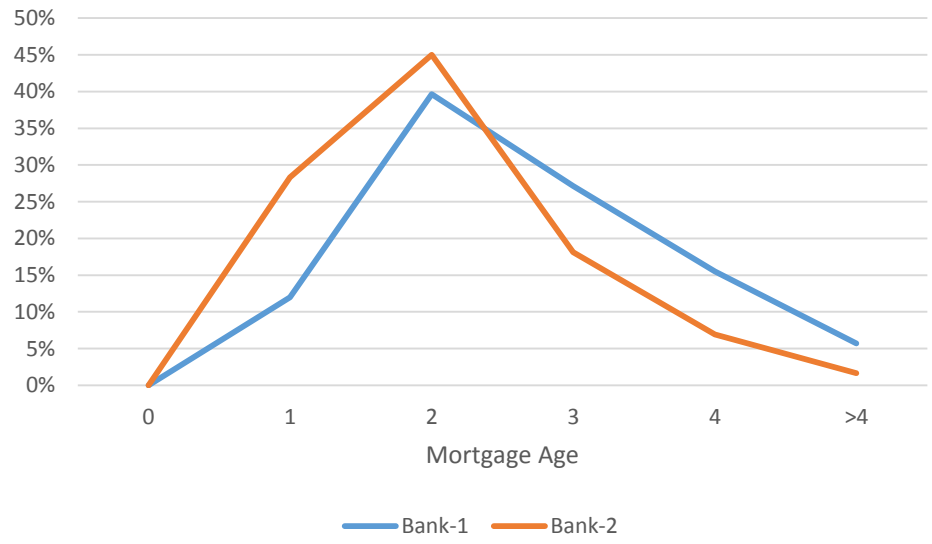


Figure 96: Default Risk According to Mortgage Age

For the prepayment behavior, on the other hand, we observe that 5-years of timeframe is more relevant for surveillance. 85% of the prepayments occurred within 5 years in the 2005-2006 vintages of Bank 1. Whereas in 2007 to 2009 vintages this indicator exceeded 95% level. Similarly for Bank 2, more than 95% of all prepayments were observed within 5 years for 2007-2009 vintages.

Table 40: Prepayments by Vintage

Bank 1	***<1year***	***1-2 years***	***2-3 years***	***3-4 years***	***4-5 years***	***>5 years***	***Total***
2005	788	1366	1278	996	1034	721	6183
2006	557	1783	1530	1741	1508	1081	8200
2007	651	2110	2875	1607	814	514	8571
2008	741	2267	1372	666	436	232	5714
2009	804	2034	1073	954	366	2	5233
2010	784	2362	3353	2022	49	0	8570
2011	543	2605	2105	86	0	0	5339
2012	977	1465	29	0	0	0	2471
Bank 2							
2007	469	1334	2777	1281	506	356	6723
2008	1451	5425	2565	1001	758	306	11506
2009	2927	6796	2055	2470	1027	11	15286
2010	3268	2850	6051	3096	111	0	15376
2011	1359	11988	3776	240	0	0	17363
2012	10703	2578	35	0	0	0	13316

Figure 97 gives prepayment risk according to mortgage age. Similar to default risk, prepayment risk is also materialized earlier in Bank 2. Prepayment risk is highest in the second year for both banks.

Figure 97: Prepayment Risk According to Mortgage Age

Figure 98 depicts mortgage termination risks according to delinquency. A mortgage is considered delinquent if there was a delinquency in any of the payments between 30 to 90 days. According to this analysis, delinquency is one of the most important determinants of default risk. Delinquency history indicates to 6-fold and 3-fold increase in default for Bank 1 and Bank 2 respectively. This analysis also indicate that prepayment risk is higher for the loans with delinquency history. Delinquency indicator has been widely used by banks in their credit scoring models (behavioral models). However, studies in the literature mostly excluded this variable due to unavailability of data. This is the first publicly available work to incorporate delinquency dummy for Turkey.

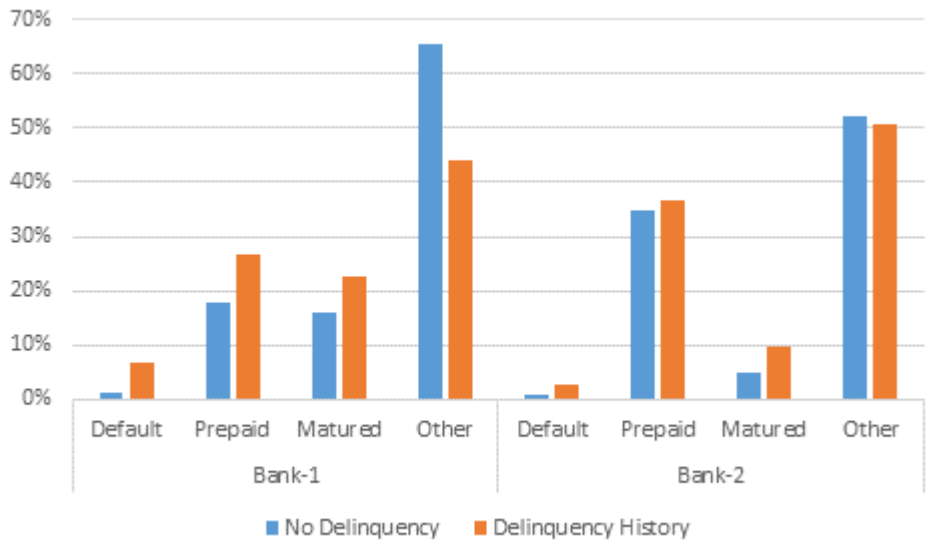


Figure 98: Mortgage Termination Risks and Delinquency

Figure 99 depicts mortgage termination risks according to maturity. The theoretical literature indicated that maturity is an important indicator of default and prepayment risks. Here we observe that both prepayment and default risks increase with maturity.

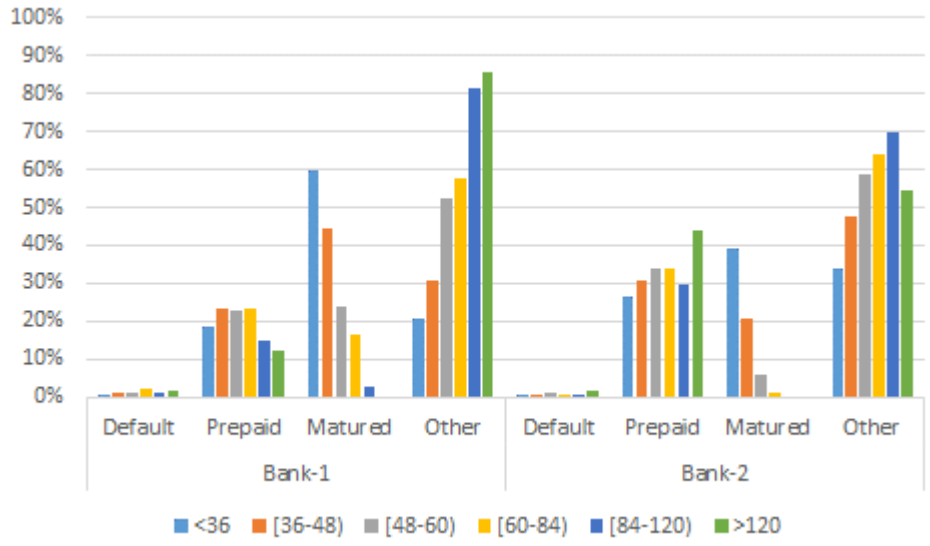


Figure 99: Mortgage Termination Risks According to Maturity

Figure 100 shows that origination interest rate is one of the most relevant and strongest risk factor with respect to prepayment and default. Not only the prepayment risk but also the default risk increases with origination interest rates.

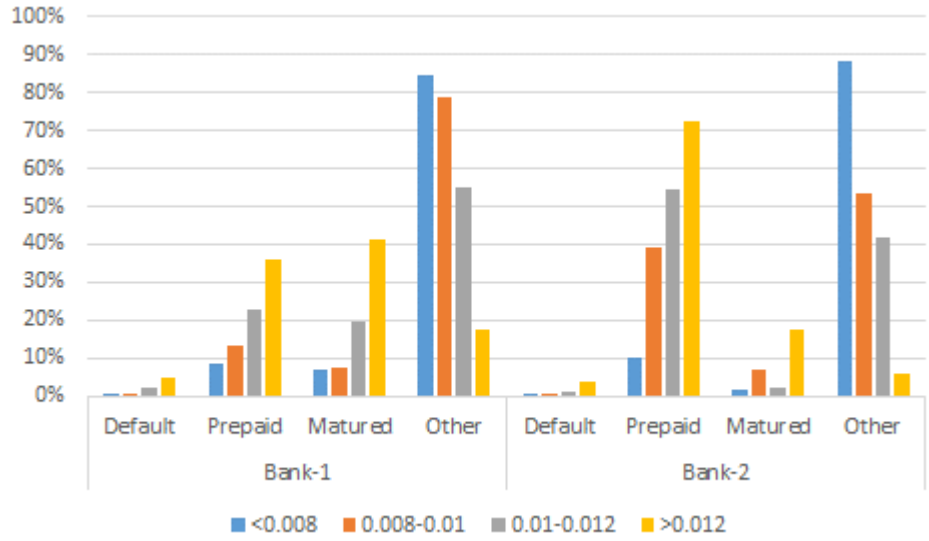


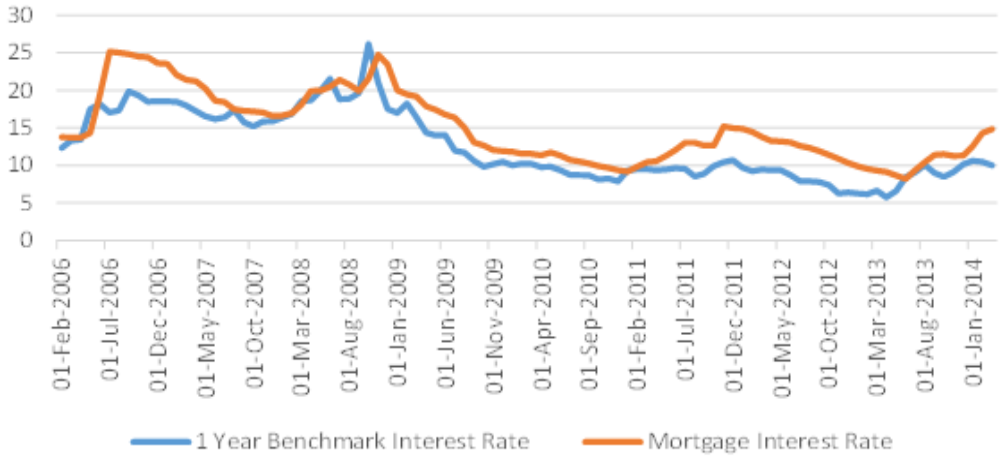
Figure 100: Mortgage Termination Risks According to Interest Rates

Figure 101 illustrates the relationship between mortgage interest rates and benchmark interest rates[138]. During 2006-2007 period, mortgage interest rates were significantly higher compared to the benchmark interest rates. Annual mortgage interest rates has decreased from 20% level in 2008 to 10% level in 2013. In line with the assessments in the previous section, in 2014 there has been a significant increase not only in mortgage interest rates but also in benchmark interest rates.

It should be noted that significant decreases in mortgage interest rates could fuel prepayment risk (i.e. refinancing becomes advantageous for the borrower) and

[138] For the benchmark, the interest rate of benchmark 1-year government bonds is used. For the mortgage interest rate, exposure weighted origination interest rate is calculated.

fluctuations in the benchmark interest rates could indicate an increase in default risk as benchmark interest rates are affected by the adverse developments in the economy.



Source: Thomson Reuters, Bank Data

Figure 101: Mortgage Rates vs Benchmark Interest Rates

Figure 102 indicates that nominal loan amount is a weak explanatory variable with respect to default and prepayment risks.

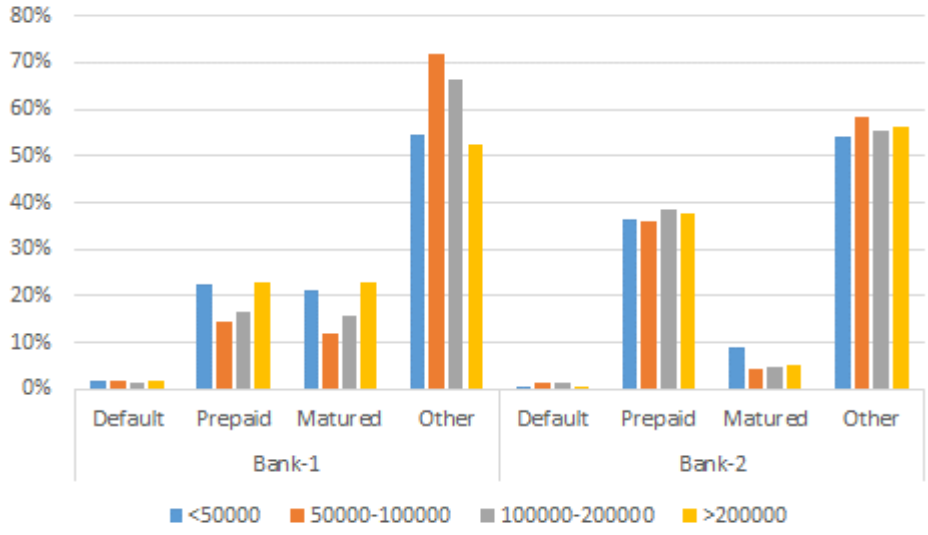


Figure 102: Mortgage Termination Risks According to Loan Amount

On the other hand, after adjusting the loan amount for inflation, it is clearly seen that real loan amount is a stronger indicator of default. Additionally, especially in Bank 2, prepayment risk increases with the loan amount.

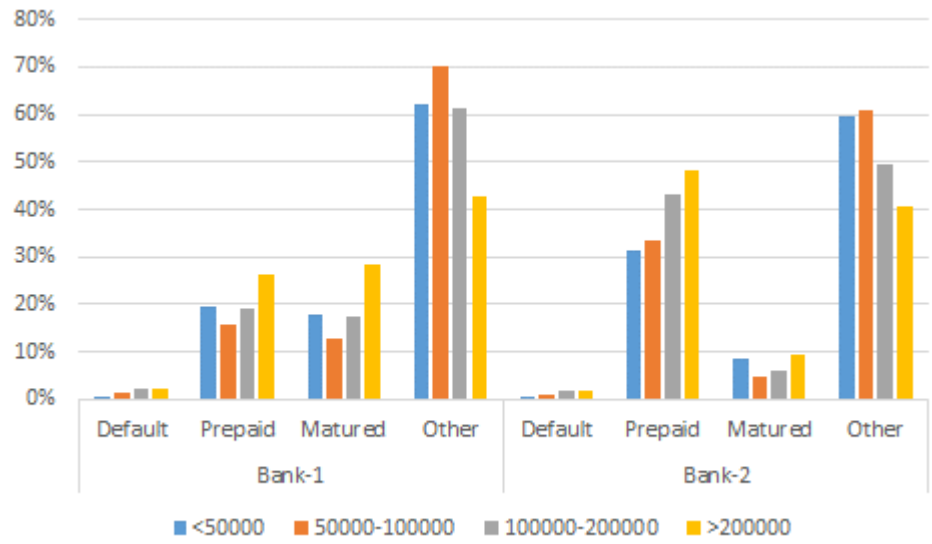


Figure 103: Mortgage Termination Risks According to Loan Amount – Inflation Adjusted

Surprisingly, the Loan to Value ratio does not have a monotonic relationship with the default and prepayment and hence seems to be a weak risk factor[139].

[139] It should be noted that for Bank 1 there are significant number of missing values for the appraisal value variable. Therefore, LTV is missing for a significant number of data points.

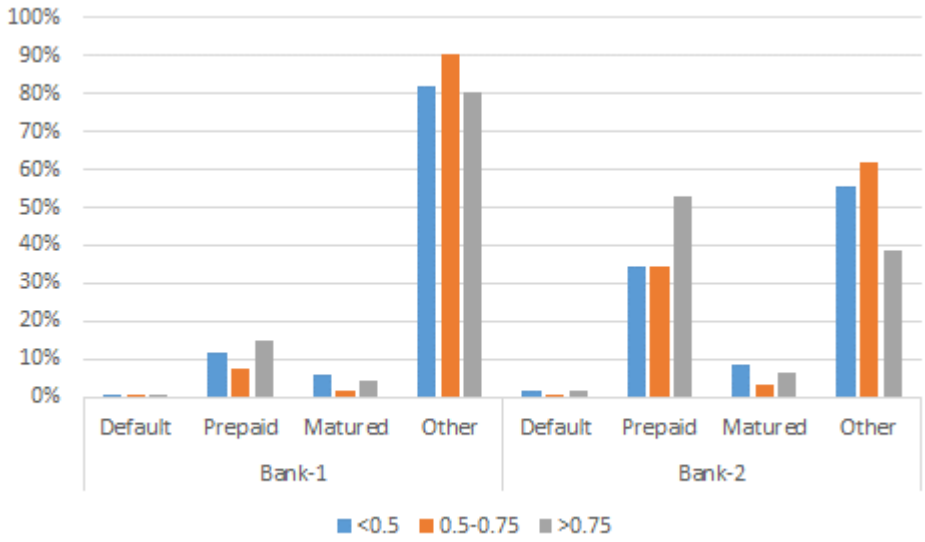


Figure 104: Mortgage Termination Risks According to LTV

Figure 105 provides the Current LTV analysis for Bank 2. According to this figure, although both default and prepayment risks seem to be higher for higher CLTV groups, there is no linear relationship between the CLTV and the default and prepayment risks.

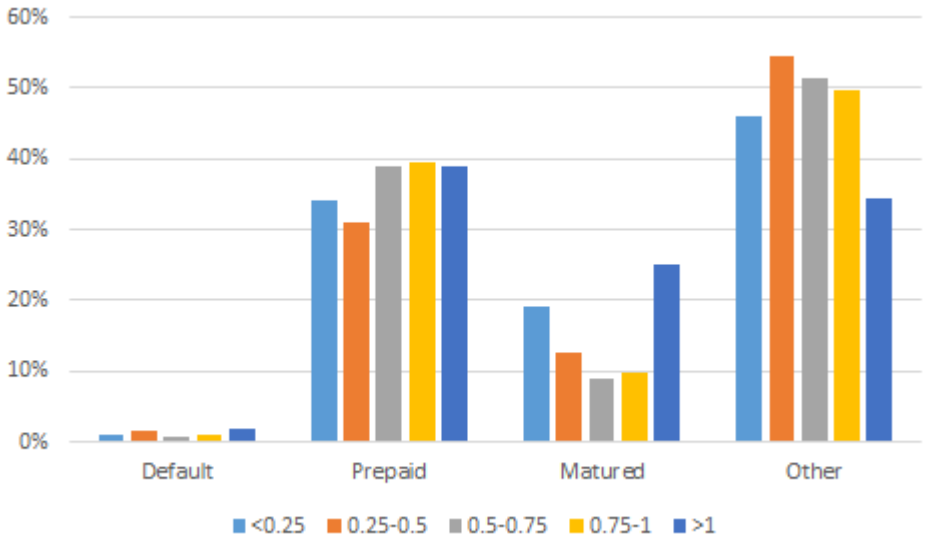


Figure 105: Mortgage Termination Risks According to CLTV

Figure 106 provides mortgage termination risks according to income groups. Here we observe that the prepayment risk increases with the income level of the borrower. Therefore, income level appears to be a strong risk factor for prepayment risk. On the default side, the relationship is not that strong. For bank 2, default risk increases with income, however for Bank 1, a monotonic relationship cannot be observed[140].

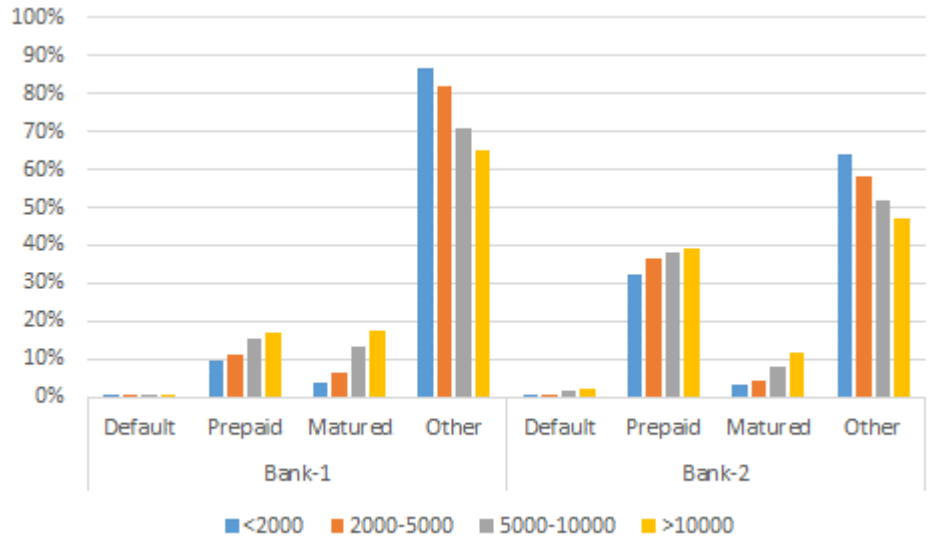


Figure 106: Mortgage Termination Risks According to Income

Similar to previous analysis, the discrimination power of the income variable increases after adjusting for inflation (Figure 107).

[140] It should be noted that income variable is missing for significant number of data points for Bank1.

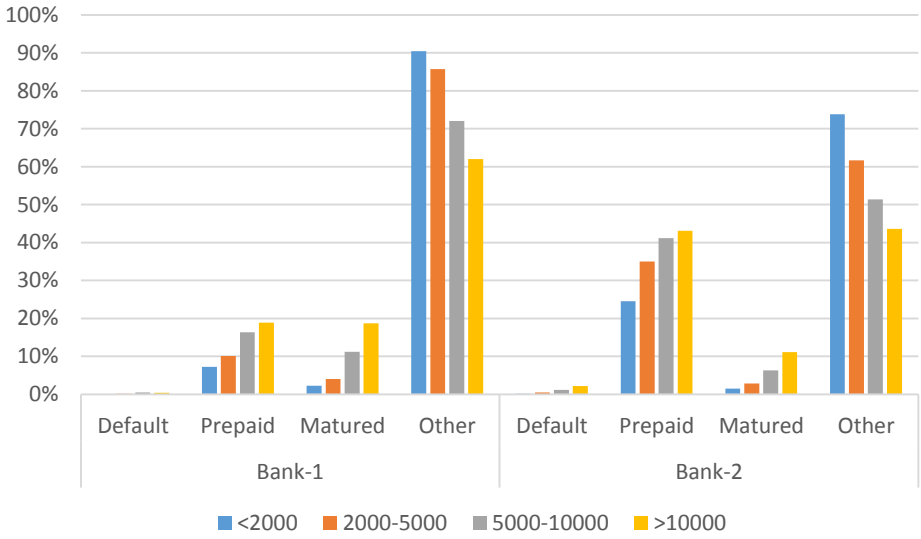


Figure 107: Mortgage Termination Risks According to Income – Inflation Adjusted

Figure 108 shows mortgage terminations according to payment to income ratio. As it has already been discussed in the previous section, reliability of income data in Turkey limits the usefulness of this indicator in default and prepayment modeling.

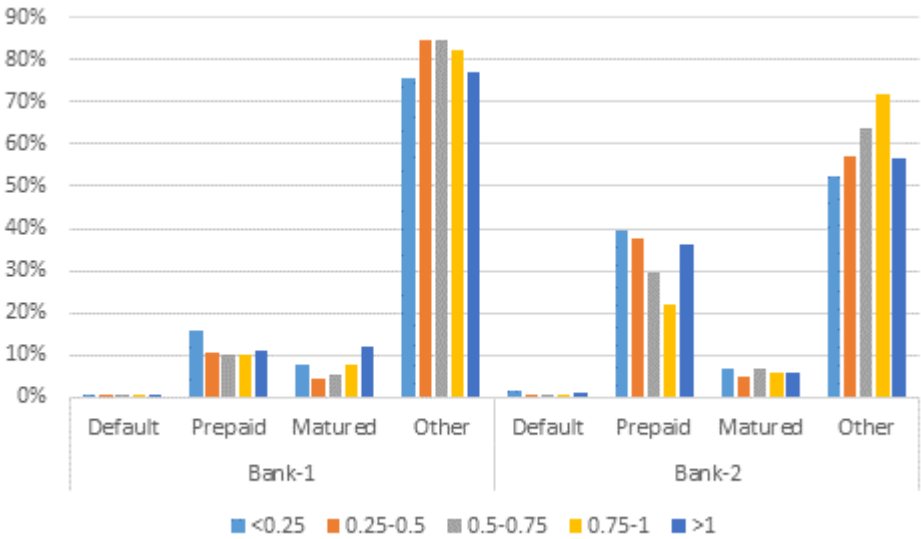


Figure 108: Mortgage Termination Risks According to Payment to Income Ratio

According to Figure 109, there is no clear relationship between default and the age of the borrowers. On the other hand, there seems to be a positive relationship between prepayment and age of the borrower for Bank 1. However, this relationship is not apparent for Bank 2. Also, as indicated above, younger population prefers longer maturities and hence percentage of matured loans that is extended to younger population is lower compared to the older population segments.

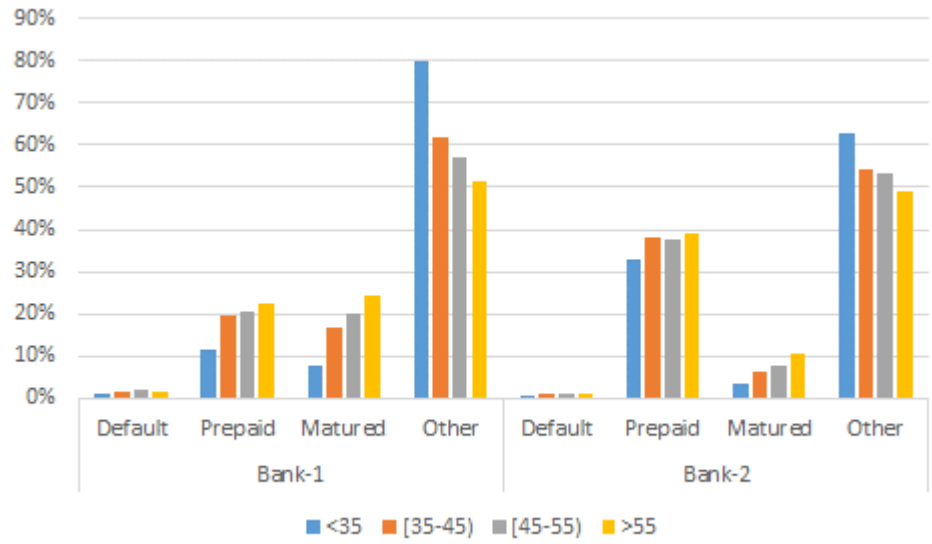


Figure 109: Mortgage Termination Risks According to Age of the Borrower

Figure 110 indicates that there is no major difference among males and females in terms of default and prepayment risks for both banks.

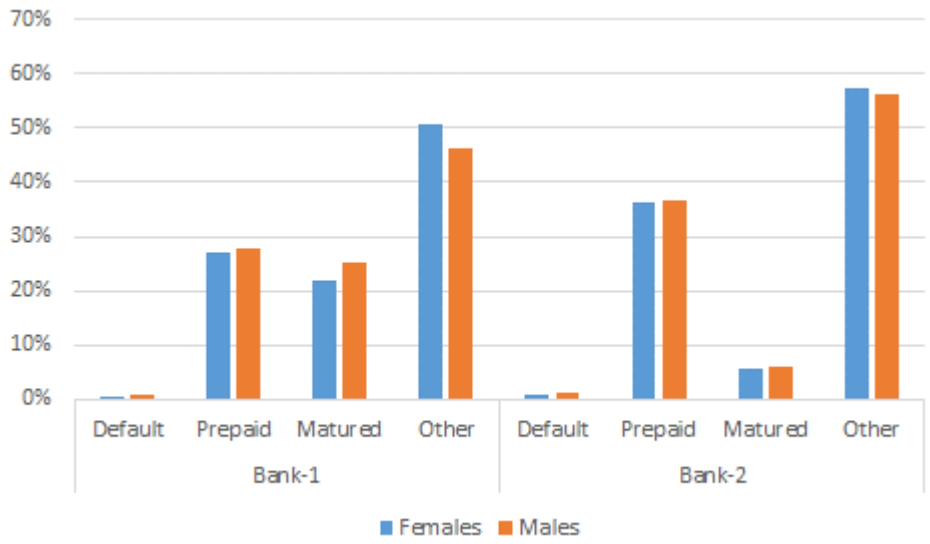


Figure 110: Mortgage Termination Risks According to Gender

Figure 111 illustrates the relationship between marital status and default and prepayment risks. Default risk is lower in the married group compared to singles for both Bank 1 and Bank 2. On the other hand, prepayment risk is higher in Bank 1 but lower in Bank 2 for the married borrowers.

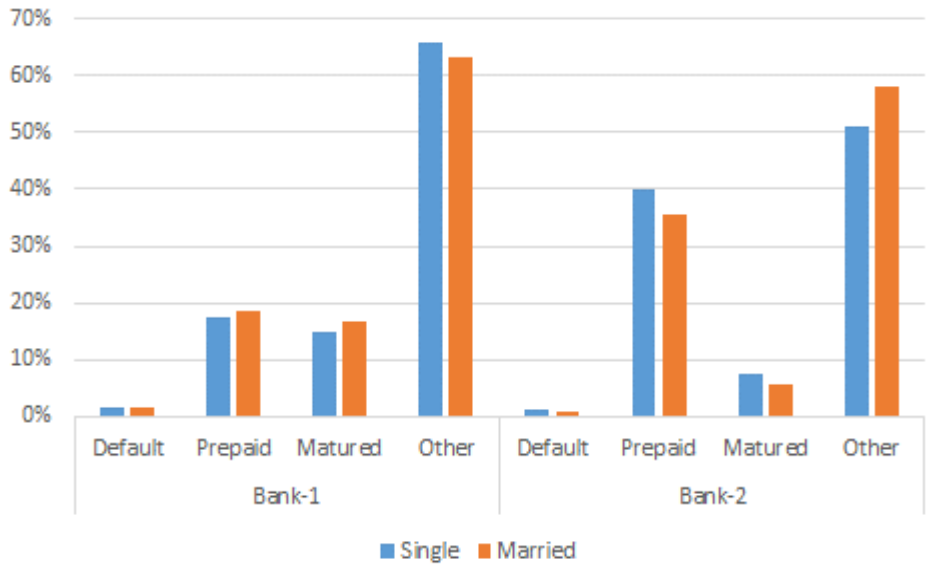


Figure 111: Mortgage Termination Risks According to Marital Status

Figure 112 depicts the relationship between mortgage termination risks and education level. For Bank 1 and Bank 2 default risk is lower and prepayment risk is higher in the university or higher education buckets. This is parallel to the expectations, as income level and financial literacy is anticipated to increase with education.

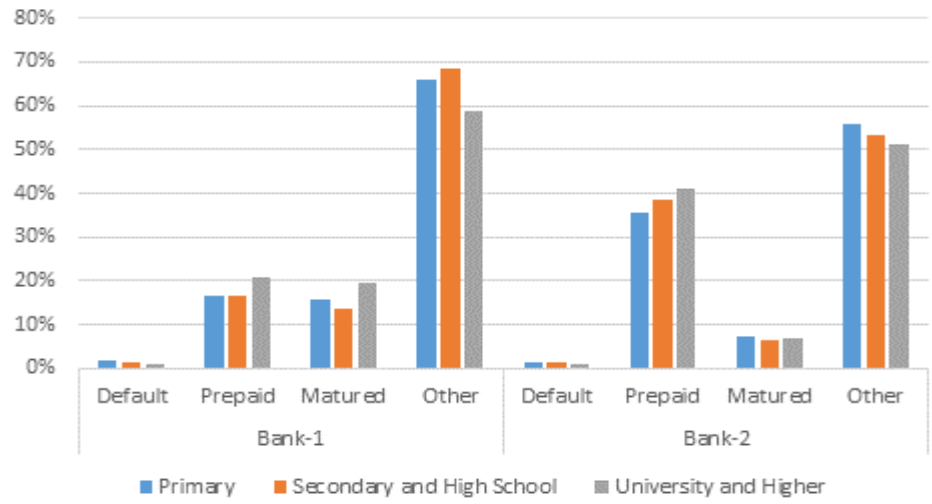


Figure 112: Mortgage Termination Risks According to Education Level

Figure 113 shows the relationship between occupation and default / prepayment risks. For Bank 1, both prepayment and default risks are higher in the private and self-employed groups. A similar assessment can be made with regards to default risk in Bank 2. However, prepayment risk is highest for the public employment category.

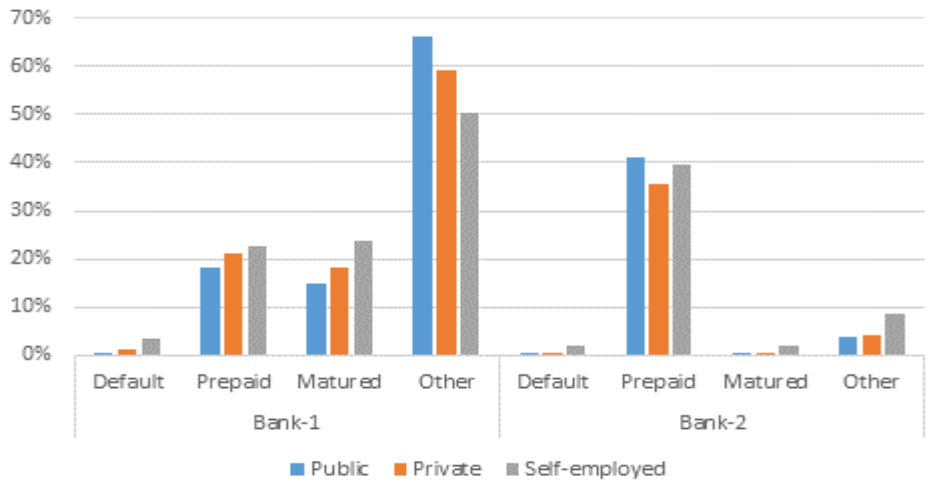


Figure 113: Mortgage Termination Risks According to Occupation

As described in the data section, Bank 1 could be able to provide restructuring data. Figure 114 provides information on mortgage termination risks according to restructured mortgage loans and non-restructured ones. This table shows that restructuring has no effect on prepayment risk since the risk is almost same for the restructured and non-restructured loans. However, there is significant difference in terms of default risk. Default rate is much higher for non-restructured loans and very close to zero for the restructured ones. BRSA's provisioning regulation allows banks to restructure their loans only when there is temporary liquidity problems with the borrower. This simple analysis show that restructuring effectively reduces the default risk for Bank 1.

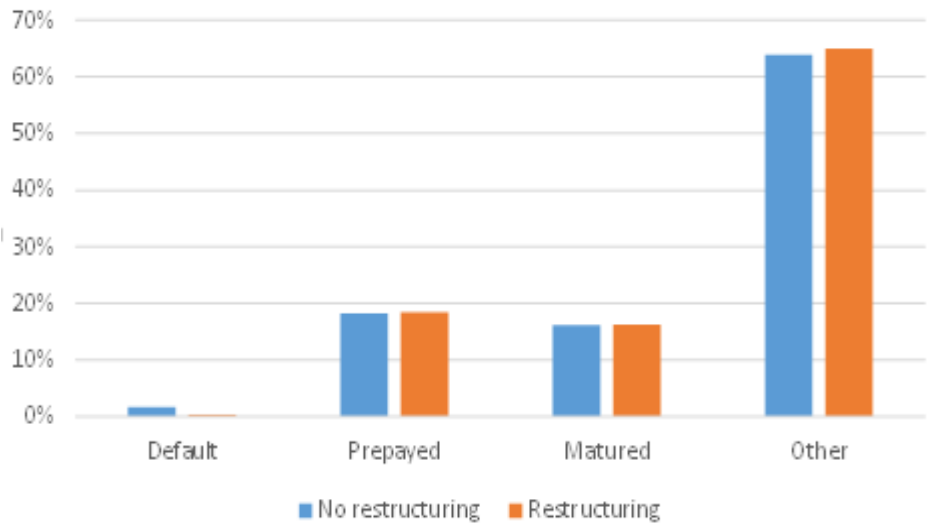


Figure 114: Mortgage Termination Risks and Restructuring – Bank 1

Figure 115 provides mortgage termination risks according to region. It should be noted that city code is missing for significant number of observations for Bank 1. Analysis with the available data reveal that default risk is highest in the region excluding three main cities and prepayment risk is highest in Izmir for Bank 2.

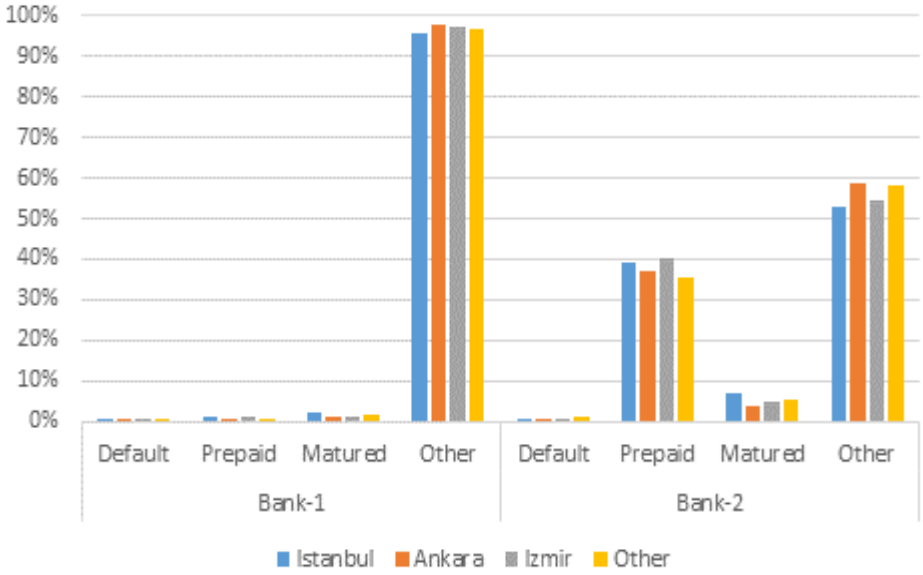
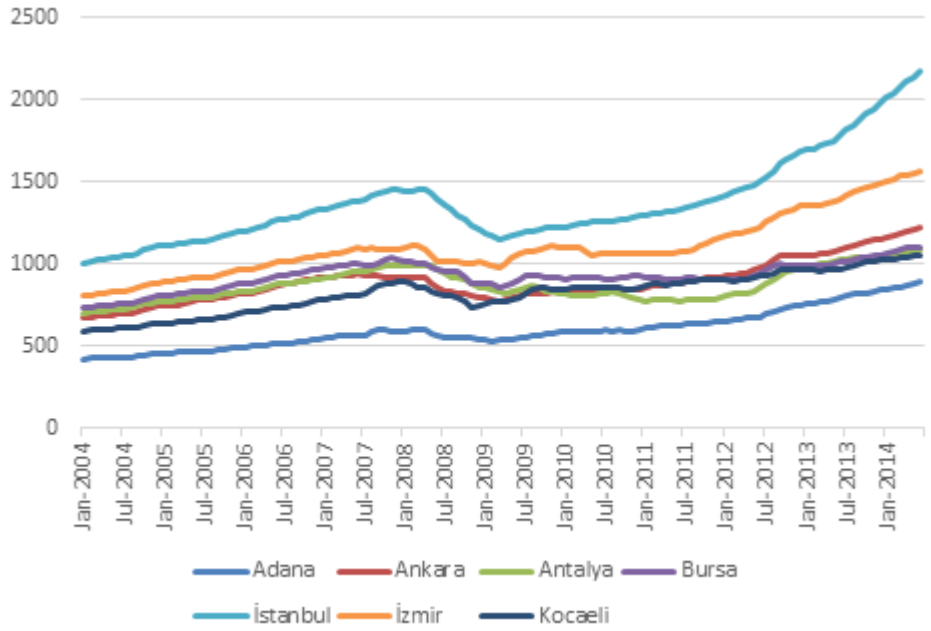


Figure 115: Mortgage Termination Risk According to Region

Figure 116 also provides information that is consistent with the previous Figure. In the last four years, house prices went up most in Istanbul, corresponding to a price increase around 70%. Izmir ranked second in terms of the change in average house prices[141].



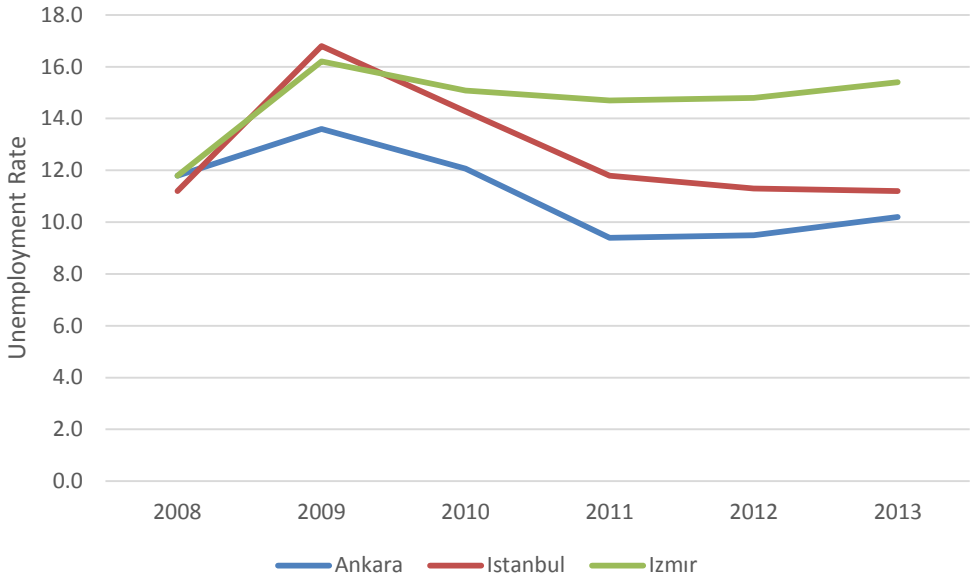
Data Source: REIDIN

Figure 116: Regional Development of House Prices

Turkish Statistical Institute (Turkstat) has been providing regional unemployment rates since 2008. According to this indicator, there has been significant variability across unemployment rates of different cities. For instance, although 2008 unemployment levels were quite similar, unemployment in Izmir has increased to 16% level and unemployment in Ankara has decreased to 10% level by 2013.[142]

[141] The house price appreciation data based on CBRT index is given in Appendix F.

[142] It should be noted again that this info does not correspond to the needs of this study. Since regional unemployment data are not available before 2008.



Data Source: Turkish Statistical Institute

Figure 117: Regional Unemployment Rates

Lien of the collateral is provided for small number of observations. According to this information default risk is slightly higher in lower liens compared to first liens in Bank 1.

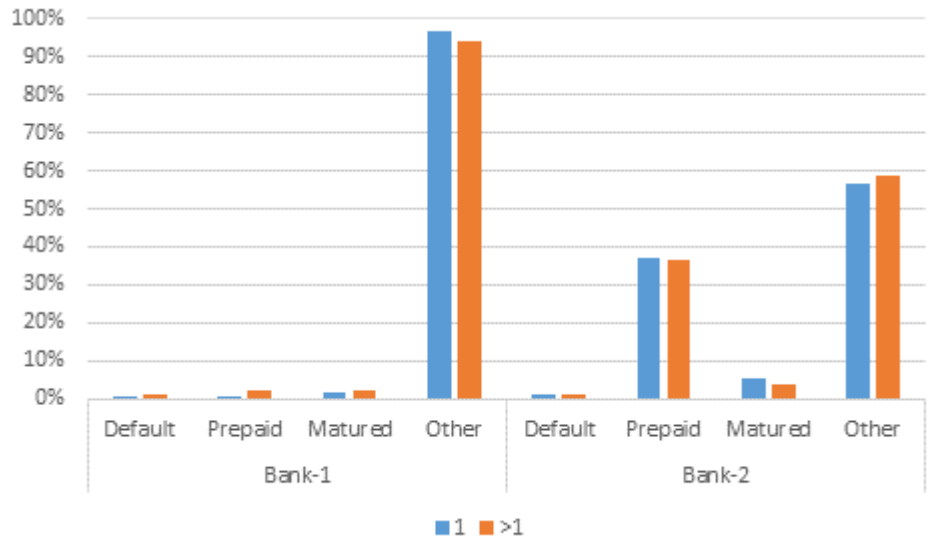


Figure 118: Mortgage Termination Risks According to Lien of the Collateral

Figure 119 shows that default risk is higher in the other-purposes bucket compared to home-purchase-mortgages. On the other hand, prepayment behavior differs according to the purpose of the loan. This might be due to differences in these bank's lending practices.

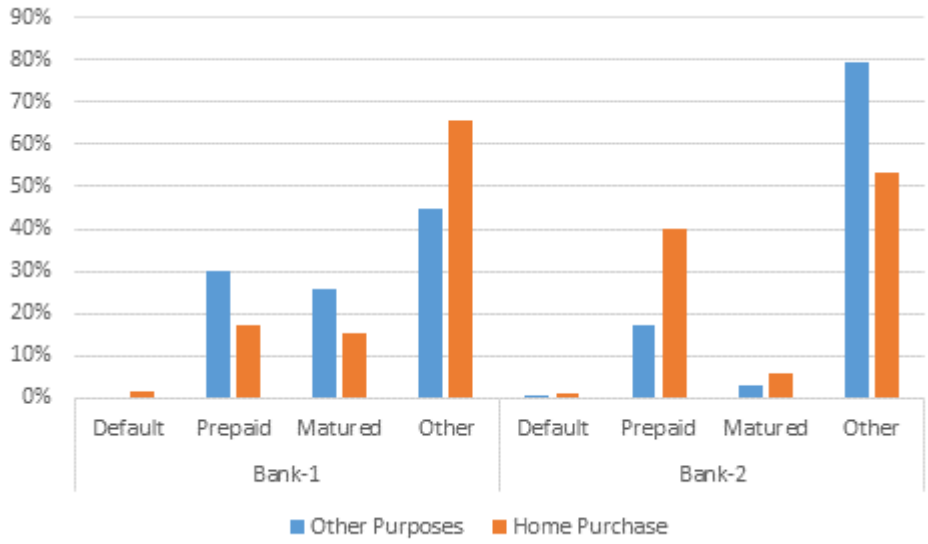


Figure 119: Mortgage Termination Risks According to the Purpose of the Loan

Figure 120 illustrates mortgage termination risks according to the dummy variable showing whether the purchased house is the first house of the borrower or not. Theoretically, it is assumed that if it is the first house of the borrower, borrower will make every effort to pay back her/his loan. On the other hand, if the purchased loan is only one of the houses that the consumer owns, tendency to make mortgage payments might decrease. It should be noted that limited number of data could be obtained for this variable. Although it is not very clear from the figure, calculations show that default risk in first-houses is almost half of the default risk in the other-category. Additionally, we observe that prepayment risk is also higher in the other-category. This is also sensible because the owner already has more than one house which might be accepted as an indicator of high income.

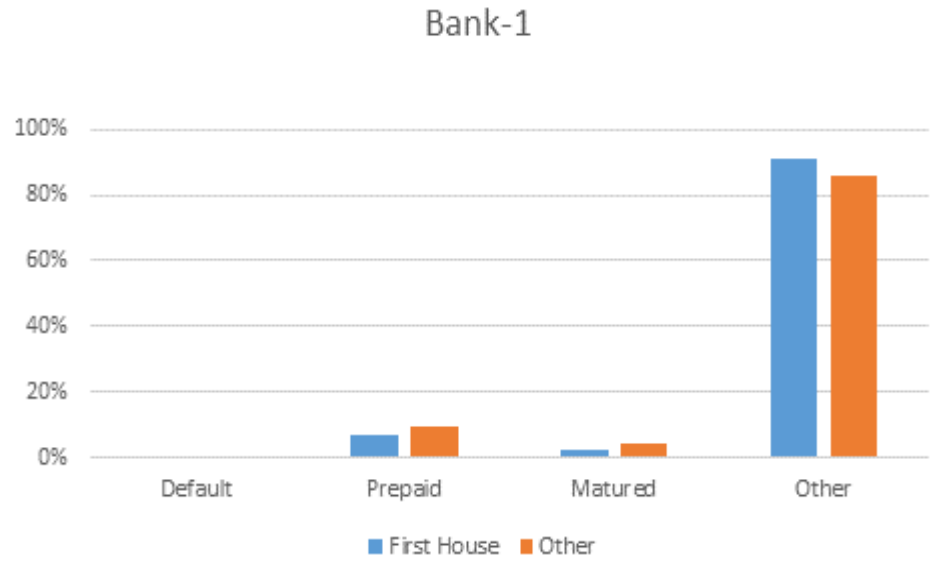


Figure 120: Mortgage Termination Risks According to First House Dummy

Finally, Figure 121 provides the link between mortgage termination risks and internal scores of Bank 2[143]. It shows that Bank 2's scoring approach is quite successful at differentiating mortgages according to their default behavior. On the other hand, these scores provide no information about the prepayment behavior.

[143] Bank 1 has also provided internal scores data. However, the altered scoring methodology produced skewed scores therefore alignment could not be made. For simplicity, only the result regarding Bank 2 is presented here where adjustment of pre and post methodology scores could be made.

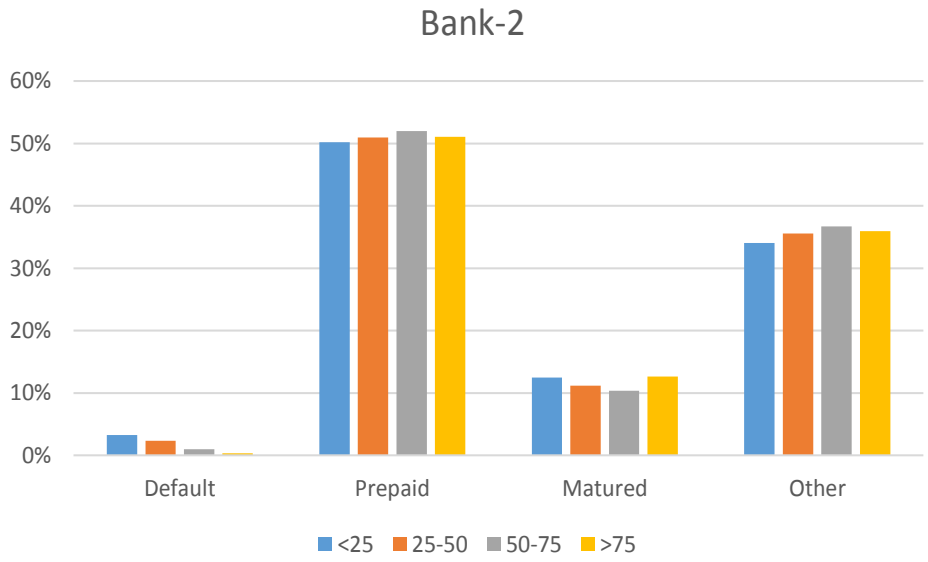


Figure 121: Mortgage Termination Risks According to Internal Score

Other Indicators

In this part, the trends in dynamic LTV (i.e. current LTV) ratio and Poption variable are discussed which are widely used as default and prepayment proxies in the literature.

In a specific year, for each of the non-terminated loans, total outstanding balance is divided by the house price that is corrected for house price index in order to calculate the CLTV ratio[144]. The table below is the averages of these figures at the end of each year[145]. We observe that there is a downward trend in the dynamic LTV ratios which is mainly supported by increasing house prices.

[144] Here REIDIN Index is used as it is the only source for past house price developments in the sample period.

[145] Current LTV is not calculated for Bank 1 due to high number of missing values for the appraisal value variable.

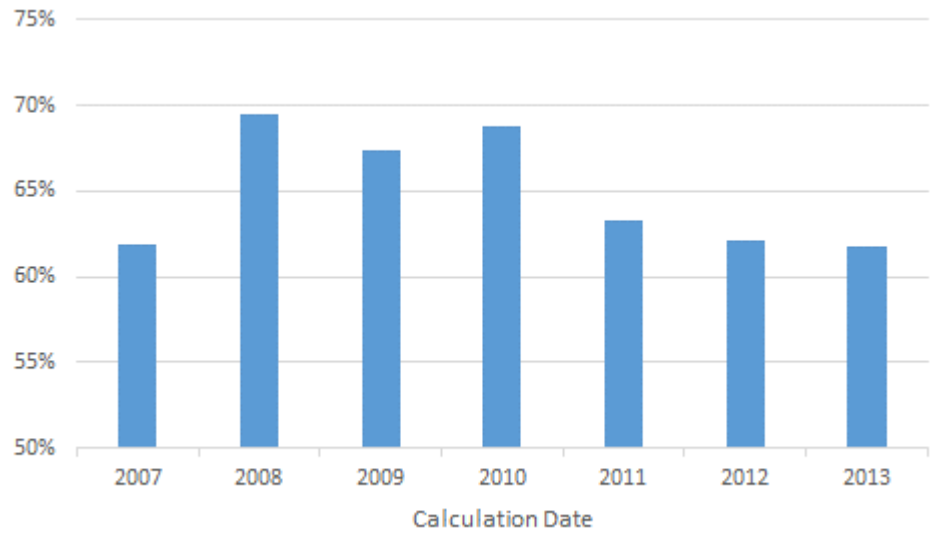


Figure 122: Current LTV Ratio

For the prepayment proxy, the following formula is used for calculating the present values of all future installments using both the original interest rate and the market rate[146].

$$poption = \frac{\sum_{t=1}^{\tau} \frac{Installment_t}{\left(1+\text{market rate}_q\right)^t} - \sum_{t=1}^{\tau} \frac{Installment_t}{(1+\text{interest rate})^t}}{\sum_{t=1}^{\tau} \frac{Installment_t}{\left(1+\text{market rate}_q\right)^t}} \qquad (60)$$

where; τ is the number of remaining installments at period q,

q is the calculation quarter,

Installment is the installment amount,

Interest rate is the origination interest rate.

[146] For market rate, average mortgage rate at each quarter in the sample is used. The calculation is done by including the data of Bank-1 and Bank-2.

At each quarter average value of Poption variable is provided in Figure 123. According to this figure, the prepayment option was in the money (i.e. for the whole portfolio, average origination interest rates were higher than the prevailing mortgage interest rates at that period) during 2009-2011 period for the whole portfolio of both Bank-1 and Bank-2. Additionally, due to recent rate hikes, currently this option is out of the money. In other words, current increase in the mortgage interest rates reduced the incentives for refinancing.

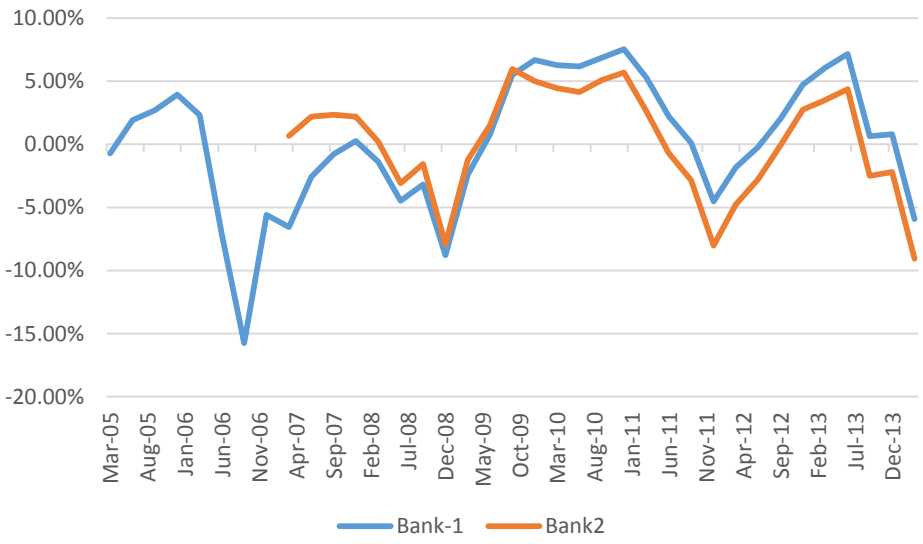


Figure 123: Poption Variable

4.6.3 Modeling Results: Prepayment and Defaults Risks

In modeling the prepayment and default risks, the following set of variables is used for Bank-1 and Bank-2. Due to the missing data problem, some of the variables defined in the data section were not integrated into the modeling framework. For instance, the regional unemployment data is not available for all years (data starts from 2008) whereas the first house, purpose of the loan and area variables were available for only a few years. Additionally, restructured loans that are reported by

Bank-1 are excluded from the analyses as inclusion creates additional complexities in modeling (i.e. change in interest rate, maturity etc.).

Default and prepayment dummies are reformatted so that they took the value of "1" if there is default/prepayment within 12 months after the calculation date and "0" otherwise. Similarly, delinquency dummy is assigned a value of "1" if there is a delinquency in the last one year. Otherwise, it is assigned a value of "0".

In the estimation the *coxph()* function of the survival package is used by employing a time-dependent covariates approach.[147] As explained by Fox (2002:7) *coxph()* copes with time dependent covariates by requiring that each time period for an individual appear as a separate row in the data set.

[147] For a more detailed analysis on using *coxph()* function in a time dependent covariates setting, see Fox (2002) and Putter (2014)

Table 41: Variables Used in Modeling

Variables	Bank 1	Bank 2	Time Varying Covariates
CEMV	+	-	+
Poption	+	+	+
CLTV	+	+	+
Year Dummy	+	+	-
City Dummy	-	+	-
Delinquency Dummy	+	+	+
Income	-	+	-
Age	+	+	-
Gender Dummy	+	-	-
Initial Marital Status Dummy	+	+	-
Married/Divorced Dummy	+	+	+
Occupation Dummy	+	+/-[148]	-
Remaining Maturity	+	+	+
Credit Amount	+	+	-
Lien	+	-	-
Interest Rate	+	+	-
Education Dummy	+/-	+	-

As described in the data section, while for Bank 1, loan information is available starting from 2005, for Bank 2 this information is available starting from 2007. Additionally, the quality of data and the availability of variables change from one bank to another. Therefore, different models are constructed for these two banks and results of these models are provided below. Moreover, variables such as collateral age, floor area and first house dummy are not included into the models as there are significant amount of missing values for these variables.

[148] "+/-" means due to limited number of missing values, significance of the variable is assessed separately.

To be able to evaluate the out of sample performances of the models, data is randomly divided into two halves as model building and validation samples. In the modeling, some variables were considered as time varying covariates.

Taking into account that Deng *et al.* (2000) is the most cited paper on prepayment and default modeling, a similar approach is followed in constructing models. Consequently, variables are included in the models according to the sequence provided in Table 42.

Table 42: Variables Included in the Models

Models	#1	#2	#3	#4	#5
Key determinants as described by Deng *et al.* (2000 and 2005) (CEMV, Poption, CLTV)	+	+	+	+	+
Origination Year Dummy		+	+	+	+
Delinquency			+	+	+
Borrower characteristics (Age, Gender) and other available variables (Remaining Maturity, Loan Amount, Mortgage Interest Rate)				+	+
Squared terms of option variables and interactions[149]					+

All of the models presented below were estimated using R software (version 3.1.2). For survival modeling, the competing risks framework is chosen and Kalbeisch-Prentice approach is employed. Variance inflation factors were also investigated in order to control for multicollinearity. Note that, for the monetary variables, inflation adjusted figures were used in order to eliminate the effect of inflation.

[149] Prepayment and default literature do not point to specific interaction terms to be included in models. Nevertheless, the present study includes the income-age interaction, which was observed in the descriptive analyses section. However, this term created multicollinearity problems and results of this model is not presented.

Model 1:

It is important to note that, due to missing data problems (i.e. missing values for CEMV and CLTV variables) Bank 1 will be included to the analysis starting from Model 3. In other words, Model 1 and Model 2 are carried out only for Bank 2.

Table 43 provides survival modeling results for Bank 2 by using key determinants traditionally used by the industry and the literature. In this model, Current Equity to Market Value (a proxy for the put option), Prepayment Option Indicator (a proxy for the call option) and Current Loan to Value variables are used as covariates[150]. This model basically takes into account the main variables used in the structural models.

According to Model 1, Current Equity to Market Value variable is insignificant in the default model. It is expected that the probability of default decreases as the equity of a borrower increases. A similar situation is also seen in Deng *et al.* (2005). This might be due to problems related to appraisal data, or might mean that, based on the currently available data, Turkish mortgage borrowers are not effectively utilizing the financial put option. Current legal framework could also have an effect on this. On the other hand, as expected, the prepayment option indicator (*poption*) has a positive sign and this variable is significant in the prepayment model.

Table 43: Survival Model 1 for Default and Prepayment – Bank 2

	Default Model			**Prepayment Model**		
	coef	robust se	p	coef	robust se	p
CEMV	0.048	0.260	0.850	0.347	0.049	0.000
Poption	1.543	0.458	0.001	8.053	0.077	0.000
CLTV	0.694	0.227	0.002	0.669	0.038	0.000
Likelihood Ratio Test	51.900			13954.000		
p-value	0.000			0.000		

[150] It should be noted that this model has the omitted variable bias, since it excludes many important consumer level variables.

Model 2:

Model 2 extends the previous model with origination year dummies. It is observed that all the origination year dummies are significant in the default and prepayment model. Moreover, we see that compared to baseline year (2007), default risk has been higher in loans originated in 2008 and lower in loans originated between 2009 and 2012. This is consistent with the tighter lending standards after the global financial crisis period. Additionally, we observe that during the fast credit period of 2010-2011, Bank-2 did not eased its lending standards. In this and following models, we also observe that CLTV has a negative sign in the default model[151]. This is consistent with the sorting-by-observed hypothesis. According to the sorting-by-observed-risk hypothesis, prepayment and default risks are observable via credit analysis and therefore smaller LTV ratios are associated with riskier borrowers[152]. On the prepayment side, it is seen that loans originated during 2009 and 2010 had lower prepayment speeds compared to the ones originated in 2007.

Table 44: Survival Model 2 for Default and Prepayment – Bank 2

	Default Model			**Prepayment Model**		
	coef	robust se	p	coef	robust se	p
CEMV	-1.244	0.288	0.000	0.219	0.052	0.000
Poption	0.870	0.387	0.025	8.087	0.104	0.000
CLTV	-0.924	0.245	0.000	0.673	0.041	0.000
Year – 2008	0.635	0.093	0.000	0.165	0.023	0.000
Year – 2009	-1.120	0.113	0.000	-0.114	0.021	0.000
Year – 2010	-1.160	0.103	0.000	-0.289	0.021	0.000
Year – 2011	-1.108	0.111	0.000	0.279	0.022	0.000
Year – 2012	-1.110	0.131	0.000	0.504	0.023	0.000
Likelihood Ratio Test	679.000			16722.000		
p-value	0.000			0.000		

[151] It should be noted that sign of a variable in a model might change as the effects of variables in those models are partial effects. We have controlled that there is no multicollinearity problem in these models.

[152] For more details, see Chiang *et al.* (2002).

Model 3:

Table 45 presents default and prepayment model results for Bank 1, including the prepayment option, origination year dummies and delinquency dummy. Default model for Bank 1 shows that delinquency in payments significantly increases default risk. Additionally, loans that were originated in 2006-2008 are riskier (default risk) than the ones originated in 2005 and loans originated after 2009 are less risky (default risk) compared to the ones originated in 2005.

Table 45: Survival Model 3 for Default and Prepayment – Bank 1

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	p
Poption	0.074	0.156	0.000	1.129	0.066	0.000
Year-2006	0.390	0.070	0.000	-0.072	0.023	0.002
Year-2007	0.462	0.069	0.000	-0.004	0.023	0.870
Year-2008	0.609	0.074	0.000	-0.005	0.027	0.850
Year-2009	-0.936	0.109	0.000	-0.322	0.027	0.000
Year-2010	-2.083	0.120	0.000	-0.592	0.023	0.000
Year-2011	-1.808	0.121	0.000	-0.679	0.026	0.000
Year-2012	-2.706	0.230	0.000	-0.901	0.035	0.000
Delinquency	1.822	0.052	0.000	0.348	0.029	0.000
Likelihood Ratio Test	3188.000			2653.000		
p-value	0.000			0.000		

Similarly, the results presented in Table 46 for Bank 2 show that delinquency is an important indicator of default risk. Additionally, parallel to results for Bank 1, prepayment option is significant and has a positive sign in the prepayment model.

Table 46: Survival Model 3 for Default and Prepayment – Bank 2

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	p
CEMV	-1.353	0.290	0.000	0.224	0.052	0.000
Poption	-0.011	0.381	0.980	8.173	0.105	0.000
CLTV	-1.111	0.248	0.000	0.685	0.041	0.000
Year – 2008	0.539	0.094	0.000	0.174	0.023	0.000
Year – 2009	-1.182	0.113	0.000	-0.111	0.021	0.000
Year – 2010	-1.227	0.103	0.000	-0.286	0.021	0.000
Year – 2011	-1.218	0.110	0.000	0.286	0.022	0.000
Year – 2012	-1.190	0.131	0.000	0.510	0.023	0.000
Delinquency	1.463	0.096	0.000	-0.187	0.026	0.000
Likelihood Ratio Test	885.000			16787.000		
p-value	0.000			0.000		

Model 4:

Table 47 provides prepayment and default modeling results for Bank 1 including borrower characteristics and other available variables. Accordingly, default risk decreases as age increases, but age variable is insignificant in the prepayment model. Marital status at origination has no material effect/marginal effect on prepayment and default. This is also valid for marital status change variable. Table 47 also shows that an increase in original credit amount increases default risk whereas, it has no significant effect on prepayment risk. It is also observed that default risk is significantly lower for borrowers that have higher education. We also note that, in line with expectations, prepayment risk is higher in the secondary education and higher education categories compared to primary education category. Finally, an increase in the origination interest rate increases both the default risk and the prepayment risk.

Table 47: Survival Model 4 for Default and Prepayment – Bank 1

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	P
Poption	-2.125	0.161	0.000	0.281	0.104	0.007
Year-2006	0.239	0.070	0.001	-0.049	0.023	0.036
Year-2007	0.270	0.069	0.000	-0.011	0.024	0.630
Year-2008	0.414	0.074	0.000	0.053	0.027	0.049
Year-2009	-0.688	0.110	0.000	-0.225	0.028	0.000
Year-2010	-1.537	0.125	0.000	-0.371	0.027	0.000
Year-2011	-1.395	0.126	0.000	-0.408	0.030	0.000
Year-2012	-2.304	0.233	0.000	-0.628	0.038	0.000
Delinquency	1.683	0.053	0.000	0.349	0.029	0.000
Age	-0.020	0.002	0.000	0.001	0.001	0.150
Initial Marital Status -Married	-0.088	0.061	0.150	-0.041	0.019	0.031
Marital Status Change - Married	-0.281	0.183	0.120	0.038	0.053	0.470
Marital Status Change - Divorced	0.188	0.558	0.740	0.177	0.176	0.310
log(Credit_Amount)	0.401	0.027	0.000	-0.006	0.010	0.560
Remaining Maturity	0.057	0.006	0.000	-0.084	0.002	0.000
Education -Secondary	-0.093	0.056	0.094	0.105	0.020	0.000
Education -Higher	-1.052	0.068	0.000	0.130	0.021	0.000
Interest Rate	1.580	0.079	0.000	0.414	0.034	0.000
Likelihood Ratio Test	4060.000			4378.000		
p-value	0.000			0.000		

Corresponding model for Bank-2 is given in Table 48. In this model, city dummies could also be included. Results show that default risk is lower in larger cities compared to other cities (cities other than the ones given in the table are grouped as other). Also, these models show that default risk and prepayment risk increase with income reported by the consumer[153]. Similar to the results for Bank-1, default risk decreases with age. Effect of gender is either insignificant or mild. For the portfolio of Bank 2, being married at the origination reduces default risk but increases

[153] As an alternative measure PTI ratio is also included into the models. However, PTI variable was insignificant in all models and therefore not included as separate analysis in this thesis.

prepayment risk. Marriage during the life of the loan decreases default risk but increases prepayment risk. For private sector and self-employed groups default risk is higher compared to the public officers group and prepayment risk is lower. Similar to the results for Bank 1, default risk increases as the maturity of the obligation and loan amount increases. Lien has no significant effect on both risks. Finally, in line with the results for Bank 1, an increase in the origination interest rate increases both the default risk and the prepayment risk.

Table 48: Survival Model 4 for Default and Prepayment – Bank 2

	Default Model			Prepayment Model		
	coef	robust se	p	Coef	robust se	p
CEMV	1.262	0.326	0.000	1.509	0.063	0.000
Poption	-2.936	0.435	0.000	6.917	0.108	0.000
CLTV	-0.637	0.235	0.007	1.098	0.046	0.000
Year – 2008	0.397	0.094	0.000	0.240	0.023	0.000
Year – 2009	0.023	0.123	0.850	0.337	0.025	0.000
Year – 2010	0.660	0.131	0.000	0.355	0.028	0.000
Year – 2011	0.336	0.134	0.012	0.806	0.029	0.000
Year – 2012	0.687	0.153	0.000	1.182	0.030	0.000
City - Adana	-0.501	0.218	0.022	0.128	0.039	0.001
City - Ankara	-0.503	0.101	0.000	0.132	0.017	0.000
City - Antalya	-0.249	0.112	0.027	0.046	0.024	0.054
City - Bursa	-0.475	0.176	0.007	0.098	0.030	0.001
City - İstanbul	-0.719	0.081	0.000	0.083	0.015	0.000
City - İzmir	-0.844	0.168	0.000	0.274	0.025	0.000
City - Kocaeli	-0.244	0.180	0.170	0.102	0.035	0.003
Delinquency	1.105	0.100	0.000	-0.255	0.027	0.000
log(Income)	0.340	0.051	0.000	0.074	0.012	0.000
Age	-0.018	0.004	0.000	-0.011	0.001	0.000
Gender - Male	-0.009	0.079	0.910	0.031	0.014	0.030
Initial Marital Status -Married	-0.270	0.086	0.002	0.148	0.018	0.000
Marital Status Change -Married	-0.613	0.118	0.000	0.208	0.023	0.000
Marital Status Change -Divorced	-0.095	0.142	0.500	0.149	0.026	0.000
Occupation - Private	1.044	0.171	0.000	-0.240	0.016	0.000
Occupation - Self Employed	1.607	0.174	0.000	-0.386	0.019	0.000
Remaining Maturity	0.251	0.015	0.000	0.098	0.003	0.000
log(Credit_Amount)	0.675	0.063	0.000	0.310	0.016	0.000
Lien	-0.005	0.121	0.970	0.162	0.020	0.000
Interest_Rate	3.858	0.178	0.000	1.405	0.042	0.000
Likelihood Ratio Test	2350.000			20821.000		
p-value	0.000			0.000		

An important result from this micro-level data is that creating general conclusions about the significance and sign of variables in these analyses by using a single bank data could create some misleading results. There can be many reasons behind the different signs of the variables for different bank models. For instance, banks have

different consumer portfolios/lending strategies that might have a significant effect on the group of loans extended by a bank. Additionally, data quality in these banks might change according to the importance assigned to this issue within the company. Consequently, results provided above show that these bank level differences could be significant.

Model 5:

Model 5 for both banks extend the models presented above with the squared terms of the option variables in order to control for nonlinear effects of option variables. According to the results presented in Table 49, squared term of the option indicator is significant in the default model and the prepayment model with a negative sign for Bank 1.

Table 49: Survival Model 5 for Default and Prepayment – Bank 1

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	p
Poption	-4.032	0.328	0.000	0.124	0.110	0.260
Poption-Squared	-6.651	1.347	0.000	-2.145	0.593	0.000
Year-2006	0.240	0.070	0.001	-0.045	0.023	0.053
Year-2007	0.317	0.069	0.000	-0.005	0.024	0.830
Year-2008	0.542	0.075	0.000	0.073	0.027	0.007
Year-2009	-0.493	0.111	0.000	-0.209	0.028	0.000
Year-2010	-1.444	0.126	0.000	-0.368	0.027	0.000
Year-2011	-1.301	0.127	0.000	-0.406	0.030	0.000
Year-2012	-2.108	0.234	0.000	-0.625	0.038	0.000
Delinquency	1.677	0.053	0.000	0.347	0.029	0.000
Age	-0.020	0.002	0.000	0.001	0.001	0.140
Initial Marital Status -Married	-0.098	0.060	0.100	-0.042	0.019	0.028
Marital Status Change - Married	-0.299	0.182	0.100	0.038	0.053	0.470
Marital Status Change - Divorced	0.194	0.553	0.730	0.178	0.176	0.310
log(Credit_Amount)	0.436	0.027	0.000	-0.003	0.010	0.750
Remaining Maturity	0.077	0.006	0.000	-0.078	0.003	0.000
Education -Secondary	-0.104	0.056	0.062	0.105	0.020	0.000
Education -Higher	-1.041	0.067	0.000	0.132	0.021	0.000
Interest Rate	1.883	0.089	0.000	0.444	0.034	0.000
Likelihood Ratio Test	4178.000			4406.000		
p-value	0.000			0.000		

Moreover, results in Table 50 show that squared term of the prepayment option has a negative sign and significant in both models for Bank 2 (similar to Bank 1). Whereas, current equity to market value indicator has a positive sign and only the squared term is significant in the default model.

Table 50: Survival Model 5 for Default and Prepayment – Bank 2

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	p
CEMV	0.364	0.248	0.140	1.077	0.066	0.000
CEMV-Squared	1.304	0.127	0.000	0.499	0.050	0.000
Poption	-2.878	0.449	0.000	7.814	0.124	0.000
Poption-Squared	-7.804	2.137	0.000	-17.825	0.688	0.000
CLTV	-0.411	0.224	0.066	1.127	0.045	0.000
Year – 2008	0.435	0.094	0.000	0.324	0.022	0.000
Year – 2009	0.042	0.122	0.730	0.415	0.024	0.000
Year – 2010	0.643	0.132	0.000	0.438	0.028	0.000
Year – 2011	0.322	0.136	0.018	0.912	0.028	0.000
Year – 2012	0.648	0.155	0.000	1.233	0.029	0.000
City - Adana	-0.495	0.218	0.023	0.126	0.038	0.001
City - Ankara	-0.509	0.101	0.000	0.127	0.017	0.000
City - Antalya	-0.243	0.112	0.030	0.044	0.023	0.059
City - Bursa	-0.462	0.174	0.008	0.104	0.029	0.000
City - İstanbul	-0.729	0.081	0.000	0.079	0.015	0.000
City - İzmir	-0.848	0.168	0.000	0.272	0.025	0.000
City - Kocaeli	-0.219	0.177	0.220	0.106	0.033	0.001
Delinquency	1.150	0.102	0.000	-0.210	0.026	0.000
log(Income)	0.319	0.050	0.000	0.069	0.011	0.000
Age	-0.018	0.004	0.000	-0.011	0.001	0.000
Gender - Male	-0.005	0.079	0.950	0.030	0.014	0.031
Married	-0.264	0.086	0.002	0.147	0.018	0.000
Occupation - Private	1.046	0.171	0.000	-0.240	0.016	0.000
Occupation - Self Employed	1.620	0.174	0.000	-0.377	0.019	0.000
Remaining Maturity	0.273	0.015	0.000	0.122	0.003	0.000
log(Credit_Amount)	0.694	0.062	0.000	0.317	0.015	0.000
Marital Status Change - Married	-0.602	0.117	0.000	0.206	0.022	0.000
Marital Status Change - Divorced	-0.098	0.142	0.490	0.144	0.025	0.000
Lien	-0.016	0.121	0.900	0.162	0.020	0.000
Interest_Rate	3.799	0.174	0.000	1.658	0.039	0.000
Likelihood Ratio Test	2385.000			21777.000		
p-value	0.000			0.000		

In addition to these analyses, the effect of some additional variables for which there were significant amount of missing values, is taken into account separately in the models presented in the Appendix F. Consequently, adding the Occupation dummies

to the final model of Bank 1, it is seen that, private sector and self-employed workers have higher default risk compared to the public workers (Appendix F, Table 68). Moreover, similar to the results for Bank 1, higher education decreases default risk and secondary and higher education increases the prepayment risk for Bank 2 (Appendix F, Table 69).

Signs of the significant variables for the default and prepayment models are presented in Appendix F, Table 70 and Table 71 respectively. Results show that an increase in the origination interest rate increases both the default risk and the prepayment risk. What is more, delinquency status is found be an important risk factor for default.

It is also observed that default risk is significantly lower for borrowers that have higher education and in line with expectations prepayment risk is higher in the secondary education and higher education groups compared to primary education group. For private sector and self-employed groups default risk is higher compared to the public officers group whereas prepayment risk is lower. While default risk increases as the maturity of the obligation and loan amount increases, it decreases as age increases. For Bank 1, marital status at origination has no material effect/marginal effect on prepayment and default. This is also valid for marital status change variable. However for Bank 2, getting married decreases the default risk and increases the prepayment risk. An increase in original credit amount increases default risk whereas, it has no significant effect on prepayment risk.

As noted by Deng *et al.* (2005) borrower's characteristics are found to be significant determinants of prepayment and default behavior. Banks can improve the performances of their mortgage portfolios by investing in their application and behavioral models. Identifying high risk borrowers and adopting a risk-based pricing in residential mortgage lending could further improve the efficiency of the market and enhance the credit availability.

Multicollinearity

One important issue which might have an effect on the signs of the variables is the presence of multicollinearity. Variance inflation factors for the largest models are provided in the table below. These values do not indicate a multicollinearity problem in the models above (VIF values exceeding 10 are generally accepted as a sign of multicollinearity).

Table 51: Generalized Variance Inflation Factors for Model 5

	Bank-1	Bank -2
CEMV	-	3.487
CEMV-Squared	-	1.610
Poption	2.063	1.381
Poption-Squared	1.646	1.124
CLTV	-	3.126
factor(Credit_Year)	1.448	4.569
factor(City_Dummy)	-	1.187
Delinquency	1.017	1.197
log(Income)	-	2.667
Age	1.100	1.253
factor(Gender)	-	1.038
factor(Initial_Marital_Status)	1.096	1.604
factor(Occupation)	-	1.554
Remaining Maturity	1.189	1.768
log(Credit_Amount)	1.205	2.257
factor(Married_Divorced)	1.085	1.456
Lien	-	1.012
Interest_Rate	1.824	4.171
factor(Education)	1.127	-

Additionally, as explained above, the Income-Age interaction was planned to be included to the model for Bank-2. However, adding this interaction created important multicollinearity problem and hence results were not provided.

Table 52: Generalized Variance Inflation Factors for the Model with Interaction Term

	GVIF
CEMV	3.502
CEMV-Squared	1.618
Poption	1.381
Poption-Squared	1.124
CLTV	3.133
factor(Credit_Year)	4.557
factor(City_Dummy)	1.189
Delinquency	1.197
log(Income)	26.392
Age	101.128
factor(Gender)	1.038
factor(Initial_Marital_Status)	1.611
factor(Occupation)	1.539
Remaining Maturity	1.762
log(Credit_Amount)	2.220
factor(Married_Divorced)	1.459
Lien	1.012
Interest_Rate	4.175
log(Income):Age	136.505

4.6.4 Model Performance

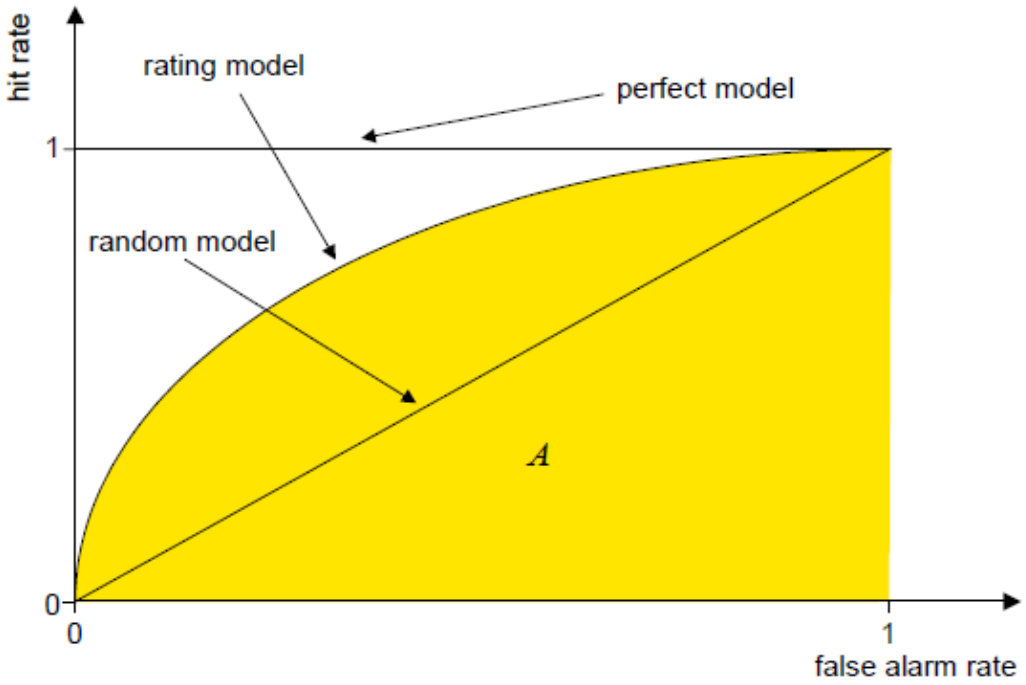
In this section, out of sample model performances are assessed using Receiver Operating Characteristics (ROC) curves. The sample that is allocated for validation is used in this analysis. The best models that provides highest out of sample ROC scores will be used in the next section in order to estimate PDs.

An ROC graph provides a tool for visualizing, organizing and selecting classifiers based on their performance. ROC graphs are two-dimensional graphs in which true positive rate is plotted on the Y axis and false positive rate is plotted on the X axis. An ROC graph depicts relative trade-offs between benefits (true positives) and costs (false positives) (Fawcett, 2004).

True Positive Rate (Sensitivity) = Positives Correctly Classified / Total Positives

1 - Specificity = False Positive Rate = Negatives Incorrectly Classified / Total Negatives

Figure 124 depicts a representative ROC curve and A represents the area under the curve. In ROC analysis, area under the curve shows the discriminatory power of the model. From this graph, it is clear that, the random model has a ROC of 50%, whereas the perfect model or crystal ball has a ROC of 100%. The interpretation of other ROC scores is also simple. An ROC score of say, x% means that, if a pair of good and bad observations are chosen at random, x% of the time the good observations (non-defaulters in this case) will have a higher score than bad observations (i.e. defaulters) (Nargundkar and Priestley (2004)).



Source: BCBS (2005ii)
Figure 124: Representative ROC Curve

As an example, assume that results of the modeling created the following output which is ordered according to the probability of default estimates. Also assume that

there are 10 defaults and 10 non defaults in the sample. Data set ordered according to probability of default is provided in Table 53, the resulting ROC curve is given in Figure 125.

Table 53: Example Calculation of a ROC Curve

Ordered Data	Default	Probability of Default	True Positive Rate	False Positive Rate	1-False Positive Rate
0	-	-	0%	0%	100%
1	1	0.9	10%	0%	100%
2	1	0.8	20%	0%	100%
3	0	0.7	20%	10%	90%
4	1	0.65	30%	10%	90%
5	1	0.6	40%	10%	90%
6	0	0.55	40%	20%	80%

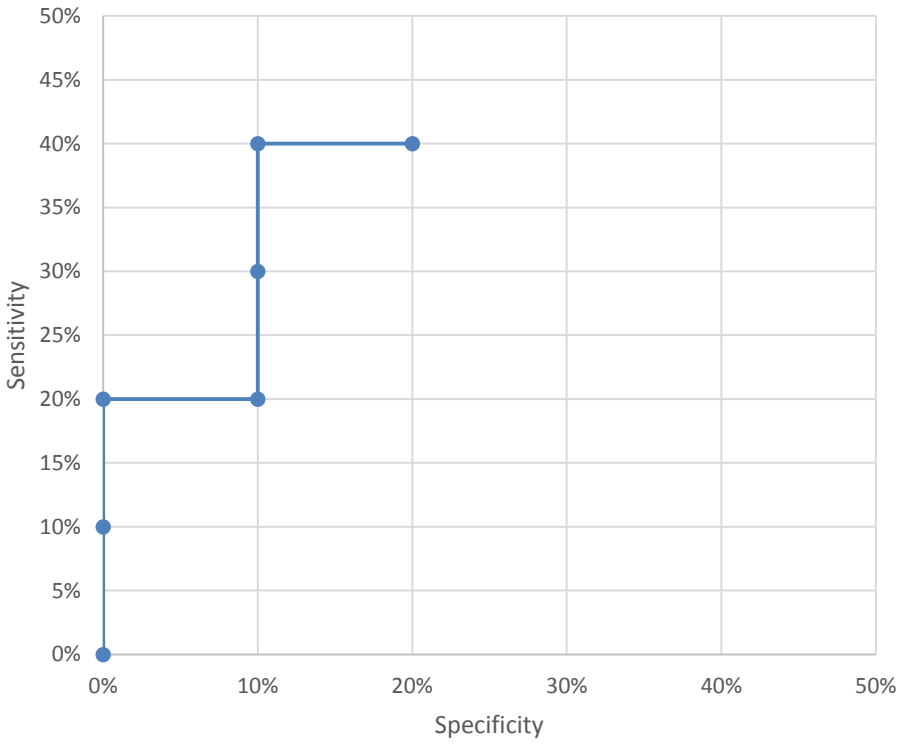


Figure 125: Representative ROC Curve

It is argued by the BCBS (2005ii) that ROC measure do not depend on the total portfolio probability of default, can be estimated on samples with non-representative default/non-default proportions and figures for bank portfolios with different fractions of defaulters may be directly compared. Additionally, BCBS's Accord Implementation Group highlighted the ROC measure as one of the most meaningful measures of discrimination power. Therefore, models presented above are compared based on their ROC scores and the model with highest out of sample ROC score is used for PD estimation and analyses in the next section. In calculating a ROC curve for a model, estimated probability of default and prepayment is used for ordering.

Default risk ROC curves for Bank-1 are provided in Figure 126. Here, it can be seen that Models 3-5 for Bank 1 creates high ROC figures ranging from 0.82 to 0.86. Although Model 3 only included delinquency, option indicator and year dummies, its discriminatory power is satisfactory. Also adding customer characteristics and mortgage characteristics (Model 4) increase the discriminatory power of the model even further. On the other hand, adding squared terms of option variables (Model 5) only mildly increases the discrimination ability of the model.

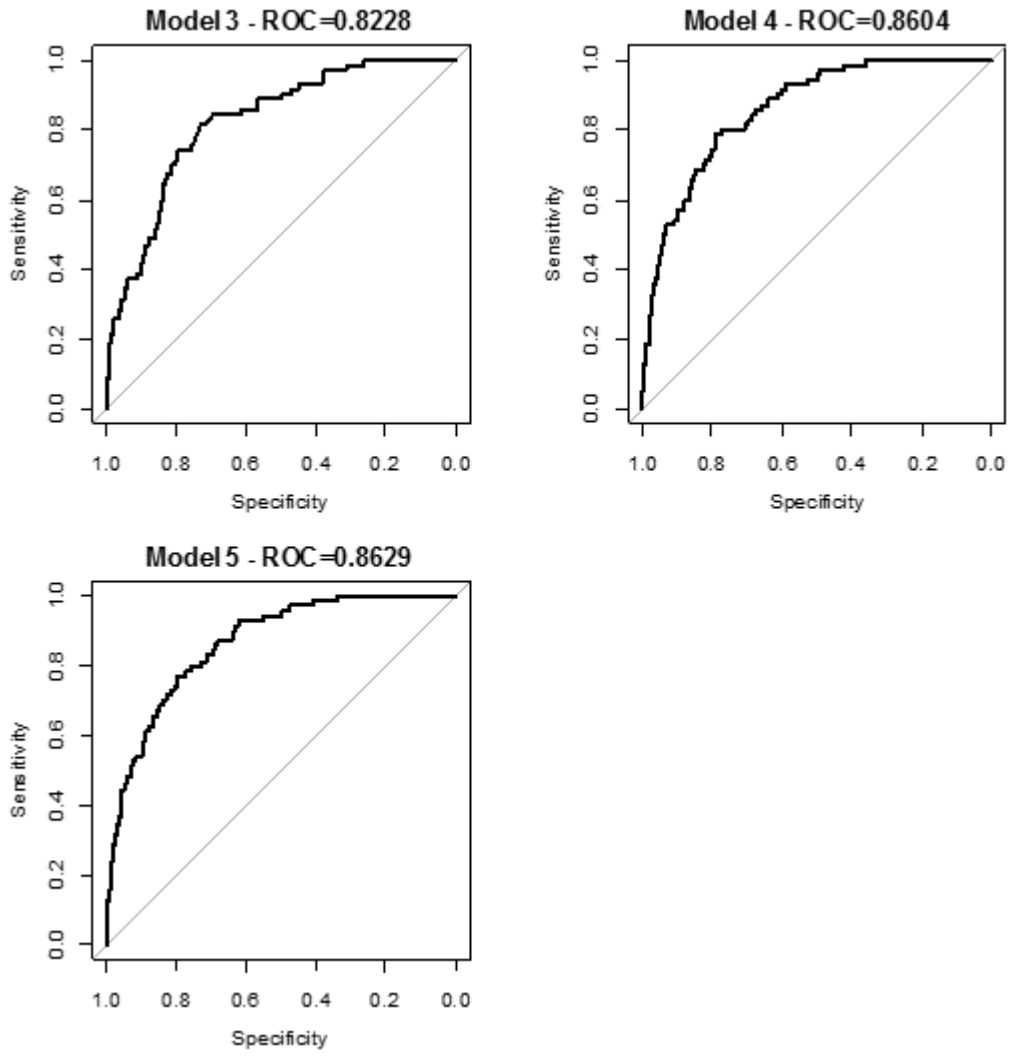


Figure 126: Bank 1 ROC Curves for Default

Bank 1 ROC curves for prepayment are given in Figure 127. This figure indicates that, ROC scores for prepayment is around 64%. It can be observed that ROC scores for prepayment are not as high as the ROC scores for default.

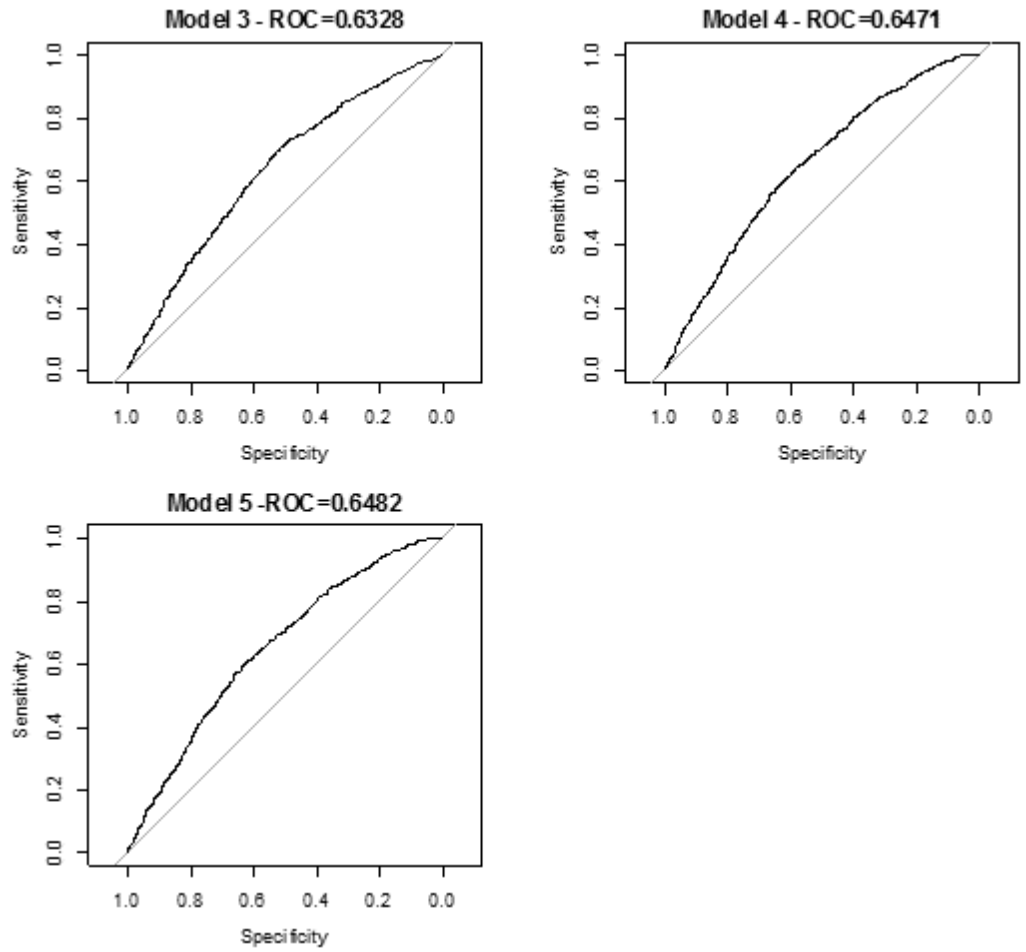


Figure 127: Bank 1 ROC Curves for Prepayment

Figure 128 depicts Bank 2 ROC curves for default risk. Similar to the results for Bank 1, models with delinquency, consumer characteristics and mortgage characteristics provide high out of sample ROC scores. For Bank 2, moving from Model 3 to Model 4 (adding consumer characteristics and mortgage characteristics) significantly increases the discrimination power of the model. Another important issue to note is that the model which includes only option variables (Model 1) created a low ROC score. This indicates that option indicators are not as important as implied by the literature on default risk for Turkish Mortgage market.

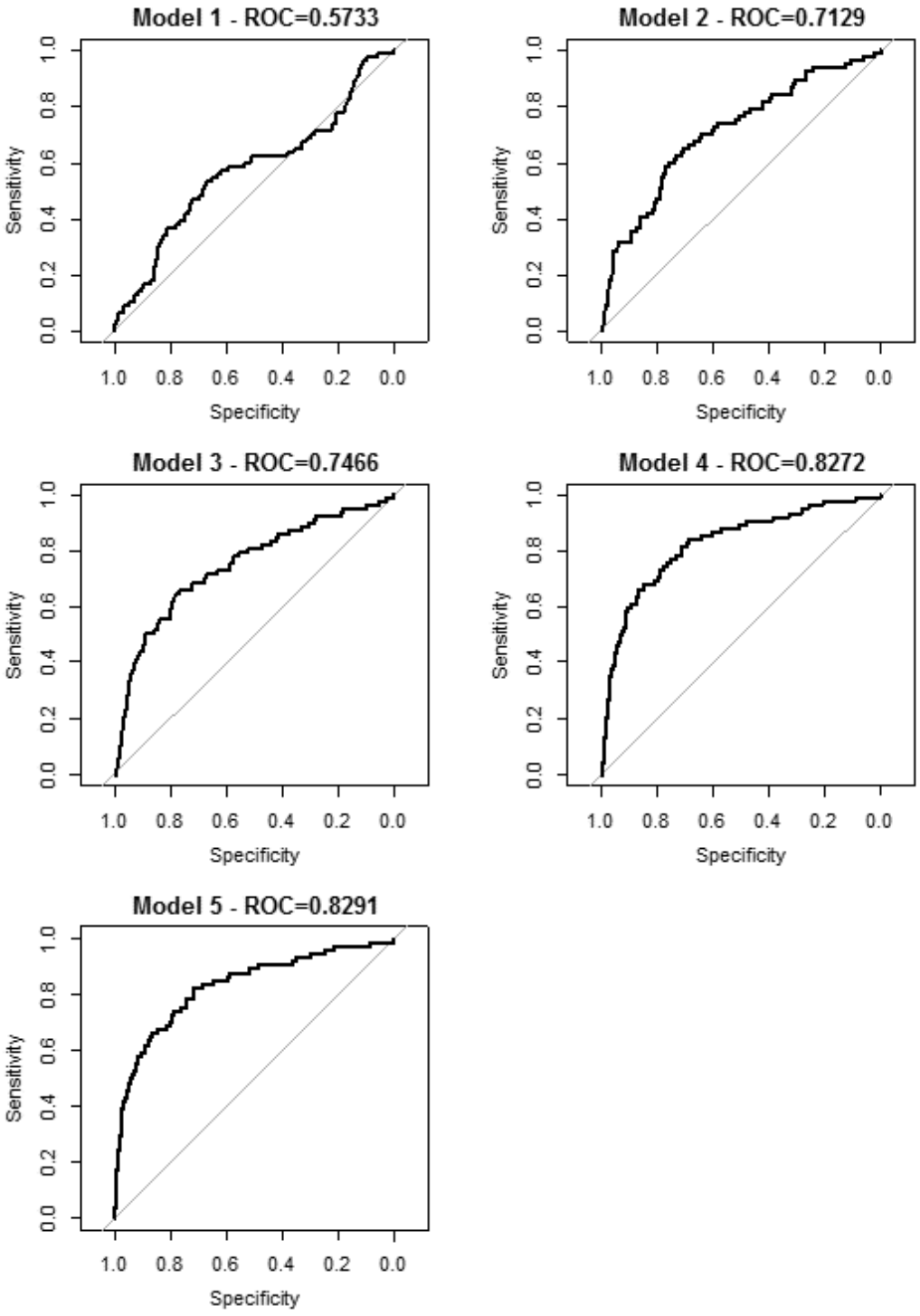


Figure 128: Bank 2 ROC Curves for Default

Similarly, Figure 129 illustrates the Bank 2 ROC curves for prepayment risk. The ROC scores presented in this graph are higher compared to the models for Bank 1. It should be noted that model for Bank 2 includes higher number of variables than the model for Bank 1 which might have contributed to the higher ROC scores for prepayment in Bank 2.

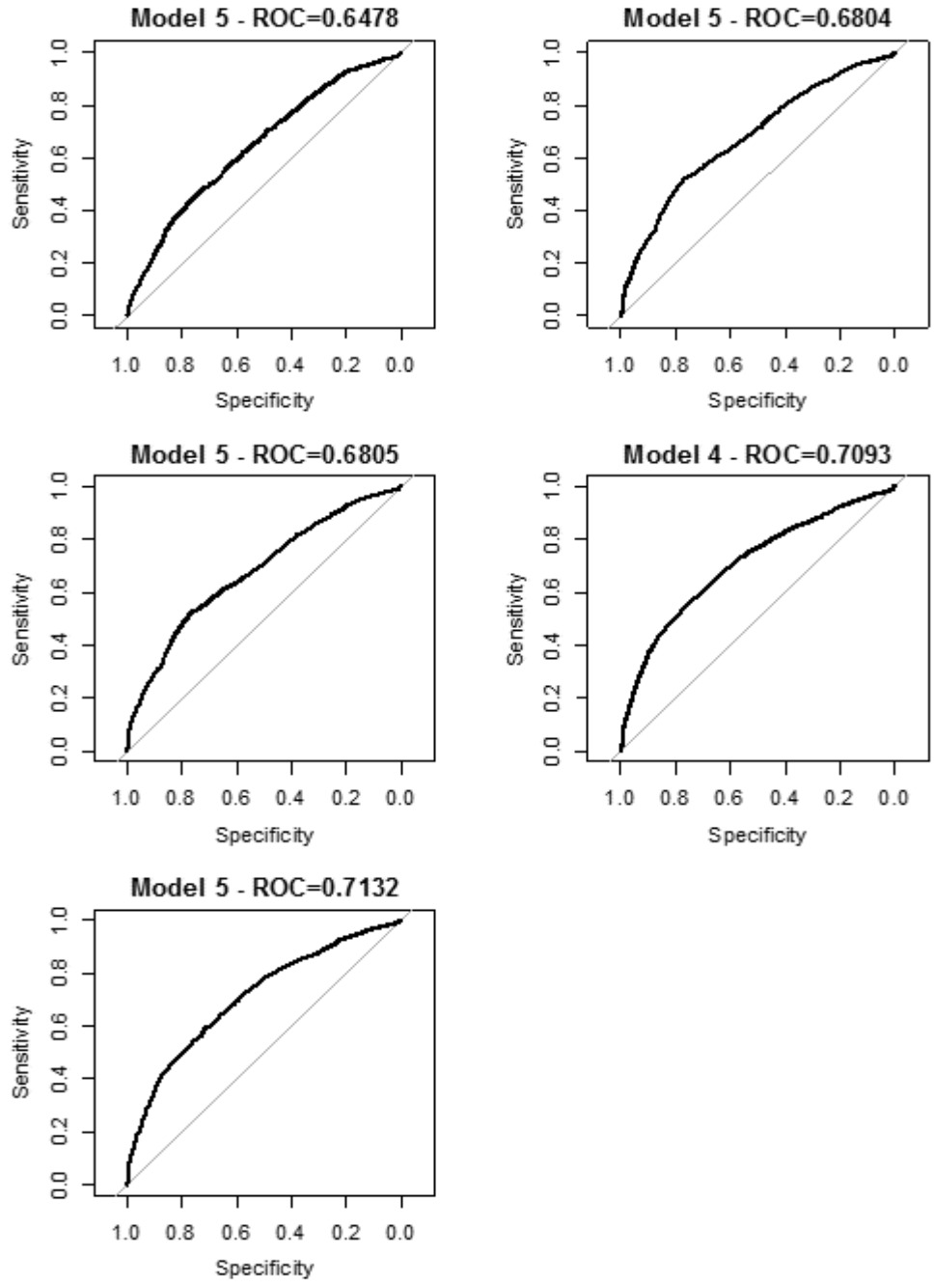


Figure 129: Bank 2 ROC Curves for Prepayment

4.7 PD Estimation

There are two main approaches to estimating probability of default using models. These are Point in Time (PIT) approach and Through the Cycle (TTC) approach. A point in time (PIT) probability of default (PD) measures the default possibility at a given point in time which creates the significant fluctuations regarding the PD estimate. This in turn might create cyclical movements in the capital requirements of a bank. On the other hand, through the cycle PDs, predict default rate performance for a customer over an economic cycle. As a result, short run changes to PDs do not lead to significant changes in capital requirements.

In this section, the long run average PDs are presented. Given that for both banks data set covers a period for which Turkish economy has experienced a full economic cycle, it can be argued that results presented in this thesis are quite prudential estimates of PDs and in line with the TTC approach.

In this subsection, average out of sample PD estimates for Bank 1 and Bank 2 are obtained using the formula presented in survival analysis theory section and employing *survfit()* function of R. Presented results are obtained based on Model 5 given in the section above. Table 54 provides some descriptive statistics about the estimated one year PDs. It can be seen that, average PD is slightly higher for Bank 1 (%0.62) compared to Bank 2 (%0.54). Moreover, first quartiles and third quartiles also reveal close estimates. On the other hand, for Bank1 maximum estimated PD is 28% whereas for Bank 2 it is around 48%.[154]

[154] Exposure weighted average PDs are 0.7595 for Bank 1 and 0.7746 for Bank 2.

Table 54: Descriptive Statistics of Estimated PDs (%)

Bank-1					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.0000	0.0770	0.2034	0.6269	0.6808	28.53

Bank-2					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.0000	0.0911	0.2091	0.5481	0.4859	47.98

Figure 130 provides PD estimates according to calculation year for Bank 1. According to this figure, estimated PDs reached around 2% during 2008 due to the effects of global financial crisis. However, a sharp reduction in PDs are observed after the global financial crisis period.

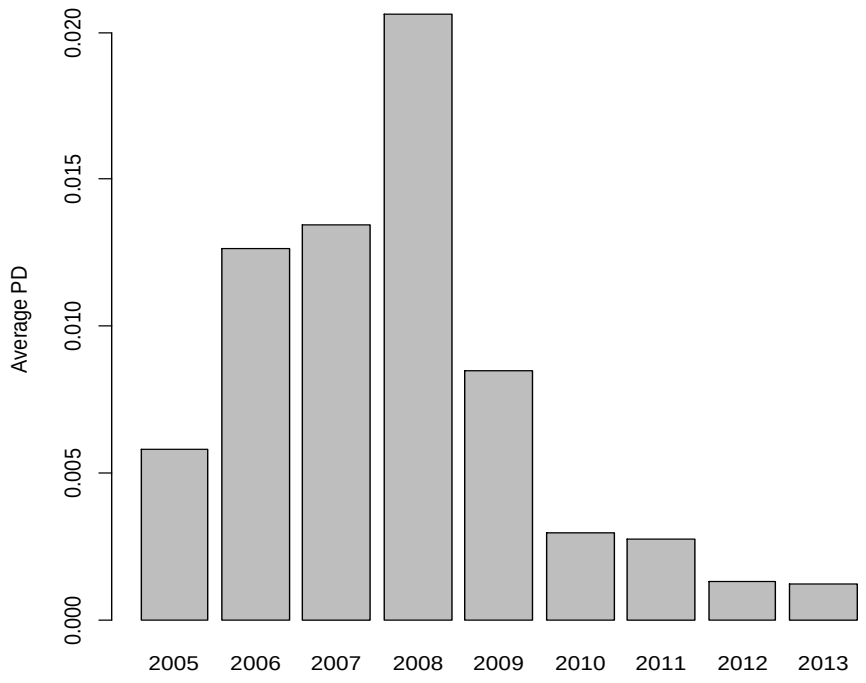


Figure 130: Average PDs by Calculation Year – Bank 1

Similarly, Figure 131 shows average estimated PDs for Bank 2. A similar trend in estimated PDs is also observed for this bank, where PDs were highest during 2008 and PD estimates for the year 2013 were less than 0.5%.

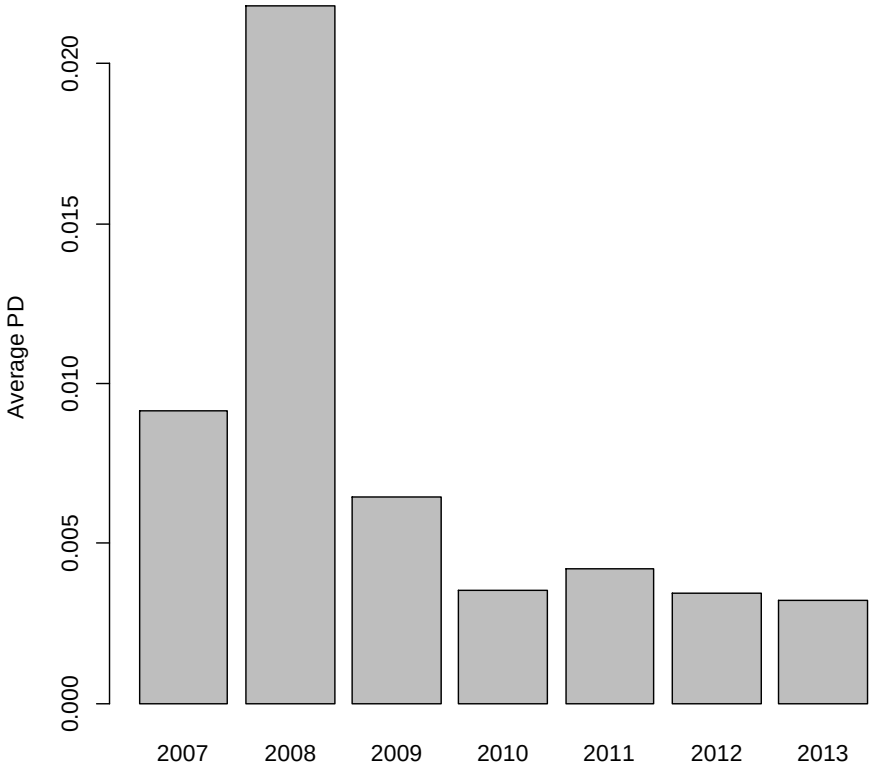


Figure 131: Average PDs by Calculation Year – Bank 2

Figure 132 provides the relationship between estimated PDs at the origination and origination interest rates. According to this figure, although origination interest rate distribution does not differ considerably for the PD bands lower than 10%, this bank is applying an interest rate that is significantly higher for consumers with PDs higher than 10%.

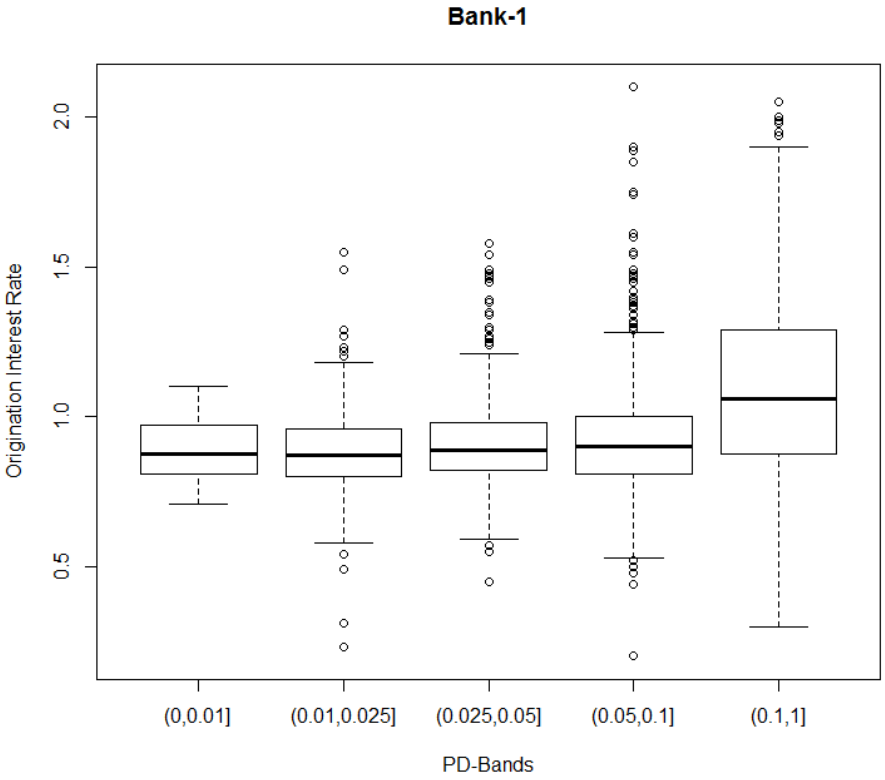


Figure 132: Risk Based Pricing– Bank 1

On the other hand, for Bank 2, origination interest rate and estimated PD relationship is more monotonic. In other words, average origination interest rate increases at every PD band as the PD of a consumer increases. Therefore, it can be concluded that Bank 2 is more risk averse, and doing risk based pricing better.

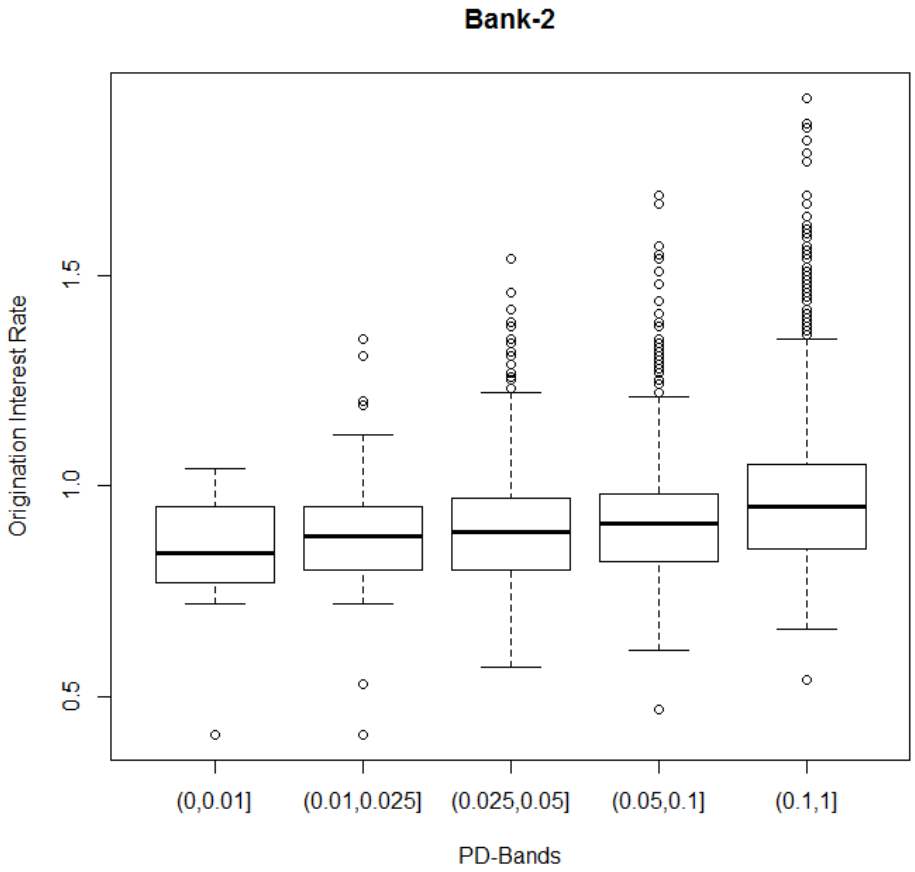


Figure 133: Risk Based Pricing– Bank 2

4.8 LGD Estimation

In order to use the internal ratings based approach (IRB approach), banks need to estimate the loss given default (LGD) parameter. Residential mortgage loans are generally assessed as safe lending as these loans are collateralized by real estate. In case of a default, the lender gets the possession of the collateral and sells it and the proceeds are recorded as recovered amounts.

While calculating the recovery rates, bank has to determine a collection period. This collection period is dependent on the type of lending and generally it is the longest for mortgages as the time period need for selling a real estate is very long. Recovery rates can be obtained from simulated loss given default rates by substracting loss given default form 1.

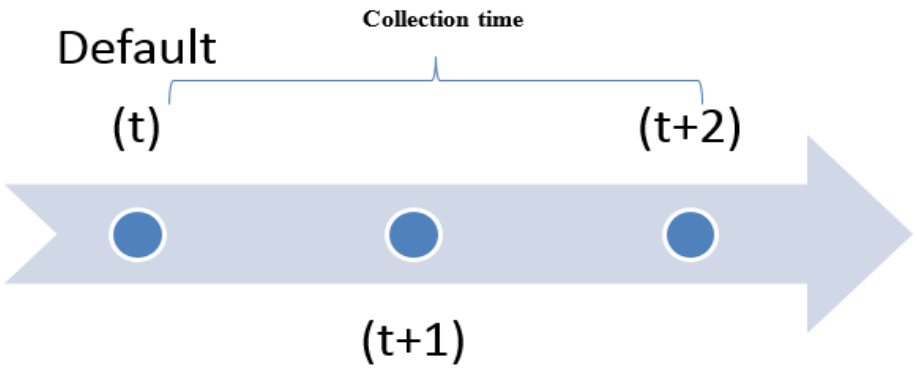


Figure 134: Recovery Period

Following Donchev (2009) a beta function is fitted to the recovery rate. The beta distribution fits the purposes of LGD modeling very well as it creates recovery rates between 0 and 1 and can have a large variety of shapes. Figure 135 depicts various beta distributions for the different levels of parameters.

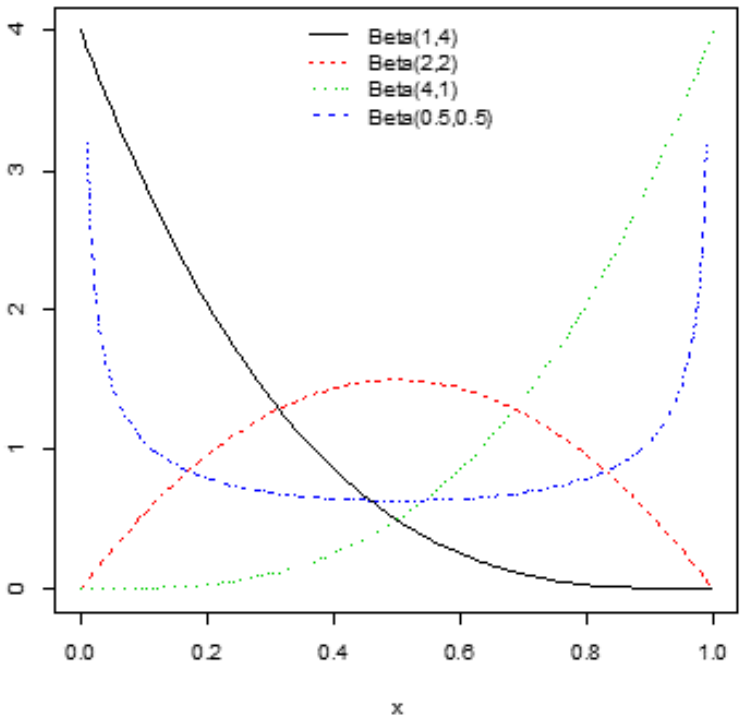


Figure 135: Beta Distribution for Various Parameter Values

The probability density function of the Beta distribution is given by:

$$f(x) = \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} x^{\alpha-1}(1-x)^{\beta-1} \quad (61)$$

where; Γ (z) = $\int_0^\infty t^{z-1} e^{-t} dt$, i.e. the gamma function and 0<*x*<*1*, $\alpha > 0, \beta > 0$.

For this distribution, $\mu = \frac{\alpha}{\alpha+\beta}$ and $\sigma = \sqrt{\frac{\alpha\beta}{(\alpha+\beta)^2(1+\alpha+\beta)}}$ (62)

When we have the mean (μ) and standard deviation (σ) of the historical recovery rates, then a Beta distribution could be fitted to the data by selecting;

$$\alpha = \mu\left(\frac{\mu(1-\mu)}{\sigma^2} - 1\right) \text{ and } \beta = (1-\mu)\left(\frac{\mu(1-\mu)}{\sigma^2} - 1\right)^{155} \quad (63)$$

Average and standard deviation estimates for loss given default is requested from the sample banks. Average LGD is set to 30% and standard deviation of LGD is set to 30% based on the response received from the banks. This corresponds to α=0.4 and β=0.93 in the beta distribution. The resulting LGD distribution under this setting is provided below.

[155] See, Gupton and Stein (2005) for more details.

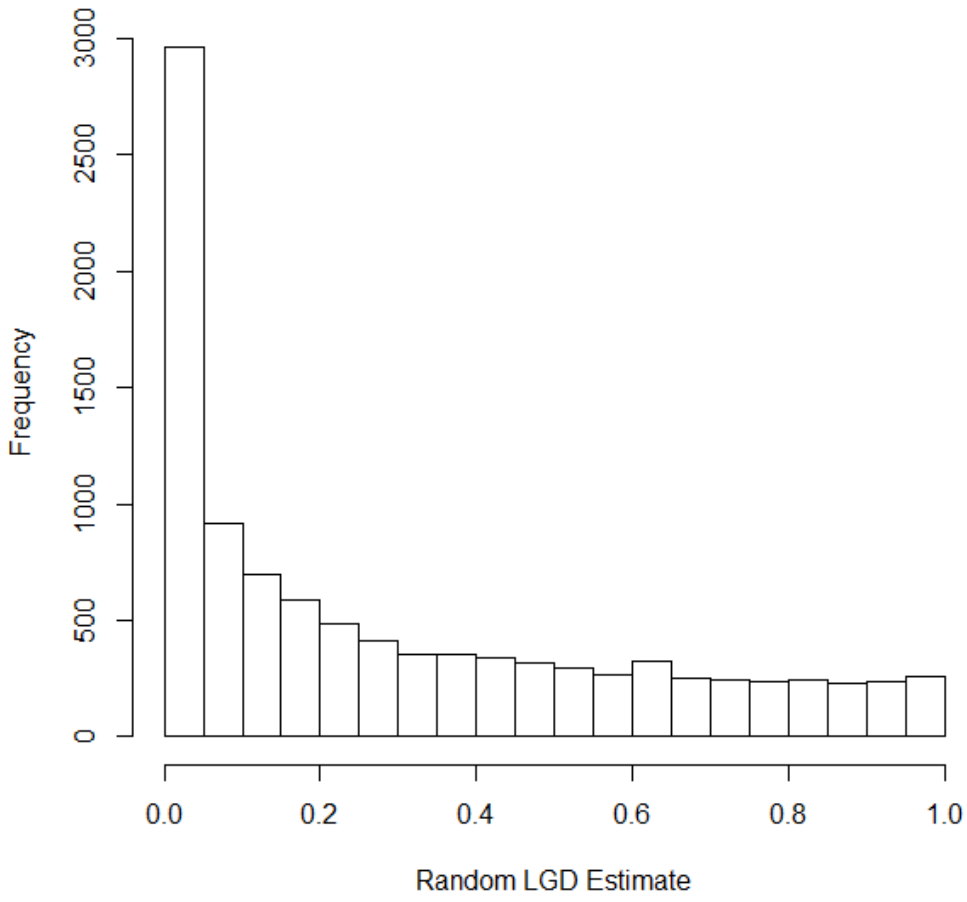


Figure 136: LGD Estimates (10000 Simulations)

According to an EU level study (EBA, 2012), median exposure weighted LGD is estimated to be around 12%. Moreover, the third quartile for exposure weighted LGD estimates in the EU banks is around 16%. Taking these figures into account, it is argued that 30% LGD figure is a quite prudential estimate for LGD of the Turkish residential mortgage market.

4.9 Evaluation of Policy Choices and Recommendations for Turkey

In this section, capital adequacy and provisioning regulations that are currently in force in Turkey are assessed from the perspective of effectiveness.

In order to provide optimum amount of credit to the economy, financial institutions need to create a balance between the capital and provisions they held and risks taken. Underestimation of risks may lead to default of an institution which could even harm the financial stability. On the other hand, overestimating risks may result in creating credit less than the potential, which leads to less than expected profit and growth. For instance, literature on developing economies argue that extreme liquidity in developing countries restricts the growth rates. Excessive capital and provision could also create the same effect.

In this regard, too high capital requirements and too high provisioning requirements would indicate tight regulation. Whereas too low figures would indicate insufficient regulation. Therefore, evaluating the regulatory requirements on the basis of risk is critical.

4.9.1 Capital Adequacy Calculation

The general level of capital requirements that are held by Turkish banks is assessed in this subsection using the models presented in the section above. Currently, all banks in Turkey are subject to the standardized approach to credit risk under the Regulation on Measurement and Evaluation of Banks Capital Adequacy (Capital Adequacy Regulation). This regulation can simply be evaluated as the transposition of the Basel-II standards into national legislation. However, Capital Adequacy Regulation requires banks to use a 50% risk weight for residential mortgage exposures which is more conservative compared to the Basel-II rules. The assessments in this section will help assessing the appropriateness of this choice.

The PD estimates and LGD simulations are inserted into the Internal Ratings Based (IRB) formula that is provided by the Basel Committee on Banking Supervision. Therefore, the results presented here also provides us with the preliminary figures on IRB risk weights if the banks were to use the IRB approach.

It should also be noted that these estimates are obtained over the validation sample. Therefore, all results presented here are out of sample estimates. As it is required by the Basel framework that a floor of 0.03% is applied for PDs that are estimated to be under 0.03%.

Additionally, Paragraph 266 of Basel II framework requires an LGD floor of 10% for retail exposures secured by residential properties. In the Basel II framework dated 2006, it was also mentioned that the Basel Committee would review necessity of this floor during the transition period of Basel-II. In the press release dated 13 July 3009[156], by taking into account the volatility in mortgage portfolios during global financial crisis, the committee decided to maintain the 10% LGD floor.

Table 55 provides the estimated risk weights for the bank's residential mortgage portfolios. According to this table, for both banks, estimated risk weights could become as low as 0.9% (when the PD is bound by 0.03% floor and LGD is bound by 10% floor). Mean risk weights calculated is very close in both banks, 24.75% and 22.45% for Bank 1 and Bank 2, respectively. Moreover, depending on the exposure, risk weights could reach up to 458% in Bank 1 and 592% in Bank 2.

Table 55: Estimated Risk Weights for Bank's Residential Mortgage Portfolios

Bank-1					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.0098	0.0389	0.1008	0.2476	0.2545	4.5850
Bank-2					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.0098	0.0406	0.0933	0.2245	0.2392	5.9200

Given that banks apply these risk weights to their exposures and calculate their capital adequacy ratios accordingly, the exposure weighted risk weights is also

[156] http://www.bis.org/publ/bcbs_nl14.htm

calculated. According to this calculation, exposure weighted risk weights are 28.76% for Bank 1 and 27.45% for Bank 2.

Figure 137 illustrates the boxplot of estimated risk weights for Bank 1. In line with the results presented in the above table, the risk weights are quite skewed.

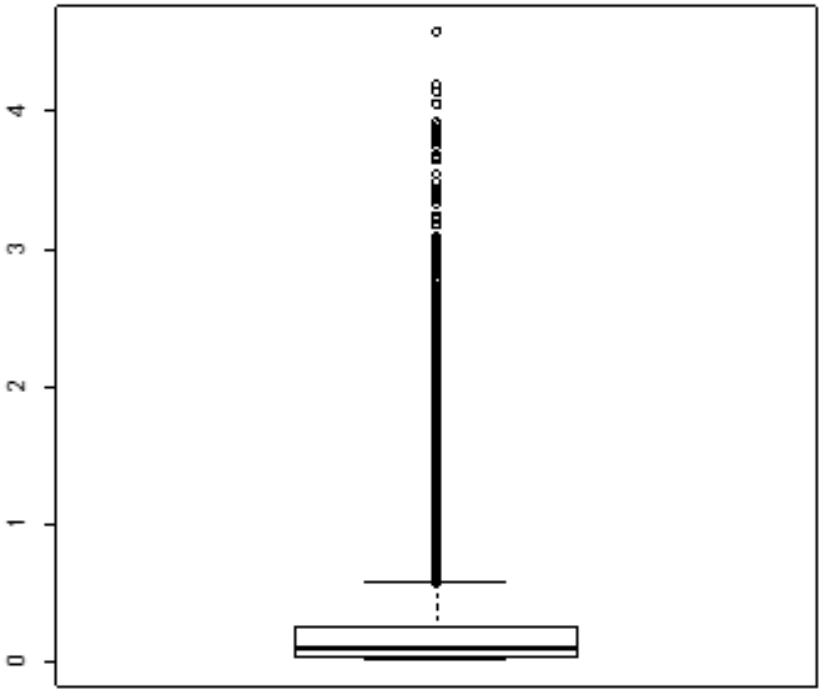


Figure 137: Boxplot of Risk Weights – Bank 1

Boxplot of risk weights for Bank 2 also reveals similar results. Skewness of the risk weights show that by controlling the lending practices, banks can significantly reduce risk weights applied, even beyond the current level presented above.

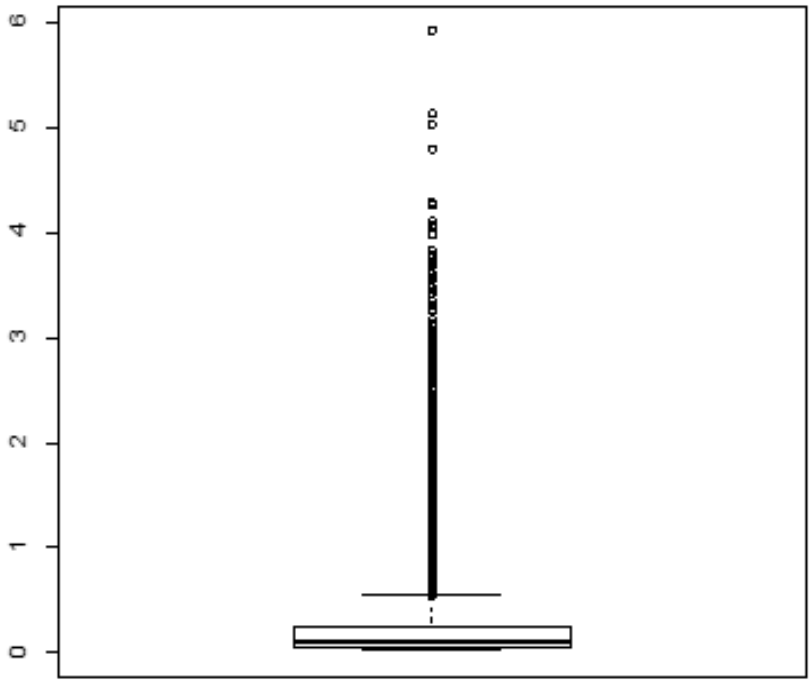


Figure 138: Boxplot of Risk Weights – Bank 2

According to a recent report from the financial supervisory authority of Norway, current risk weights is for mortgages is around 10% in Norway[157]. Moreover, EBA (2013) provides an EU level comparison of risk weighted assets for residential mortgages. According to this report, first quartile of exposure weighted risk weights in the sampled banks is around 10% and third quartile of exposure weighted risk weights is around 20%. Taking all these information into consideration, the results presented above are considered as quite prudential estimates regarding the Turkish mortgage market.

As another step for quality check, the exposure weighted risk weights are calculated using Model 4 presented in the modeling section. According to this model, exposure weighted risk weight is estimated as 29.26% for Bank 1 and 26.95% for Bank 2.

157 http://www.finanstilsynet.no/Global/Venstremeny/Aktuelt_vedlegg/2014/1_kvartal/Prudent_risk_weights_for_mortgages.pdf

These results also show that different models presented in the previous section do not significantly alter the results presented.

As described in the literature review section, different segmentation schemes have effects on the capital requirements that is calculated using the IRB formula. According to the literature, the more segmented a portfolio, the smaller the capital requirement. Additionally, Basel-II does not have a limit on the maximum amount of bucketing for the creation of sub-segments. Therefore, we believe that the capital requirement estimates given above are valid. Nevertheless, in order to eliminate the effect of segmentation, all residential mortgage loans are assumed to belong to the same sub-segment. Therefore, exposure weighted PDs are used in the IRB formula for another quality check. Therefore, a PD of 0.75% is used for Bank 1 and 0.77% is used for Bank 2. The risk weights corresponding to these PDs and a fixed LGD of 30% are 31.24% and 31.66% respectively. This means that, if no subsegments are formed and all the loans are assumed to be the same, which creates highest risk weights according to the IRB formula, appropriate long run risk weight for banks mortgage portfolios is still less than 35%. In other words, 35% risk weight is an appropriate risk weight and prudential risk weight of 50% should be relaxed for Turkish mortgage market.

4.9.2 General Provisioning Rate Calculation

In order to assess the appropriateness of the current provisioning rules that are enforced by the "Regulation on Procedures and Principles for Determination of Qualifications of Loans and Other Receivables by Banks and Provisions to be Set Aside" the following approach is employed.

Step 1: Modeling data set is divided into two separate parts (loans with delinquency and loans with no delinquency)

Step 2: For loans that have no delinquency (Standard Loans Category), 1 year PD is estimated based on Model 5 and provisioning rate is calculated for the validation data.
Step 3: For loans that have delinquency (Close Watch Category), PD is estimated for a period until the maturity of the loan and provisioning rate is calculated for the validation data.

As discussed in the sections above, this approach is also consistent with the methodology set by the International Accounting Board which will be effective from 2017. IFRS 9 standard requires provisioning equal to 12-month expected losses for financial instrument for which risks has not increased significantly since initial recognition. Additionally, for the financial instruments that have increased credit risk after the initial recognition lifetime expected credit losses needs to be allocated as any escalation in credit risk after the initial recognition is unlikely to be fully compensated by interest rate increases.

As noted before, BCBS argued that due to its backward looking nature delinquency data might not be appropriate at all times in implementing ECL and considers the use of 30 days delinquency status as the only indicator for increased credit risk as a low-quality implementation of an ECL model[158]. However, the analysis provided below indicates that delinquency is an important indicator regarding the expected losses in Turkey. Moreover, the current Turkish regulatory system heavily relies on delinquency status in order to separate loans according to standard and substandard. Therefore, the analysis provided below are quite reasonable and appropriate estimates for Turkish market.

The provisioning rate estimated from the models is obtained using the formula below;

[158] It should be noted that the IFRS 9 encourages companies to use additional indicators to assess impairment. Nevertheless, the only data that is easily incompatible with the setting of this thesis is the delinquency indicator.

$$\text{Expected Loss Rate} = \frac{\sum_{i=1}^{n} Exposure_i * PD_i * LGD_i}{\sum_{i=1}^{n} Exposure_i} \quad (64)$$

In this calculation 30% LGD rate is used since this is the estimated loss given default by the sector.

Table 56: Provisioning Rate Estimation

Loan Category	*Current Regulation*	*Estimation*	
		Bank 1	Bank 2
Standard	1%	0.19%	0.24%
Close Watch	2%	3.46%	1.25%

According to Table 56, the provisioning rate that is implied by the loan portfolios of these two banks is 0.19% and 0.24% for Bank 1 and Bank 2, respectively. It should be noted that these numbers are not calculated over the most recent portfolio composition of the banks but the portfolios over a long time period (i.e. from 2005-2013 for Bank 1 and 2007-2013 for Bank 2). Therefore, this figure is prudent in the sense that it also covers the PDs estimated over the global financial crisis period.

To sum up, it is observed that current provisioning rate for standard type loans is extremely high compared to their riskiness. This has a negative effect on banks reported earnings as higher provisions directly reduce the total profit of a bank. For the loans with delinquency, on the other hand, the situation is a little bit different. For these type of loans, provisioning rate is estimated to be 3.46% for Bank 1. This is significantly higher than current rate specified in the regulation (2%). Whereas for Bank 2, this rate is around 1.25% and estimated provision rate for close watch type loans for Bank 2 is less than the rate specified in the regulation.

4.9.3 Prepayment Penalty Calculation

According to Consumer Protection Act, for fixed rate mortgages prepayment penalty cannot exceed 1% of the remaining balance if the remaining maturity is less than 36 months and 2% if the remaining maturity is more than 36 months.

In order to assess the appropriateness of this rule, past developments are assessed and effect of prepayments to the profitability of the bank is considered. Here it is assumed that banks hedge the interest rate risk at the inception of each mortgage product. Therefore, the difference between present value of the future installments at current market rate and the present value of the future installments at origination interest rate are assumed to be a loss for the bank.

$$\text{Prepayment Loss Rate} = \frac{\sum_{t=1}^{\tau} \frac{Installment_t}{\left(1+\text{market rate}_q\right)^t} - \sum_{t=1}^{\tau} \frac{Installment_t}{(1+\text{interest rate})^t}}{\text{Remaining Balance}} \quad (65)$$

and $RM = \text{PV}(1+\text{interest rate})^n - Installment * \left[\frac{(1+\text{interest rate})^n - 1}{interest\ rate}\right]$

where RM=Remaining Balance

PV = Original loan amount

n = Number of payments made

Figure 139 depicts the cost of prepayment for Bank 1. According to this figure, during periods where mortgage interest rates had fallen sharply, Bank 1 faced economic losses up to 3.5% for mortgages with remaining maturity less than 36 months and 7% for the mortgages with remaining maturity more than 36 months.

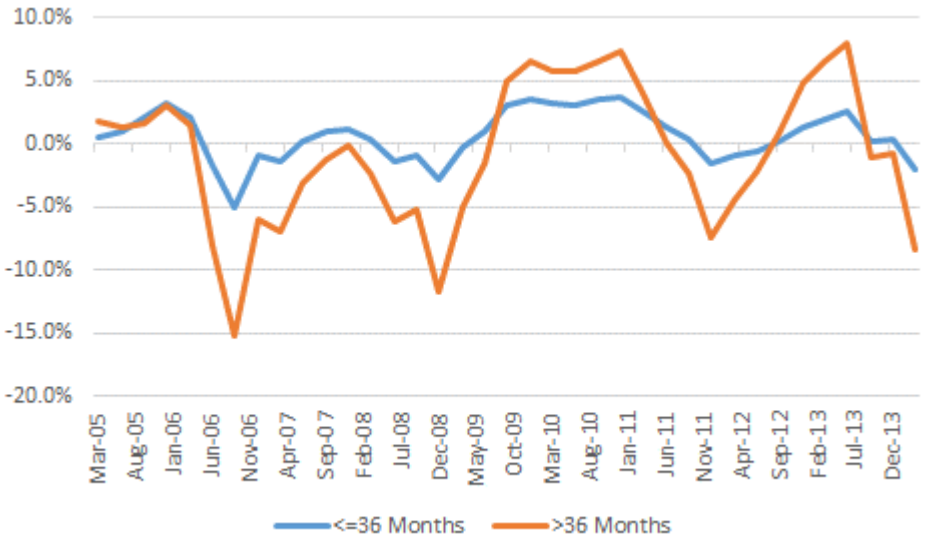


Figure 139: Cost of Prepayment – Bank 1

Figure 140 presents the cost of prepayment for Bank 2. This figure, also shows that similar to Bank 1, Bank 2 faced economic losses up to 4% for mortgages with remaining maturity less than 36 months and 7.5% for the mortgages with remaining maturity more than 36 months.

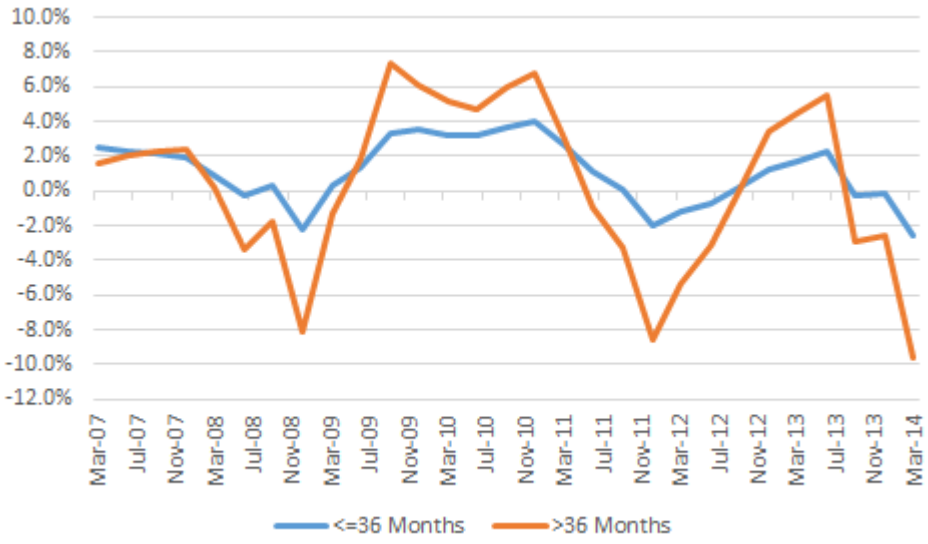


Figure 140: Cost of Prepayment – Bank 2

The analyses presented above show that the prepayment penalty that is set by the Law (i.e. 1% for the loans with remaining maturity less than 36 months and 2% for more than 36 months) corresponds to less than one-third of the economic losses due to prepayment. Currently, these losses could be easily tolerated since the share of mortgage loans in bank portfolios is small. However, the prepayment penalties may require recalibration if Turkish mortgage market will experience a fast growth in the future. Another possible effect of this rule might be on the contract terms. It is essential that mortgage loans have longer maturities for better accessibility. On the other hand, analyses above show that economic cost of prepayment for the banks extending longer term mortgages is much larger. This in turn could translate to either increased interest rates for longer term mortgages or shortened contract terms.

4.10 Recommendations

The descriptive analyses on mortgage originations in Turkey provide us important results. According to these analyses, accessibility of mortgage products have been increasing. For instance, average age of the mortgage borrowers, average floor area of the underlying mortgages and average appraisal values of the underlying mortgages have been decreasing. However, in Turkey governmental support to housing is provided through TOKI and Turkish authorities have not been effectively employing policies targeted at affordability of housing and increasing homeownership rate through the use of mortgage market. Other country examples such as Malaysia, Chile and South Africa provide valuable examples on this ground. To illustrate, the governmental agency interaction in Korea has helped the lengthening of maturity of the contracts significantly. Although, interest rates are still very high in Turkey (compared to the developed countries) which make very long maturities economically infeasible choice for consumers, a governmental agency can play a role and help increases the accessibility of the low and medium income segments to housing.

The estimation of risk weights and provisioning rates for Turkish mortgage market revealed some important results. For instance, the analysis on risk weighted assets for Turkish residential mortgages indicate that current risk weight applied for these loans is excessively tight. It is important for authorities to guarantee that there is enough room for compensating unexpected losses that might occur. Nevertheless, too tight standards could have a negative impact on the development of the market.

Analysis on provisioning rate provide significant support for the assessment that current provisioning rate for standardized loans are significantly higher than the optimal level. Calibrating this number for the sector could have a positive effect on the profitability of the sector. On the other hand, provisioning rate varies significantly for close watch loans. Therefore, it needs to be estimated separately by each bank.

To sum up, there is significant room in the regulation side that might help supporting the development of mortgage market in Turkey. In this respect, national authorities including the Central Bank of the Republic of Turkey that is responsible from the financial stability and Banking Regulation and Supervision Agency that is responsible from the soundness of the financial system need to re-assess the appropriateness of the current calibration of risk weights and provisioning requirements. It should be noted that current regulatory setting is quite restrictive and against the growth of the mortgage market.

On the prepayment penalty issue, there is again more than one related institution. From the point of view of the banking regulator, the prepayment penalties should be calibrated in a way that it does not disturb the healthiness of the banking sector. On the other hand, from the consumer protection point of view, higher penalties are negative for consumers. As a result, current regulation which requires a 1% prepayment penalty up to 36 months and 2% prepayment penalty when the remaining maturity is more than 36 months seem to be designed in a way to protect consumers more. However, national authorities might need to recalibrate the prepayment fee to protect the financial institutions in case strong movements in the interest rates are

observed following a rapid growth in the mortgage portfolios of banks. Therefore, the analysis presented in the section above provides a good basis for national authorities for monitoring.

As noted by Deng *et al.* (2005) borrower's characteristics are found to be significant determinants of prepayment and default behavior. Banks can improve the performances of their mortgage portfolios by investing in their application and behavioral models. Identifying high risk borrowers and adopting a risk-based pricing in residential mortgage lending could further improve the efficiency of the market and enhance the credit availability.

Although, banks participating with their data in this work have been able to create a significant amount of data history, there is still a huge room for development. Especially, data on appraisal values and income seem to be problematic and both the banks and national authorities should consider ways to improve the quality of this data.

Finally, as indicated by the analysis above, using Internal Ratings Based approaches for the mortgage portfolios could provide significant reduction in risk weighted assets and create additional room for the banks to extend more credit. As a result, banks should be encouraged to apply for getting approval from the Banking Regulation and Supervision Agency for their IRB models if other portfolios of the banks also provide similar results regarding the risk weighted assets.

CHAPTER V

CONCLUSION

Today, the importance of housing policy and mortgage markets is widely recognized. Housing policy and policy with regards to the mortgage markets is an important tool for governments in both economic and social terms and mortgage markets are not only important for developed countries but also important for developing countries such as Turkey. For the developing countries, the importance of mortgage market comes mainly from its role in fighting against poverty and promoting homeownership. For the developed countries, on the other hand, recent policy discussions are mainly focusing on macroprudential tools and using mortgage market as a countercyclical instrument.

Literature on Turkish mortgage market is investigated on this background and it is noted that the literature is quite shallow. The analyses and discussions presented in this thesis aim to provide answers to the questions that can be categorized under two main categories; namely potential and riskiness of the Turkish mortgage market.

Results on the potential of the Turkish mortgage market showed that Turkish market has a low frontier (around 10% of the GDP) compared to many other European countries (EU average is around 40%). What is more, current level of development of the market (6% of the GDP) is even under this frontier. In addition to this, analysis also indicated that there is significant growth potential of the market which is fueled by the factors such as growing economy, urbanization trend and decreasing household sizes. The scenario analysis indicated that, the depth of the mortgage market could reach 20-30% of the GDP within 10 years under the most plausible scenario, which means three to five fold increase compared to the current level.

Based on modeling results presented in Chapter 3, it is argued that, in order to support the development of mortgage market, policy makers in developing countries should focus on improving the legal and regulatory framework that controls the loan origination, consumer protection and the enforcement of lenders' rights. Furthermore, planned urban development should be the focus of policy makers as urbanization process enhances access to mortgage loans.

Although housing finance was intermediated mostly by governmental agencies until 1990s, today most of the banks are offering mortgage products in Turkey. In recent years, following the macroeconomic stability and reduced interest rates, there has been a considerable growth in the amount of loans extended with the housing finance purpose. However residential mortgage debt to GDP ratio is only around 6% which is behind many developed countries.

Studying country examples indicates that some specific characteristics of the investigated countries have created the difference. For instance, in Malaysia a well-established secondary market come to the forefront in boosting the development of the primary market. In countries like Chile and South Africa, social subsidy programmes have been the engine of the mortgage market growth and in Korea a strong urbanization trend characterizes that development.

Emerging country experiences indicate the critical role of government intervention not only for the development but also for the stabilization of the market. These examples showed that government intervention is needed for the establishment and functioning of secondary market. The literature on depth of mortgage markets specifically focus on the importance of secondary market. Modeling results in Chapter 3 also partly supports this assessment. Many studies about the Turkish mortgage market were also highlighted the importance of government support (mainly tax related) for the development of the market.

Secondary mortgage market might help financial institutions to create additional funding via securitization and covered bonds market. The importance of this type of funding for financial institutions can be better understood when the preceding low

savings rate in the Turkish economy is considered. It should be noted that in Turkey secondary mortgage market is in the process of flourishing. However, for the growth of the secondary market, a deep and well-established primary market is necessary. With the help of the HFS Law, there has been a significant development in this area but current level of primary market development is not adequate for the establishment of a liquid and effective secondary market. Literature and country examples also indicates to the importance of government support in the process of establishing the secondary market. Therefore, Turkish authorities needs to evaluate the costs and benefits of such support.

For many developing countries, affordability has been one of the most important issues that is considered by the policy makers and decreasing interest rates in Turkey has been creating a positive environment. In Turkey governmental support has been mainly provided through TOKI for low income groups and Turkish authorities have not been effectively employing policies targeted at affordability of housing and increasing homeownership rate through the use of mortgage market. TOKİ also stresses that the demand for social housing cannot be satisfied with the projects of TOKİ alone.

Other country examples such as Malaysia, Chile and South Africa provide valuable case studies on this ground. To illustrate, the governmental agency intervention in Korea has helped the lengthening of maturity of the contracts significantly. Although, interest rates are still very high in Turkey (compared to the developed countries) which make very long maturities economically infeasible choice for consumers, a governmental agency can play a role and help increases the accessibility of the low income groups to housing via mortgage market. Noting that the government owned Emlakbank ceased operations in 2001 and the gap in the market could not be filled by other banks in the sector, it was argued that a state bank with an aim to support mortgages for low income families could be useful.

The earthquake risk in many geographical areas in Turkey, and specifically in Istanbul region, and the quality of the housing stock also support the assessment that mortgage market development not only for low income groups but also for wider

population segments should be encouraged by the government. Taxing plays an important role in the development of the market. In order to support the development of primary mortgage market in Turkey, literature stressed that more tax exemptions (or tax deductibility of mortgage payments) are necessary. Also given that the homeownership in the US has only slightly increased after the mortgage securitizations in 1980s, Turkish authorities need to create a balance between supporting the development of the primary market and the secondary market. Besides, it should be kept in mind that government participation in housing finance might have some negative results such as augmenting house price swings. Therefore, government support should be evaluated as a booster for the development of the market at the inception and the recent global financial crisis has shown that government should reduce its effect in time for the effective functioning of the market. Additionally, while supporting the growth of mortgage market is important for developing countries, it may not be sufficient to create positive externalities such as reducing income inequality. For instance, the Korean case is a good example of a simultaneous rise in mortgage market depth and inequality.

There are some internal and external problems limiting the growth of the mortgage market in Turkey. One of these problems is due to credit assessments[159]. Issuances of Turkish Treasury still have very low credit ratings from external credit assessment institutions. In practice, the sovereign rating of a country generally brings a ceiling to the credit assessments of other companies and instruments within that country. Therefore, this situation limits the ratings of issuances in Turkey and this in turn constraints the growth potential of the secondary and hence the primary market.

Moreover, not only the growth in residential mortgage market but also closely monitoring the household indebtedness is important. Therefore, while supporting the development of the market, national supervisors need to closely monitor the trends in non-performing loans and household debt levels. The global financial crisis has

[159] Although in April 2009 G-20 summit, leaders globally decided on reducing the use and importance of external credit assessments, these grades are still the most widely accepted indicator of credit risk in the markets.

shown the importance of using mortgage market related policies countercyclically. In this respect, Korean case exhibits a good example for developing countries.

In Turkey, there are several governmental institutions such as Capital Markets Board, Banking Regulation and Supervision Agency, Central Bank of the Republic of Turkey and Undersecretariat of Treasury that have implicit responsibilities for the development of the mortgage market. Coordination of these authorities regarding the development of mortgage market should be satisfied in order to guarantee significant growth in this area. In addition to this, although banking sector has shown a robust growth in the last decade, the capital markets are lagging behind. This is indicated as another reason limiting the product variability and volume of the secondary and hence the primary market.

After these discussions, Chapter 4 focused on policy choices that affect the mortgage market in Turkey. As noted in this thesis, residential mortgage default is not only a concern for lenders and borrowers but also a concern for regulatory institutions such as central banks and supervisory authorities. Past experience has shown that mortgage markets have significant social effects. The origins of global financial crisis has indicated that falling property values led to significant amount of mortgage loan default which in turn tightened the availability of loans for these consumers and reduced the incentives to invest in real estate. Global financial crisis has shown that falling house prices in an economy could have significant effects on financial stability. Therefore, national authorities and international organizations should closely monitor the developments in mortgage markets from the perspective of financial stability. Moreover, regulatory institutions can use default and prepayment models to prepare plans to promote homeownership and support the development of secondary market.

Briefly, Chapter 4 analyzed the riskiness in Turkish mortgage market in detail. Instead of collating all the data and constructing a single model for the sector, different models were constructed for two banks. Results showed that there are important bank level differences and sector level analysis might produce incorrect results. Modeling results showed that an increase in the origination interest rate

increases both the default risk and the prepayment risk. What is more, delinquency status is found be an important risk factor for default.

It is also observed that default risk is significantly lower for borrowers that have higher education and in line with expectations, prepayment risk is higher in the secondary education and higher education groups compared to primary education group. For private sector and self-employed groups default risk is higher compared to the public officers group whereas prepayment risk is lower. While default risk increases as the maturity of the obligation and loan amount increases, it decreases as age increases. For Bank 1, marital status at origination has no material effect/marginal effect on prepayment and default. This is also valid for marital status change variable. However for Bank 2, getting married decreases the default risk and increases the prepayment risk.

Given that borrower's characteristics are significant determinants of prepayment and default behavior, banks can improve the performances of their mortgage portfolios by investing in their application and behavioral models. Identifying high risk borrowers and adopting a risk-based pricing in residential mortgage lending could further improve the efficiency of the market and enhance the credit availability.

Modeling results also indicated that models which include option variables only (current equity to market value and prepayment option) for estimating default created low ROC scores. This shows that for Turkish Mortgage market, option indicators are not as important as implied by the literature on the default risk. However, by including the delinquency dummy, the predictive power of the default models have increased significantly. Also adding customer characteristics and mortgage characteristics further increased the discriminatory power of the models.

The analysis on risk weighted assets for Turkish residential mortgages indicate that current risk weight applied to these loans is excessively tight. The exposure weighted risk weights that is calculated using through-the-cycle one-year PD estimates show that appropriate risk weights for mortgages are 28.76% and 27.45% for Bank1 and

Bank 2 respectively. Currently, capital adequacy calculation requires a 50% risk weight for such exposures. Therefore, it can be argued that Turkish banks are holding capital twice the amount required by the models. It is important for authorities to guarantee that there is enough room for compensating unexpected losses that might occur. Nevertheless, too tight standards could have a negative impact on the development of the market. Therefore, it is concluded that 35% risk weight which is allowed by the Basel-II is more appropriate for the Turkish mortgage market.

As indicated by the analysis above, using Internal Ratings Based approaches for the mortgage portfolios could provide significant reduction in risk weighted assets and create additional room for the banks to extend more credit. As a result, banks should be encouraged to apply for getting approval from the Banking Regulation and Supervision Agency for their IRB models if other portfolios of the banks also provide similar results regarding the risk weighted assets.

The provisioning rate that is implied by the standard loan portfolios of the two banks is 0.19% and 0.24% for Bank 1 and Bank 2, respectively. It should be noted that these numbers were not calculated over the most recent portfolio composition of the banks but the portfolios over a long time period (i.e. from 2005-2013 for Bank 1 and 2007-2013 for Bank 2). Therefore, this figure is prudent in the sense that it also covers the PDs estimated over the global financial crisis period. These figures showed that current provisioning rate for standard type loans (flat 1% rate) is extremely high compared to their riskiness. This has a negative effect on banks reported earnings as higher provisions directly reduce the total profit of a bank.

For the loans with delinquency, on the other hand, the situation is a little bit different. For these loans, provisioning rate is estimated to be 3.46% for Bank 1. This is significantly higher than current rate specified in the regulation (2%). Whereas for Bank 2, this rate is estimated to be 1.25%, meaning that, estimated provision rate for close watch type mortgage loans for Bank 2 is less than the rate specified in the regulation.

In addition to these assessments, results presented in Chapter 4 have also revealed that measurement and management of prepayment risk is crucial for financial institutions. Prepayment rates have reached as much as 70% for certain vintages in the past. In addition to its importance for the financial strength of a financial institution, stable prepayment rates are also crucial for the establishment of the secondary market (i.e. RMBS issuances).

The calculation results showed that the prepayment penalty that is set by the Law (i.e. 1% for the loans with remaining maturity less than 36 months and 2% for more than 36 months) corresponds to less than one-third of the economic losses due to prepayment during the periods of significant interest rate declines. Currently, due to small share of mortgage loans in bank's portfolios, these losses could be easily tolerated. However, if Turkish mortgage market will experience a fast growth, then the prepayment penalties may need to be recalibrated. Another possible effect of this rule might be on the contract terms. For the better accessibility of mortgage loans, it is essential that mortgage loans have longer maturities. On the other hand, analysis results showed that economic cost of prepayment for the banks extending longer term mortgages is much larger. This in turn could translate to either increased interest rates for longer term mortgages or shortened contract terms.

On the prepayment penalty issue, there is again more than one related/relevant institution. From the point of view of the banking regulator, the prepayment penalties should be calibrated in a way that it does not disturb the healthiness of the banking sector. On the other hand, from the consumer protection point of view, higher penalties are negative for consumers. As a result, current regulation which requires a 1% prepayment penalty up to 36 months and 2% prepayment penalty when the remaining maturity is more than 36 months seem to be designed in a way to protect consumers more. However, national authorities might need to recalibrate the prepayment fee to protect the financial institutions in case strong movements in the interest rates are observed following a rapid growth in the mortgage portfolios of banks. Therefore, it is argued that the analyses presented in this thesis provide a good basis for national authorities for monitoring.

The analysis in Chapter 4 revealed that a better regulatory definition of prepayment is necessary. Current Law includes the following prepayment definition;

> In case the interest rate is determined to be fixed, on condition that it is stated in the contract, for one or more payments made before due, the creditor may demand a prepayment fee from the consumer. The prepayment fee cannot exceed 2% of the prepaid sum, calculated by making the necessary deductions of interest and fees. A prepayment fee cannot be demanded from the consumer, in case the interest rate or lease payments are determined to be variable.

Here, it should be explicitly stated that the mortgage loan has to be paid back completely in order it to be considered a prepayment. There were instances where Turkish banks applied a prepayment fee for payments regarding installments that were few days earlier than monthly payment date, which is totally inappropriate.

To sum up, there is significant room in the regulation side that might help supporting the development of mortgage market in Turkey. In this respect, national authorities including the Central Bank of the Republic of Turkey that is responsible from the financial stability and Banking Regulation and Supervision Agency that is responsible from the soundness of the financial system need to re-assess the appropriateness of the current calibration of policy choices. It should be noted that current regulatory setting is quite restrictive and against the growth of the mortgage market.

While answering the main research questions, many other important results are also obtained in this thesis. For instance, the baseline model that is constructed in Chapter 3 could also help decide in which countries the mortgage markets have grown more than expected and whether or not this growth would create potential macroeconomic stability problems in the long term.

Additionally, it is observed that Turkish mortgage market has shown strong growth in recent years. The consumer and product level changes behind of this growth could be investigated in more detail in the micro level. According to the best information

of the author, no such study has been conducted that comprehensively analyzed the characteristics of mortgage borrowers including their socio-economic status.

The descriptive analyses on mortgage originations in Turkey provide us important results. Some other findings about the mortgages and mortgage borrowers are as follows;

-Mortgage loan maturities are lengthening in the Turkish mortgage market on average from 5.7 years in 2007 to 7.6 years in 2013,

-Mortgage interest rates are falling and the rates are not differentiating significantly among the three lenders in our sample,

-The share of less than 100,000 TRY loans in banks' mortgage portfolios are increasing while housing prices are increasing,

-At the mortgage origination, approximately 80% of the borrowers are married and nearly 25% of them are females,

-Banks have diverging portfolios regarding the education level of the borrowers, interestingly the mortgage borrowers of the participation bank has the highest education level,

-Analyzing the occupational profile of borrowers, it is observed that whilst the share of public officials has been decreasing, the share of private sector workers and self-employed workers has been increasing.

In addition to these analyses it is noted that accessibility of mortgage products have been increasing. For instance, average age of the mortgage borrowers, average floor area of the underlying mortgages and average appraisal values of the underlying mortgages have been decreasing. Although this is a positive development that could have positive effects on the Turkish economy, it should be noted that the effect of government policies in this process is limited. Given the young population, urbanization trend and average household size, it is argued that mortgage market should be more actively supported and used as a policy tool by the national regulators.

Analyses in Chapter 3 and Chapter 4 showed that, although mortgage interest rates has declined in the last few years, it is still significantly high compared to many developed countries. The main reason behind this factor seems to be the level and volatility of inflation. Therefore, further decreases in the mortgage interest rates require inflation to be better controlled.

In line with Deng *et al.*'s (2005) recommendation for China, adopting a risk based pricing in residential mortgage lending can improve the efficiency of Turkish mortgage market and enhance the credit availability to wider sections of the society including younger households, blue-collar workers, etc. The analyses provided in Chapter 4 indicate risk based pricing in Turkish mortgage market. Nevertheless, skewness of the risk weights show that by controlling the lending practices, banks can significantly reduce risk weights applied, even beyond the current level presented above.

In Turkish system, LTV is determined as a strict limit and mortgages exceeding 75% LTV is prohibited. Instead of using such a crude measure, it would be better to allow extending credit beyond 75% LTV and require banks to have mortgage insurance for exposures exceeding such limits. This would significantly contribute to the development of the mortgage market and insurance sector in Turkey. Additionally, a similar implementation as in the case of Canada, where a government owned institution insured all mortgages by charging a small insurance fee which helped financial institutions to apply a 0% risk weight for all mortgages[160], could boost the development of the market. Nevertheless, such an agency for insurance should be risk focused.

In the current transition period from slums and informally built housing to planned housing projects, opposition is growing with the argument that culturally significant neighborhoods are being demolished especially by the projects undertaken by the

[160] Basel-II standard allows 0% risk weight to be applied for government guaranteed exposures in the domestic currency.

Housing Development Administration (TOKI). Special emphasis should be given to these growing concerns when designing national housing policy.

Last but not least, data is a major problem regarding the quantitative analysis to support decisions about mortgage markets. In the analyses presented in Chapter 3, many additional variables (including tax deductibility, LTV rates) could not be included to the benchmark model due to data related problems. Additionally, in order for policymakers to make more informed decisions about the mortgage market, the literature on Turkish mortgage market needs to flourish. This requires better cooperation between Turkish financial institutions and academy. On the other hand, the analyses presented in Chapter 4 required individual loan level information. However, it was observed that many variables that might explain the default and prepayment behavior could not be obtained from banks databases (or there were significant amount of missing values). Although, a huge progress is obtained on the data quality ground, there is still room for progress. Especially, data on appraisal values and income seem to be problematic and both the banks and national authorities should consider ways to improve the quality of this data. In this respect, Turkish regulators such as Banking Regulation and Supervision Agency and Central Bank of the Republic of Turkey should support data collection and banks needs to invest more.

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APPENDICES

A. VARIABLES USED IN MODELING

Table 57: Definition of Variables and the Sources of Data

Variable	Model Notation	Data Source	Reasoning	Data Issues
Residential Mortgage Debt to GDP Ratio	RMD_GDP	Hypostat2013	Dependent Variable	
Domestic Credit Provided by Banking Sector to GDP	-	World Bank Database	Used in order to calculate residential mortgage credit to total credit ratio	For Norway and Iceland, data is available for only a limited number of years.
Share of Residential Mortgage Credit In Total Credit	Mortgage-to-Credit	Obtained by combining RMD_GDP and Domestic Credit Provided by Banking Sector to GDP	Dependent Variable	
Representative Interest Rates on New Mortgage Loans	Interest	Hypostat 2013	Intuition suggests that as representative interest rates decrease, the demand for mortgage loans would be higher, which also increases the credit stock if there is no specific funding problem.	
Volatility of Representative Interest Rates on New Mortgage Loans	Vol_Interest	Standard deviation of Representative Interest Rates on New Mortgage Loans between 2005 and 2012.	Given that some portion of mortgage loans are variable rate, the volatility of representative interest rates could be negatively associated with the development of the market.	Not enough data before 2005, for the volatility calculation. Therefore only considered in the cross sectional analysis.
Real GDP Growth Rate*	R_GDP_G	Hypostat 2013	Following Djankov *et al.* (2007), growth rate is included as a control variable.	
Inflation Rate	Inflation	Worldbank Database	An important indicator of macroeconomic stability. Badev. *et al.* (2014)	

Table 57: Definition of Variables and the Sources of Data (continued)

Volatility of Inflation rate	Vol_CPI	Worldbank Database	An important indicator of macroeconomic stability. Badev. *et al.* (2014)	
Share of Secondary Residential Mortgage Market Issuances in Residential Mortgage Debt	Secondary	Hypostat 2013	Literature emphasizes the role of the secondary market for the development of the primary market. Mortgage securities are a vehicle for tapping into the capital markets for funds for housing and increasing the flow of funds into the housing sector. Chiquier *et al.* (2004).	
Spread of Representative Interest Rates over Consumer Prices**	Premium	Hypostat 2013	It affects not only the demand for mortgage loans but also the supply of it. Bardhan and Edelstein (2007)	
Strength of Legal Rights Index	Legal	World Bank Doing Business Database	Given that mortgages are long-term loans a strong legal system would contribute to the development of the market by reducing the risks taken by the lending institutions. Warnock & Warnock (2008)	
Depth of Credit Information Index	Credit_Inf	World Bank Doing Business Database	When lending institutions reach a satisfactory amount of data, the lending amount would be positively affected, as institutions are better able to evaluate their risks. Warnock & Warnock (2008)	Not available for Luxembourg and Malta and missing for some years for certain countries.
Capital to Assets Ratio of Banks	CapitaltoAssets	World Bank Database	International capital standards for banks created capital advantage for banks, focusing more on residential mortgage loans. Therefore, a negative correlation is expected between capital to assets ratio and depth of mortgage markets.	
Urbanization Rate	Urban	World Bank Database	Bardhan & Edelstein (2007), Badev. *et al.* (2014) & Renaud (2005)	
Gross National Income per capita PPP	GNI_PPP	UNDP Database	Development of mortgage market increases together with households' income level. Warnock & Warnock (2008)	
Unemployment Rate	Unemp	OECD, Eurostat, Econstats	Unemployment rate is an important indicator of the macroeconomic condition and the payment capacity of borrowers.	

Table 57: Definition of Variables and the Sources of Data (continued)

Development Dummy	Development	IMF World Economic Outlook	Mortgage markets are deeper in developed countries.	
Age Dependency Ratio	Age_Dependency	World Bank Database	Age Dependency ratio is the ratio of people older than 64 to the working-age population (ages 15-64). Badev *et al.* (2014)	
Population Growth Rate	Pop_Growth	World Bank Database	Badev *et al.* (2014)	
House Price Index	House_Price	Hypostat 2013	Increasing house prices could be linked to housing market growth, an example of which is the US market. Arsenault (2012)	Missing for Lithuania and only available for certain years. Hence, only considered in the cross sectional analysis.
Average Household Size	Hhold_Size	Eurostat and various internet sources.	A decrease in average household size is associated with an increase in housing demand. Bardhan & Edelstein (2007)	Only available for certain years. Hence, only considered in the cross sectional analysis.
Insurance Company Assets to GDP Ratio	InsurancetoGDP	World Bank Database	Badev et.al. (2014) indicate that both mortgage depth and housing loan penetration increase with the development of the insurance sector.	Only available for certain years and missing for two countries. Hence, only considered in the cross sectional analysis.

[*] Economic growth increases all equilibrium variables in the real estate market (Dipasquale & Wheaton, 1992, p.191), so it is expected that it will have a positive effect on the deepening of the mortgage market. On the other hand, the analysis (for the 1999–2012 period) has shown that there is a significant negative relationship between RMD_GDP and R_GDP_G. This is also consistent with the "too much finance" hypothesis of Arcand *et al.* (2012).

[**] Spread between mortgage interest rate and realized inflation is calculated as: $[(100+Interest_t)/(100+Cons\_Prices_t)-1]*100$.

Table 58: Descriptive Statistics by Country

Austria	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	25.61	2.3	26.05	21.9	27.9	6
MortgagetoCredit	8	0.19	0.01	0.19	0.17	0.21	0.04
Interest	8	3.68	0.96	3.64	2.71	5.32	2.61
R_GDP_G	8	1.61	2.42	2.08	-3.82	3.71	7.53
Cons_Prices	8	2.15	0.91	2.24	0.51	3.27	2.76
Vol_CPI	8	0.78	0.32	0.81	0.4	1.15	0.75
Secondary	8	3	1.5	3.28	0.4	4.5	4.1
Spread	8	1.51	1.23	1.64	-0.39	3.19	3.58
Legal	8	7	0	7	7	7	0
Credit_Inf	8	6	0	6	6	6	0
CapitaltoAssets	8	6.49	1.01	6.75	4.8	7.5	2.7
Urban	8	67.19	0.47	67.18	66.53	67.88	1.35
GNI_PPP	8	35178.75	1094.86	35297.5	33300	36438	3138
Unemp	8	4.46	0.43	4.4	3.8	5.2	1.4
Development	8	1	0	1	1	1	0
Age_Dependency	8	25.52	1.29	25.63	23.65	27.14	3.49
Pop_Growth	8	0.44	0.12	0.42	0.29	0.68	0.39
House_Price	8	108.53	10.28	105.25	97	129	32

Belgium	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	40.39	5.15	39.6	33.3	46.5	13.2
MortgagetoCredit	7	0.36	0.03	0.35	0.32	0.4	0.08
Interest	7	4.36	0.39	4.15	3.95	5.02	1.07
R_GDP_G	7	1.37	1.95	1.77	-2.8	2.88	5.68
Cons_Prices	7	2.36	1.45	2.19	-0.05	4.49	4.54
Vol_CPI	7	1.09	0.59	1.13	0.46	1.73	1.27
Secondary	7	4.39	5.72	0	0	12.62	12.62
Spread	7	1.96	1.46	1.86	0.4	4.61	4.2
Legal	7	6	0	6	6	6	0
Credit_Inf	7	4	0	4	4	4	0
CapitaltoAssets	7	3.94	0.86	4.1	2.7	5	2.3
Urban	7	97.39	0.07	97.39	97.29	97.49	0.19
GNI_PPP	7	33263.86	728.61	33418	32210	34102	1892
Unemp	7	7.77	0.58	7.9	7	8.4	1.4
Development	7	1	0	1	1	1	0
Age_Dependency	7	26.07	0.21	26.01	25.83	26.36	0.53
Pop_Growth	7	0.83	0.27	0.79	0.55	1.39	0.84

Table 58: Descriptive Statistics by Country (continued)

House_Price	7	109.7	11.72	112.2	89.5	123.8	34.3

Bulgaria	n	mean	sd	median	min	max	range
Year	6	2009.5	1.87	2009.5	2007	2012	5
RMD_GDP	6	19.33	1.67	19.15	17.6	21.3	3.7
MortgagetoCredit	6	0.29	0.03	0.29	0.25	0.33	0.08
Interest	6	8.71	0.9	8.68	7.49	10.1	2.61
R_GDP_G	6	1.68	4.4	1.3	-5.5	6.4	11.9
Cons_Prices	6	5.52	4.01	3.59	2.44	12.35	9.91
Vol_CPI	6	3.57	0.8	3.88	2.4	4.26	1.86
Secondary	6	0	0	0	0	0	0
Spread	6	3.15	3.86	4.12	-2.86	7.15	10.01
Legal	6	9	0	9	9	9	0
Credit_Inf	6	5.33	1.03	6	4	6	2
CapitaltoAssets	6	9.77	1.33	10.4	7.7	10.8	3.1
Urban	6	72.33	0.94	72.29	71.12	73.64	2.52
GNI_PPP	6	11117.5	399.9	11225	10379	11474	1095
Unemp	6	8.85	2.77	8.55	5.6	12.3	6.7
Development	6	0	0	0	0	0	0
Age_Dependency	6	26.72	0.86	26.61	25.72	28.01	2.3
Pop_Growth	6	-0.87	0.79	-0.55	-2.47	-0.48	1.99
House_Price	6	123.62	20.95	120.3	104.1	161.1	57

Cyprus	n	mean	sd	median	min	max	range
Year	5	2010	1.58	2010	2008	2012	4
RMD_GDP	5	64.06	8.91	68.5	49.5	70.9	21.4
MortgagetoCredit	5	0.2	0.02	0.2	0.18	0.22	0.04
Interest	5	5.48	0.54	5.33	4.73	6.05	1.32
R_GDP_G	5	0.25	2.41	0.4	-2.4	3.63	6.03
Cons_Prices	5	2.62	1.57	2.39	0.37	4.67	4.3
Vol_CPI	5	1.44	0.24	1.52	1.01	1.57	0.56
Secondary	5	8.29	18.54	0	0	41.45	41.45
Spread	5	2.8	1.7	2.29	1.24	5.65	4.41
Legal	5	9	0	9	9	9	0
Credit_Inf	3	2	0	2	2	2	0
CapitaltoAssets	5	5.64	0.83	5.6	4.9	6.9	2
Urban	5	70.33	0.29	70.31	69.96	70.71	0.74
GNI_PPP	5	24796.6	607.53	24771	23825	25326	1501
Unemp	5	7	3.1	6.3	3.6	11.8	8.2
Development	5	1	0	1	1	1	0
Age_Dependency	5	16.41	0.42	16.37	15.91	16.98	1.07

Table 58: Descriptive Statistics by Country (continued)

Pop_Growth	5	1.2	0.08	1.2	1.11	1.31	0.2
House_Price	5	132.82	7.89	134.4	121.9	142.8	20.9

Czech Republic	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	10.49	3.02	11.1	5.7	14.3	8.6
MortgagetoCredit	8	0.18	0.03	0.19	0.14	0.21	0.07
Interest	8	4.49	0.95	4.29	3.17	5.69	2.52
R_GDP_G	8	2.67	3.98	2.78	-4.51	7.02	11.53
Cons_Prices	8	2.67	1.67	2.23	1.04	6.35	5.31
Vol_CPI	8	1.76	0.44	1.9	1.05	2.16	1.1
Secondary	8	12.99	13.85	6.12	3.46	41.4	37.95
Spread	8	1.8	1.62	1.94	-0.62	4.52	5.14
Legal	8	6.38	0.52	6	6	7	1
Credit_Inf	8	5	0	5	5	5	0
CapitaltoAssets	8	6.06	0.51	6.05	5.4	6.8	1.4
Urban	8	73.54	0.1	73.53	73.42	73.7	0.28
GNI_PPP	8	21902	814.88	22054.5	20370	23216	2846
Unemp	8	6.55	1.14	6.85	4.4	7.9	3.5
Development	8	0.5	0.53	0.5	0	1	1
Age_Dependency	8	21.24	1.28	20.97	19.83	23.42	3.59
Pop_Growth	8	0.36	0.34	0.32	-0.23	0.87	1.09
House_Price	7	125.83	18.44	133.7	99.9	146.3	46.4

Denmark	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	95.85	6.52	97.5	85	103.4	18.4
MortgagetoCredit	8	0.47	0.01	0.47	0.45	0.49	0.04
Interest	8	5.02	0.88	4.94	3.67	6.5	2.83
R_GDP_G	8	0.41	2.81	1.34	-5.67	3.39	9.06
Cons_Prices	8	2.2	0.66	2.09	1.33	3.4	2.07
Vol_CPI	8	0.67	0.19	0.77	0.35	0.84	0.49
Secondary	8	59.47	16	59.21	33.56	85.13	51.57
Spread	8	2.76	0.99	2.75	1.23	4.14	2.91
Legal	8	8.88	0.35	9	8	9	1
Credit_Inf	8	4	0	4	4	4	0
CapitaltoAssets	8	5.3	0.67	5.5	4.2	6.2	2
Urban	8	86.49	0.43	86.51	85.86	87.07	1.21
GNI_PPP	8	33819.62	914.2	33589	32474	34969	2495
Unemp	8	5.56	1.81	5.4	3.4	7.6	4.2
Development	8	1	0	1	1	1	0

Table 58: Descriptive Statistics by Country (continued)

Age_Dependency	8	24.7	1.43	24.55	22.91	26.94	4.03
Pop_Growth	8	0.42	0.1	0.43	0.28	0.59	0.31
House_Price	8	92.5	8.34	89.3	82.3	104.9	22.6

Estonia	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	35.7	6.42	35.7	23.4	44.4	21
MortgagetoCredit	8	0.41	0.03	0.41	0.34	0.45	0.1
Interest	8	4.07	1.07	3.68	2.89	5.83	2.94
R_GDP_G	8	3.03	8.39	5.72	-14.1	10.1	24.2
Cons_Prices	8	4.66	2.99	4.26	-0.08	10.37	10.45
Vol_CPI	8	2.89	1.15	3.36	1.21	3.92	2.71
Secondary	8	0	0	0	0	0	0
Spread	8	-0.51	2.25	-0.89	-4.11	3.96	8.07
Legal	8	6.38	0.52	6	6	7	1
Credit_Inf	8	5	0	5	5	5	0
CapitaltoAssets	8	8.79	0.44	8.7	8.2	9.5	1.3
Urban	8	69.47	0.05	69.45	69.42	69.57	0.15
GNI_PPP	8	16931.25	1000.93	17140.5	15782	18347	2565
Unemp	8	9.66	4.42	9	4.7	16.9	12.2
Development	8	0.25	0.46	0	0	1	1
Age_Dependency	8	25.73	0.66	25.65	24.83	26.79	1.97
Pop_Growth	8	-0.09	0.09	-0.06	-0.24	-0.01	0.23
House_Price	8	81.56	19.84	72.5	63.4	114.3	50.9

Finland	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	38.42	5.23	39.05	30.8	44.4	13.6
MortgagetoCredit	8	0.41	0.01	0.42	0.4	0.42	0.03
Interest	8	3.17	1.19	2.75	1.97	5.02	3.05
R_GDP_G	8	1.21	4.43	2.82	-8.54	5.34	13.87
Cons_Prices	8	2.06	1.38	2.04	0	4.07	4.07
Vol_CPI	8	1.28	0.43	1.52	0.58	1.67	1.09
Secondary	8	5.29	4.12	2.83	1.85	12.08	10.24
Spread	8	1.1	1.35	1.51	-0.9	2.42	3.32
Legal	8	8	0	8	8	8	0
Credit_Inf	8	4	0	4	4	4	0
CapitaltoAssets	8	6.69	1.99	6.3	4.4	9.4	5
Urban	8	83.36	0.32	83.36	82.91	83.82	0.91
GNI_PPP	8	32293.5	1017	32374	30850	33618	2768
Unemp	8	7.62	0.75	7.65	6.3	8.4	2.1

Table 58: Descriptive Statistics by Country (continued)

Development	8	1	0	1	1	1	0
Age_Dependency	8	25.37	1.46	24.89	23.9	28.08	4.18
Pop_Growth	8	0.44	0.05	0.46	0.34	0.48	0.14
House_Price	8	107.92	9.22	105.95	93.1	120.7	27.6

France	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	36.43	4.73	36.7	29.3	42.1	12.8
MortgagetoCredit	7	0.29	0.02	0.3	0.27	0.32	0.05
Interest	7	4.15	0.69	3.95	3.44	5.32	1.88
R_GDP_G	7	1.01	2.02	1.83	-3.15	2.47	5.61
Cons_Prices	7	1.64	0.82	1.68	0.09	2.81	2.73
Vol_CPI	7	0.6	0.37	0.53	0.21	1.01	0.8
Secondary	7	6.65	3.31	5.14	3.37	12.17	8.8
Spread	7	2.48	0.8	2.38	1.75	3.81	2.05
Legal	7	6.43	1.13	7	4	7	3
Credit_Inf	7	4	0	4	4	4	0
CapitaltoAssets	7	4.36	0.42	4.4	3.7	4.9	1.2
Urban	7	83.73	1.54	83.76	81.56	85.74	4.19
GNI_PPP	7	30335.57	475.35	30378	29700	30997	1297
Unemp	7	8.67	0.71	8.9	7.4	9.3	1.9
Development	7	1	0	1	1	1	0
Age_Dependency	7	25.6	0.44	25.38	25.26	26.46	1.2
Pop_Growth	7	0.6	0.1	0.56	0.51	0.75	0.25
House_Price	7	101.2	5.87	101.4	91	108.6	17.6

Germany	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	47.7	2.78	46.95	44.8	52.3	7.5
MortgagetoCredit	8	0.37	0.01	0.37	0.35	0.39	0.04
Interest	8	4.27	0.64	4.36	3.07	5.04	1.97
R_GDP_G	8	1.45	3.01	2.18	-5.15	4.01	9.16
Cons_Prices	8	1.69	0.73	1.79	0.31	2.63	2.32
Vol_CPI	8	0.65	0.3	0.69	0.25	0.95	0.71
Secondary	8	3.67	0.94	3.51	2.32	5.05	2.73
Spread	8	2.54	0.88	2.65	1.04	4.09	3.05
Legal	8	7.38	0.52	7	7	8	1
Credit_Inf	8	6	0	6	6	6	0
CapitaltoAssets	8	4.39	0.2	4.35	4.1	4.8	0.7
Urban	8	73.69	0.25	73.68	73.36	74.07	0.72
GNI_PPP	8	33761.75	1291.31	34008.5	31470	35431	3961

Table 58: Descriptive Statistics by Country (continued)

Unemp	8	7.95	1.98	7.6	5.4	11.1	5.7
Development	8	1	0	1	1	1	0
Age_Dependency	8	30.63	1.35	30.91	28.38	32.1	3.72
Pop_Growth	8	-0.1	0.12	-0.12	-0.25	0.11	0.37
House_Price	8	102.72	3.12	102.55	99.8	108.7	8.9

Greece	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	32	5.06	33.3	23.5	37.6	14.1
MortgagetoCredit	7	0.26	0.03	0.25	0.22	0.3	0.08
Interest	7	4.17	0.58	4.24	3.42	5.1	1.68
R_GDP_G	7	-0.58	4.66	-0.21	-7.1	5.51	12.62
Cons_Prices	7	3.29	1.11	3.33	1.21	4.71	3.5
Vol_CPI	7	0.75	0.5	0.53	0.29	1.35	1.05
Secondary	7	7.68	6.35	6.3	3.3	21.43	18.12
Spread	7	0.86	1.09	0.92	-1.23	2.28	3.52
Legal	7	4	0	4	4	4	0
Credit_Inf	7	4.43	0.53	4	4	5	1
CapitaltoAssets	7	6.23	0.74	6.5	4.9	7	2.1
Urban	7	60.87	0.41	60.86	60.32	61.46	1.15
GNI_PPP	7	24249.29	1272.01	24551	21840	25519	3679
Unemp	7	10.63	3.48	9.5	7.7	17.7	10
Development	7	1	0	1	1	1	0
Age_Dependency	7	28.25	0.4	28.2	27.68	28.92	1.24
Pop_Growth	7	0.3	0.18	0.4	-0.07	0.41	0.47
House_Price	7	99.71	6.92	100	88.3	107.7	19.4

Hungary	n	mean	sd	median	min	max	range
Year	6	2009.17	2.48	2009.5	2005	2012	7
RMD_GDP	6	21.6	4.98	23.1	12.1	25.8	13.7
MortgagetoCredit	6	0.28	0.05	0.3	0.19	0.32	0.13
Interest	6	11.93	1.44	12.22	9.93	13.45	3.52
R_GDP_G	6	-0.13	3.73	1.08	-6.8	3.96	10.76
Cons_Prices	6	4.73	1	4.55	3.55	6.07	2.52
Vol_CPI	6	1.68	0.42	1.75	0.92	2.17	1.26
Secondary	6	9.18	4.97	8.98	2.2	14.91	12.71
Spread	6	6.88	1.83	6.53	4.81	9.27	4.46
Legal	6	7	0	7	7	7	0
Credit_Inf	6	4.67	0.52	5	4	5	1
CapitaltoAssets	6	9.77	1.01	10	8.2	10.9	2.7
Urban	6	68.51	1.26	68.7	66.36	69.91	3.54

Table 58: Descriptive Statistics by Country (continued)

GNI_PPP	6	16204.5	279.84	16112.5	15975	16752	777
Unemp	6	9.67	1.74	10.45	7.2	11.2	4
Development	6	0	0	0	0	0	0
Age_Dependency	6	24.09	0.76	24.2	22.83	24.94	2.11
Pop_Growth	6	-0.22	0.05	-0.21	-0.28	-0.15	0.13
House_Price	6	95.58	6.27	94.35	88	105.9	17.9

Iceland	n	mean	sd	median	min	max	range
Year	3	2006	1	2006	2005	2007	2
RMD_GDP	3	99.4	7.28	98.7	92.5	107	14.5
MortgagetoCredit	3	0.35	0.03	0.34	0.32	0.38	0.06
Interest	3	4.7	0.54	4.69	4.17	5.24	1.07
R_GDP_G	3	5.97	1.26	5.99	4.71	7.23	2.52
Cons_Prices	3	5.25	1.35	5.06	4	6.68	2.68
Vol_CPI	3	1.75	0.05	1.77	1.69	1.79	0.09
Secondary	3	1.85	1.78	2.01	0	3.55	3.55
Spread	3	-0.51	1.17	0.16	-1.86	0.17	2.03
Legal	3	7	0	7	7	7	0
Credit_Inf	3	5	0	5	5	5	0
CapitaltoAssets	3	7.37	0.45	7.4	6.9	7.8	0.9
Urban	3	93.15	0.12	93.15	93.04	93.27	0.23
GNI_PPP	3	34096.33	832.95	33630	33601	35058	1457
Unemp	3	2.63	0.35	2.6	2.3	3	0.7
Development	3	1	0	1	1	1	0
Age_Dependency	3	17.75	0.01	17.75	17.75	17.77	0.02
Pop_Growth	3	2.15	0.5	2.35	1.58	2.53	0.95
House_Price	3	103.4	10.33	100	95.2	115	19.8

Ireland	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	78.33	9.83	79.8	61	91.7	30.7
MortgagetoCredit	8	0.39	0.01	0.38	0.38	0.41	0.04
Interest	8	3.79	0.83	3.41	3.04	5.16	2.12
R_GDP_G	8	1.35	4.08	1.18	-5.46	5.88	11.33
Cons_Prices	8	1.77	3.1	2.51	-4.48	4.88	9.36
Vol_CPI	8	2.45	1.43	2.3	1.03	4.05	3.02
Secondary	8	8.84	5.65	7.3	2.38	19.3	16.92
Spread	8	2.06	2.67	0.99	0.04	7.87	7.83
Legal	8	9	0	9	9	9	0
Credit_Inf	8	5	0	5	5	5	0
CapitaltoAssets	8	5.36	0.95	5.05	4.5	7.1	2.6

Table 58: Descriptive Statistics by Country (continued)

Urban	8	61.48	0.71	61.47	60.48	62.51	2.04
GNI_PPP	8	31939	2943.62	31863	28508	35653	7145
Unemp	8	9.31	4.89	9	4.3	14.7	10.4
Development	8	1	0	1	1	1	0
Age_Dependency	8	16.64	0.53	16.44	16.18	17.63	1.44
Pop_Growth	8	1.5	0.91	1.87	0.26	2.39	2.12
House_Price	8	83.92	19.36	85.3	54.8	108.5	53.7

Italy	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	18.54	3.2	17.1	15.1	23.3	8.2
MortgagetoCredit	7	0.14	0.01	0.14	0.13	0.15	0.02
Interest	7	4.12	1.12	3.64	2.67	5.69	3.02
R_GDP_G	7	0.05	2.68	0.93	-5.49	2.2	7.69
Cons_Prices	7	2.04	0.84	2	0.75	3.38	2.62
Vol_CPI	7	0.64	0.33	0.62	0.28	1.03	0.75
Secondary	7	12.78	9.84	8.39	4.54	31.12	26.58
Spread	7	2.03	1.03	2.24	0.56	3.57	3.01
Legal	7	3	0	3	3	3	0
Credit_Inf	7	5.14	0.38	5	5	6	1
CapitaltoAssets	7	8.11	0.9	7.9	7	9.4	2.4
Urban	7	67.97	0.29	67.97	67.59	68.4	0.81
GNI_PPP	7	27813	984.77	28145	26605	28993	2388
Unemp	7	7.41	0.89	7.7	6.1	8.4	2.3
Development	7	1	0	1	1	1	0
Age_Dependency	7	30.4	0.6	30.31	29.61	31.38	1.77
Pop_Growth	7	0.61	0.14	0.6	0.4	0.77	0.37
House_Price	7	102.83	4.05	104.9	94.7	105.5	10.8

Latvia	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	29.85	5.82	30.45	19.4	36.9	17.5
MortgagetoCredit	8	0.36	0.04	0.37	0.27	0.4	0.13
Interest	8	4.93	1.13	4.74	3.66	7.02	3.36
R_GDP_G	8	2.57	10.02	5.15	-17.95	12.23	30.19
Cons_Prices	8	5.98	5.06	5.46	-1.09	15.4	16.49
Vol_CPI	8	4.3	1.84	4.22	2.24	6.39	4.15
Secondary	8	0.15	0.18	0.08	0	0.43	0.43
Spread	8	-0.84	3.74	-0.86	-7.26	5.24	12.5
Legal	8	10	0	10	10	10	0
Credit_Inf	8	4.38	0.74	4.5	3	5	2

Table 58: Descriptive Statistics by Country (continued)

CapitaltoAssets	8	8.36	0.9	7.85	7.6	9.6	2
Urban	8	67.82	0.11	67.8	67.71	68	0.29
GNI_PPP	8	14263	1015.73	14081.5	12880	15750	2870
Unemp	8	12	5.22	11.9	6	18.7	12.7
Development	8	0	0	0	0	0	0
Age_Dependency	8	26.62	0.89	26.73	25.2	27.7	2.5
Pop_Growth	8	-1.62	2.64	-0.54	-8.08	-0.44	7.64
House_Price	7	101.37	25.31	87.7	76.9	137.8	60.9

Lithuania	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	17.54	4.14	18.3	10.8	22.6	11.8
MortgagetoCredit	8	0.3	0.04	0.31	0.25	0.34	0.09
Interest	8	4.14	0.99	3.88	2.97	5.83	2.86
R_GDP_G	8	3.09	7.75	4.85	-14.74	9.84	24.58
Cons_Prices	8	4.5	2.9	3.94	1.33	10.93	9.59
Vol_CPI	8	2.96	0.89	3.38	1.4	3.78	2.38
Secondary	8	0	0	0	0	0	0
Spread	8	-0.3	1.95	-0.18	-4.6	2.33	6.93
Legal	8	5	0	5	5	5	0
Credit_Inf	8	6	0	6	6	6	0
CapitaltoAssets	8	8.74	1.61	8.05	7.3	11.7	4.4
Urban	8	66.91	0.2	66.89	66.64	67.23	0.59
GNI_PPP	8	15861.62	1023.65	15897.5	14050	17150	3100
Unemp	8	10.5	5.12	10.75	4.3	17.8	13.5
Development	8	0	0	0	0	0	0
Age_Dependency	8	22.37	0.07	22.37	22.23	22.48	0.26
Pop_Growth	8	-1.72	2.5	-0.61	-7.81	-0.52	7.29

Luxembourg	n	mean	sd	median	min	max	range
Year	7	2009	2.16	2009	2006	2012	6
RMD_GDP	7	43.94	5.07	46.6	35.4	48.9	13.5
MortgagetoCredit	7	0.24	0.02	0.24	0.21	0.28	0.07
Interest	7	3.19	1.29	2.37	2	4.9	2.9
R_GDP_G	7	1.44	4.04	1.9	-5.56	6.59	12.14
Cons_Prices	7	2.44	1.02	2.66	0.37	3.41	3.04
Vol_CPI	7	0.82	0.47	1.12	0.24	1.25	1.01
Secondary	7	0.18	0.47	0	0	1.25	1.25
Spread	7	0.74	1.36	1.24	-1.12	2.39	3.51
Legal	7	4	0	4	4	4	0
CapitaltoAssets	7	5.39	0.58	5.2	4.8	6.5	1.7

Table 58: Descriptive Statistics by Country (continued)

Urban	7	84.92	0.53	84.93	84.18	85.64	1.46
GNI_PPP	7	51512.43	4842.1	48998	45823	59616	13793
Unemp	7	4.77	0.39	4.9	4.1	5.1	1
Development	7	1	0	1	1	1	0
Age_Dependency	7	20.77	0.35	20.59	20.47	21.37	0.9
Pop_Growth	7	1.9	0.34	1.83	1.54	2.49	0.95
House_Price	6	104.48	7.93	100.75	98.6	118.2	19.6

Malta							
Country*	n	mean	sd	median	min	max	range
Year	2	2011.5	0.71	2011.5	2011	2012	1
RMD_GDP	2	45	0.99	45	44.3	45.7	1.4
MortgagetoCredit	2	0.29	0.01	0.29	0.29	0.3	0.01
Interest	2	3.74	0.42	3.74	3.44	4.03	0.59
R_GDP_G	2	1.4	0.57	1.4	1	1.8	0.8
Cons_Prices	2	2.57	0.22	2.57	2.42	2.72	0.3
Vol_CPI	2	1.11	0.12	1.11	1.03	1.2	0.17
Secondary	2	0	0	0	0	0	0
Spread	2	1.14	0.62	1.14	0.7	1.57	0.88
Legal	2	3	0	3	3	3	0
CapitaltoAssets	2	6.6	0.14	6.6	6.5	6.7	0.2
Urban	2	94.9	0.11	94.9	94.82	94.98	0.15
GNI_PPP	2	21138.5	64.35	21138.5	21093	21184	91
Unemp	2	6.45	0.07	6.45	6.4	6.5	0.1
Development	2	1	0	1	1	1	0
Age_Dependency	2	21.99	0.7	21.99	21.49	22.48	0.98
Pop_Growth	2	0.28	0.17	0.28	0.16	0.4	0.24
House_Price	2	97.1	1.56	97.1	96	98.2	2.2

Netherlands	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	101.67	6.42	103.3	93.5	108.4	14.9
MortgagetoCredit	8	0.51	0.02	0.5	0.48	0.53	0.05
Interest	8	4.83	0.41	4.88	4.11	5.37	1.26
R_GDP_G	8	1.09	2.48	1.67	-3.67	3.92	7.59
Cons_Prices	8	1.78	0.57	1.64	1.17	2.49	1.32
Vol_CPI	8	0.67	0.26	0.58	0.38	1.2	0.82
Secondary	8	10.13	5.63	7.92	5.62	21.98	16.36
Spread	8	3	0.65	2.98	2.23	4.13	1.9
Legal	8	6	0	6	6	6	0

Table 58: Descriptive Statistics by Country (continued)

Credit_Inf	8	5	0	5	5	5	0
CapitaltoAssets	8	4.31	1.95	3.8	3	8.9	5.9
Urban	8	81.93	1.19	81.97	80.17	83.52	3.34
GNI_PPP	8	36901.62	990.48	37247.5	35270	38198	2928
Unemp	8	4.03	0.85	4.15	2.8	5.3	2.5
Development	8	1	0	1	1	1	0
Age_Dependency	8	22.39	1.4	22.1	20.79	24.79	4
Pop_Growth	8	0.37	0.14	0.42	0.16	0.51	0.35
House_Price	8	98.84	5.3	99.75	89	105.8	16.8

Norway	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	62.49	5.65	60.4	55.2	68.8	13.6
MortgagetoCredit	2	0.66	0	0.66	0.66	0.66	0.01
Interest	7	4.9	1.23	4.4	3.82	7.21	3.39
R_GDP_G	7	1.1	1.58	1.22	-1.63	2.65	4.29
Cons_Prices	7	2.03	0.98	2.17	0.73	3.77	3.04
Vol_CPI	7	1.06	0.17	1.08	0.82	1.34	0.52
Secondary	7	7.17	5.98	9.64	0	15.24	15.24
Spread	7	2.82	1.68	2.38	1.62	6.43	4.82
Legal	7	6	0	6	6	6	0
Credit_Inf	7	4	0	4	4	4	0
CapitaltoAssets	7	6.59	0.56	6.7	5.9	7.4	1.5
Urban	7	78.45	0.68	78.46	77.49	79.37	1.88
GNI_PPP	7	48069.71	571.16	47950	47447	49019	1572
Unemp	7	3.31	0.7	3.3	2.5	4.6	2.1
Development	7	1	0	1	1	1	0
Age_Dependency	7	22.51	0.27	22.44	22.3	23.05	0.75
Pop_Growth	7	1.08	0.25	1.25	0.68	1.3	0.62
House_Price	7	111.57	14.54	112.6	88	132.7	44.7

Poland	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	14.8	5.75	16.55	5.7	21	15.3
MortgagetoCredit	8	0.26	0.06	0.27	0.15	0.32	0.17
Interest	8	6.8	0.72	6.79	5.74	8.05	2.31
R_GDP_G	8	4.21	1.87	4.26	1.6	6.79	5.19
Cons_Prices	8	3.04	1.15	3.13	1.11	4.35	3.23
Vol_CPI	8	1.18	0.34	1.19	0.66	1.82	1.15
Secondary	8	0.47	0.45	0.33	0.17	1.53	1.36
Spread	8	3.65	0.79	3.58	2.25	4.77	2.53

Table 58: Descriptive Statistics by Country (continued)

Legal	8	8.5	0.53	8.5	8	9	1
Credit_Inf	8	5.38	0.74	5.5	4	6	2
CapitaltoAssets	8	7.92	0.33	7.85	7.5	8.6	1.1
Urban	8	61.12	0.22	61.1	60.84	61.46	0.61
GNI_PPP	8	15847.75	1503.03	16070.5	13470	17776	4306
Unemp	8	10.71	3.42	9.6	7.1	17.7	10.6
Development	8	0	0	0	0	0	0
Age_Dependency	8	18.99	0.36	18.84	18.72	19.78	1.06
Pop_Growth	8	0.12	0.33	0.02	-0.06	0.91	0.98
House_Price	5	107.56	4.52	109.3	100	111.6	11.6

Portugal	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	61.86	5.56	63.45	51.5	66.9	15.4
MortgagetoCredit	8	0.34	0.02	0.34	0.32	0.37	0.05
Interest	8	3.78	1	3.82	2.43	5.42	2.99
R_GDP_G	8	-0.11	2.15	0.38	-3.23	2.37	5.59
Cons_Prices	8	2.18	1.37	2.67	-0.84	3.65	4.49
Vol_CPI	8	1.08	0.63	1.21	0.23	1.74	1.51
Secondary	8	9.26	4.68	7.25	5.38	18.47	13.09
Spread	8	1.58	1.11	1.15	0.08	3.56	3.47
Legal	8	3	0	3	3	3	0
Credit_Inf	8	5	0	5	5	5	0
CapitaltoAssets	8	6.15	0.5	6.25	5.3	6.7	1.4
Urban	8	59.61	1.41	59.63	57.58	61.58	4
GNI_PPP	8	20818.38	474.57	20957	19907	21365	1458
Unemp	8	9.94	2.94	8.75	7.6	15.6	8
Development	8	1	0	1	1	1	0
Age_Dependency	8	26.53	0.8	26.45	25.47	27.78	2.32
Pop_Growth	8	0.03	0.39	0.11	-0.76	0.45	1.21
House_Price	8	103.83	3.6	105.2	98	107.7	9.7

Romania	n	mean	sd	median	min	max	range
Year	6	2009.5	1.87	2009.5	2007	2012	5
RMD_GDP	6	5.05	1.18	5.15	3.4	6.6	3.2
MortgagetoCredit	6	0.1	0.01	0.1	0.09	0.12	0.03
Interest	6	7.07	1.35	7.15	5.25	8.4	3.15
R_GDP_G	6	1.98	5.3	3.08	-6.58	7.93	14.5
Cons_Prices	6	5.58	1.49	5.69	3.33	7.85	4.51
Vol_CPI	6	2.06	1.17	1.64	1.12	4.17	3.05
Secondary	6	0	0	0	0	0	0

Table 58: Descriptive Statistics by Country (continued)

Spread	6	1.42	1.28	1.16	0.04	3.06	3.01
Legal	6	9	0	9	9	9	0
Credit_Inf	6	5	0	5	5	5	0
CapitaltoAssets	6	8.95	0.92	8.75	8.1	10.7	2.6
Urban	6	52.8	0.03	52.79	52.77	52.85	0.08
GNI_PPP	6	11018.67	369.69	10942.5	10735	11734	999
Unemp	6	6.8	0.6	6.95	5.8	7.4	1.6
Development	6	0	0	0	0	0	0
Age_Dependency	6	21.22	0.09	21.21	21.14	21.37	0.24
Pop_Growth	6	-0.2	0.05	-0.19	-0.27	-0.15	0.12
House_Price	4	83.42	13.28	80.75	72.2	100	27.8

Russia	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	2.05	1.02	2.5	0.2	3.2	3
MortgagetoCredit	8	0.06	0.03	0.07	0.01	0.11	0.1
Interest	8	13.21	1.02	13	11.9	14.9	3
R_GDP_G	8	4.09	5.15	4.88	-7.82	8.54	16.36
Cons_Prices	8	9.69	3.02	9.34	5.07	14.11	9.04
Vol_CPI	8	2.74	0.77	2.57	1.97	4.08	2.1
Secondary	8	1.88	3.65	0	0	10.48	10.48
Spread	8	3.27	2.42	3.25	-1.06	6.88	7.94
Legal	8	3	0	3	3	3	0
Credit_Inf	6	4.67	0.52	5	4	5	1
CapitaltoAssets	8	12.4	0.82	12.6	10.8	13.3	2.5
Urban	8	73.45	0.37	73.44	72.93	74	1.07
GNI_PPP	8	13422.88	993.25	13675.5	11560	14461	2901
Unemp	8	6.75	0.88	6.8	5.5	8.3	2.8
Development	8	0	0	0	0	0	0
Age_Dependency	8	18.68	0.56	18.59	18.1	19.44	1.34
Pop_Growth	8	-0.03	0.37	-0.07	-0.49	0.4	0.89
House_Price	8	120.07	26.81	125.45	64.8	150.7	85.9

Slovakia	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	13.51	4.45	13.95	6.2	19.2	13
MortgagetoCredit	4	0.19	0.05	0.2	0.13	0.24	0.11
Interest	8	6.01	0.58	6.18	5.21	6.66	1.45
R_GDP_G	8	4.41	4.71	4.97	-4.93	10.49	15.43
Cons_Prices	8	3.08	1.32	3.18	0.96	4.6	3.64
Vol_CPI	8	2	0.58	1.81	1.28	2.71	1.43

Table 58: Descriptive Statistics by Country (continued)

Secondary	8	11.43	4.69	11.36	5.73	18.97	13.24
Spread	8	2.85	1.38	2.65	1.24	4.64	3.4
Legal	8	8	0	8	8	8	0
Credit_Inf	8	3.75	0.46	4	3	4	1
CapitaltoAssets	8	8.96	1.52	8.9	7	11	4
Urban	8	55.09	0.31	55.05	54.73	55.56	0.83
GNI_PPP	8	18323.25	1328.2	18823	15720	19696	3976
Unemp	8	13	2.06	13.4	9.6	16.2	6.6
Development	8	0.5	0.53	0.5	0	1	1
Age_Dependency	8	16.77	0.45	16.65	16.32	17.57	1.25
Pop_Growth	8	0.06	0.27	0.14	-0.58	0.22	0.81
House_Price	7	120.14	12.66	119	100	136.4	36.4

Slovenia	n	mean	sd	median	min	max	range
Year	5	2008	1.58	2008	2006	2010	4
RMD_GDP	5	9.56	2.87	9.1	6.3	13.6	7.3
MortgagetoCredit	5	0.11	0.02	0.1	0.09	0.14	0.05
Interest	5	5.4	1.46	5.64	3.48	7.03	3.55
R_GDP_G	5	1.94	5.95	3.59	-8.01	6.87	14.88
Cons_Prices	5	2.88	1.84	2.46	0.86	5.65	4.8
Vol_CPI	5	1.67	0.38	1.77	1.27	2.17	0.9
Secondary	5	0	0	0	0	0	0
Spread	5	2.46	0.96	2.76	1.3	3.5	2.2
Legal	5	4.4	0.55	4	4	5	1
Credit_Inf	5	3.4	0.89	4	2	4	2
CapitaltoAssets	5	8.34	0.09	8.4	8.2	8.4	0.2
Urban	5	50.16	0.16	50.16	49.96	50.37	0.41
GNI_PPP	5	25140.8	931.26	24686	24318	26463	2145
Unemp	5	5.66	1.1	5.9	4.4	7.2	2.8
Development	5	0.8	0.45	1	0	1	1
Age_Dependency	5	23.25	0.62	23.25	22.46	24.03	1.57
Pop_Growth	5	0.48	0.28	0.44	0.16	0.9	0.75
House_Price	5	113.66	8.11	114.6	100	120.6	20.6

Spain	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	60.87	4.44	62	52.3	64.9	12.6
MortgagetoCredit	7	0.3	0.02	0.29	0.27	0.33	0.06
Interest	7	3.82	1.15	3.23	2.44	5.64	3.2
R_GDP_G	7	1.15	2.82	0.89	-3.83	4.08	7.91
Cons_Prices	7	2.64	1.47	3.2	-0.29	4.08	4.36

Table 58: Descriptive Statistics by Country (continued)

Vol_CPI	7	0.91	0.75	0.49	0.22	1.73	1.51
Secondary	7	15.24	4.08	16.58	9.99	19.09	9.1
Spread	7	1.16	1.31	0.63	-0.18	3.46	3.64
Legal	7	6	0	6	6	6	0
Credit_Inf	7	5	0	5	5	5	0
CapitaltoAssets	7	6.36	0.32	6.4	5.9	6.8	0.9
Urban	7	77.05	0.26	77.05	76.7	77.43	0.73
GNI_PPP	7	27073.14	601.19	27000	26426	27864	1438
Unemp	7	13.86	5.83	11.3	8.3	21.6	13.3
Development	7	1	0	1	1	1	0
Age_Dependency	7	24.78	0.45	24.63	24.36	25.55	1.19
Pop_Growth	7	1.12	0.65	1.5	0.22	1.71	1.49
House_Price	7	95.74	6.71	95.1	85.5	104.8	19.3

Sweden	n	mean	sd	median	min	max	range
Year	5	2007	1.58	2007	2005	2009	4
RMD_GDP	5	67.48	7.29	65.8	59.9	78.7	18.8
MortgagetoCredit	5	0.52	0.02	0.52	0.5	0.55	0.04
Interest	5	3.37	1.32	3.07	1.89	5.18	3.29
R_GDP_G	5	1.03	3.87	3.16	-5.03	4.3	9.32
Cons_Prices	5	1.39	1.52	1.36	-0.49	3.44	3.93
Vol_CPI	5	1.09	0.31	0.97	0.82	1.52	0.7
Secondary	5	13.75	9.38	16.82	0	22.27	22.27
Spread	5	1.95	0.29	1.95	1.69	2.4	0.71
Legal	5	7.2	0.45	7	7	8	1
Credit_Inf	5	4	0	4	4	4	0
CapitaltoAssets	5	4.84	0.11	4.8	4.7	5	0.3
Urban	5	84.61	0.23	84.61	84.32	84.91	0.59
GNI_PPP	5	34253	1308.18	34350	32904	35571	2667
Unemp	5	7.06	0.95	7	6.1	8.3	2.2
Development	5	1	0	1	1	1	0
Age_Dependency	5	26.81	0.37	26.72	26.45	27.36	0.91
Pop_Growth	5	0.67	0.18	0.74	0.4	0.85	0.45
House_Price	5	106.12	11.03	110.7	89.8	116.2	26.4

Turkey	n	mean	sd	median	min	max	range
Year	8	2008.5	2.45	2008.5	2005	2012	7
RMD_GDP	8	4.38	1.4	4.4	2	6.1	4.1
MortgagetoCredit	8	0.07	0.01	0.08	0.04	0.08	0.04
Interest	8	15.44	3.26	16.62	11.05	18.63	7.58
R_GDP_G	8	4.5	4.9	5.78	-4.83	9.16	13.98

Table 58: Descriptive Statistics by Country (continued)

Cons_Prices	8	8.64	1.55	8.82	6.25	10.44	4.19
Vol_CPI	8	6.24	7.44	1.75	0.75	20.05	19.31
Secondary	8	0	0	0	0	0	0
Spread	8	6.25	2.51	7.12	2.29	8.8	6.51
Legal	8	4	0	4	4	4	0
Credit_Inf	8	5	0	5	5	5	0
CapitaltoAssets	8	12.34	0.55	12.2	11.7	13.4	1.7
Urban	8	69.47	1.9	69.39	66.84	72.33	5.49
GNI_PPP	8	12357.62	828.59	12303.5	11320	13710	2390
Unemp	8	10.88	1.5	10.45	9.2	14	4.8
Development	8	0	0	0	0	0	0
Age_Dependency	8	10.48	0.27	10.47	10.1	10.88	0.78
Pop_Growth	8	1.27	0.03	1.26	1.24	1.33	0.09
House_Price	6	96.27	10.53	94.25	86	114.7	28.7

UK	n	mean	sd	median	min	max	range
Year	7	2008	2.16	2008	2005	2011	6
RMD_GDP	7	82.04	3.62	83.1	75.7	87.2	11.5
MortgagetoCredit	7	0.42	0.04	0.4	0.38	0.48	0.1
Interest	7	4.76	0.88	5.05	3.62	5.75	2.13
R_GDP_G	7	0.89	3.04	1.66	-5.17	3.43	8.6
Cons_Prices	7	2.89	0.92	2.33	2.05	4.48	2.43
Vol_CPI	7	0.63	0.21	0.64	0.34	0.96	0.62
Secondary	7	8.07	3.56	7.91	1.97	14.1	12.14
Spread	7	1.82	1.48	2.06	-0.83	3.29	4.12
Legal	7	10	0	10	10	10	0
Credit_Inf	7	6	0	6	6	6	0
CapitaltoAssets	7	5.43	0.59	5.4	4.4	6.1	1.7
Urban	7	79.31	0.22	79.31	79.01	79.64	0.63
GNI_PPP	7	33444.14	898.02	33290	32475	34796	2321
Unemp	7	6.29	1.4	5.4	4.7	7.8	3.1
Development	7	1	0	1	1	1	0
Age_Dependency	7	24.72	0.56	24.55	24.17	25.69	1.52
Pop_Growth	7	0.67	0.06	0.66	0.59	0.77	0.18
House_Price	7	104.63	6.26	107.6	94.1	110.9	16.8

B. ADDITIONAL ANALYSES ON THE POTENTIAL OF THE MORTGAGE MARKET

Table 59: Robust Regression Results (RMD_GDP – OLS)

	Value	Std. Error	t value
(Intercept)	342.0331	131.3305	2.6044
R_GDP_G	-13.0758	3.1529	-4.1473
Premium	-3.4752	2.1752	-1.5976
Legal	4.1759	1.7155	2.4342
Urban	0.7359	0.3362	2.1891
Hhold_Size	-31.8101	16.4681	-1.9316
log(Age_Dependency)	-86.9488	26.2672	-3.3102

Table 60: Robust Regression Results (Mortgage-to-Credit – OLS)

	Value	Std. Error	t value
(Intercept)	61.2824	23.1291	2.6496
Urban	0.2913	0.1749	1.6657
Hhold_Size	-20.5918	5.6931	-3.617

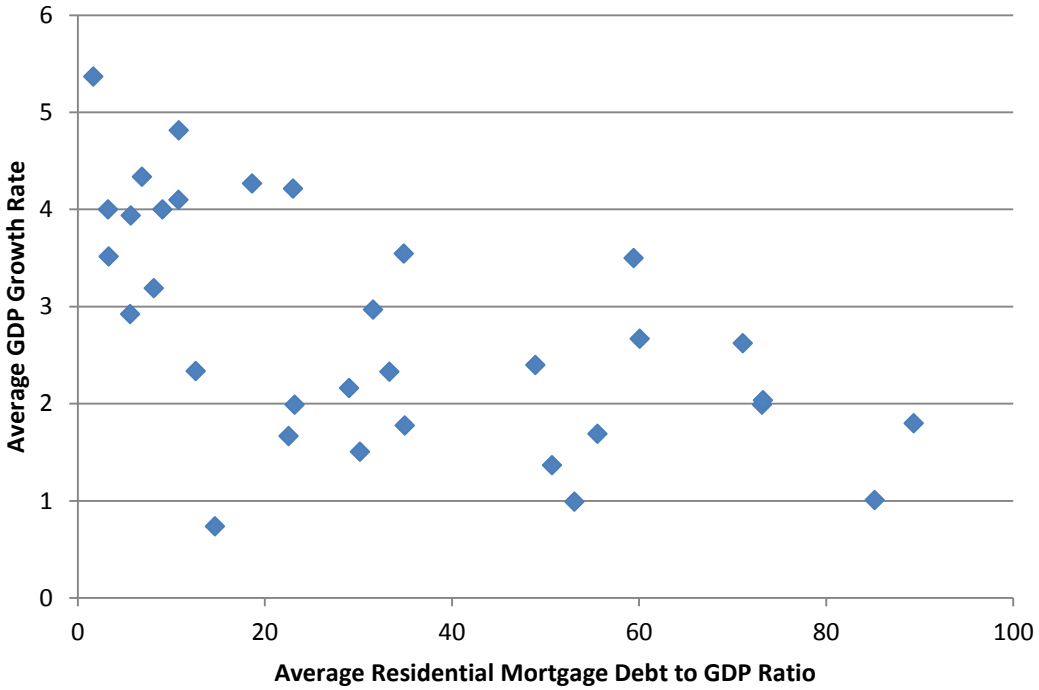


Figure 141: Relationship between Residential Mortgage Debt to GDP and Real GDP Growth Rate (1999-2012 average)

C. ADDITIONAL MODELS ON THE POTENTIAL OF THE MORTGAGE MARKET

In evaluating these analysis, it should be noted that the number of observations drop as the additional variables are inserted into the model. In order to be able to make comparisons, the initial model that is covered in the main text is used on the smaller subset of the whole data (the data that is available after adding the variable with missing values).

Appendix C-1: OLS Results

Credit information, house price index and insurance assets to GDP variables were missing for some countries. The *regsubsets* output that is obtained by using the restricted dataset is given below.

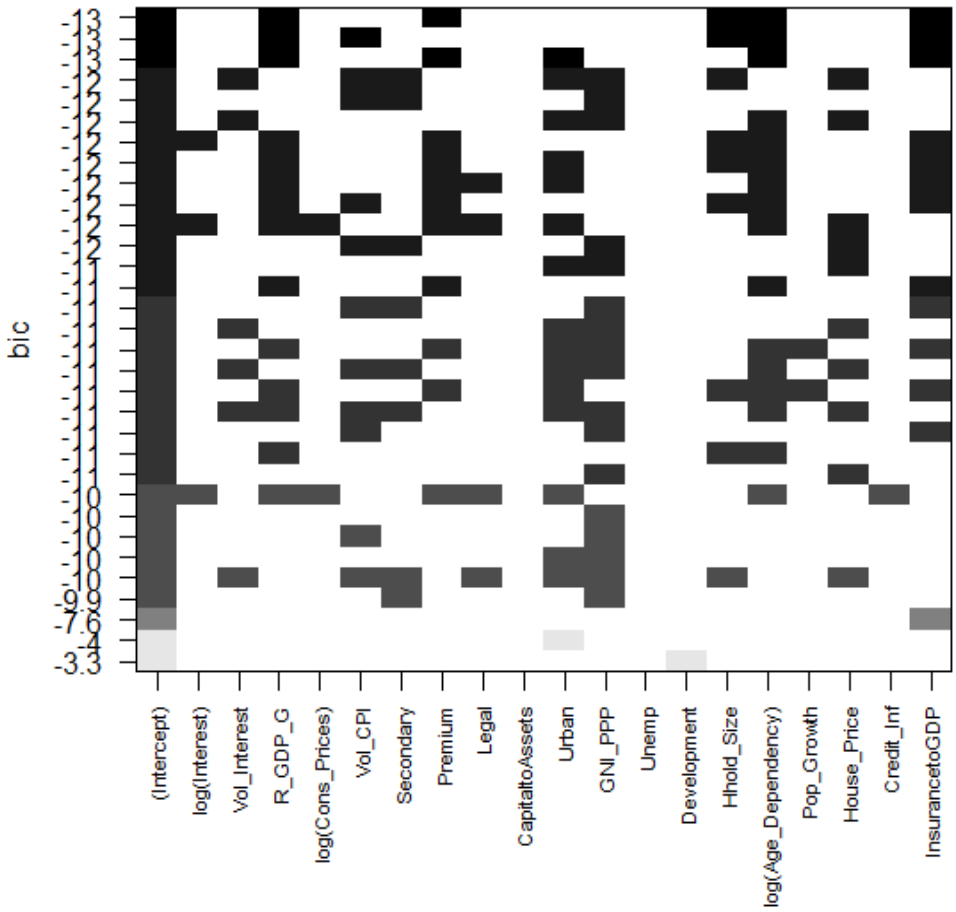


Figure 142: Regsubsets Output with Restricted Dataset (Residential Mortgage Debt to GDP)

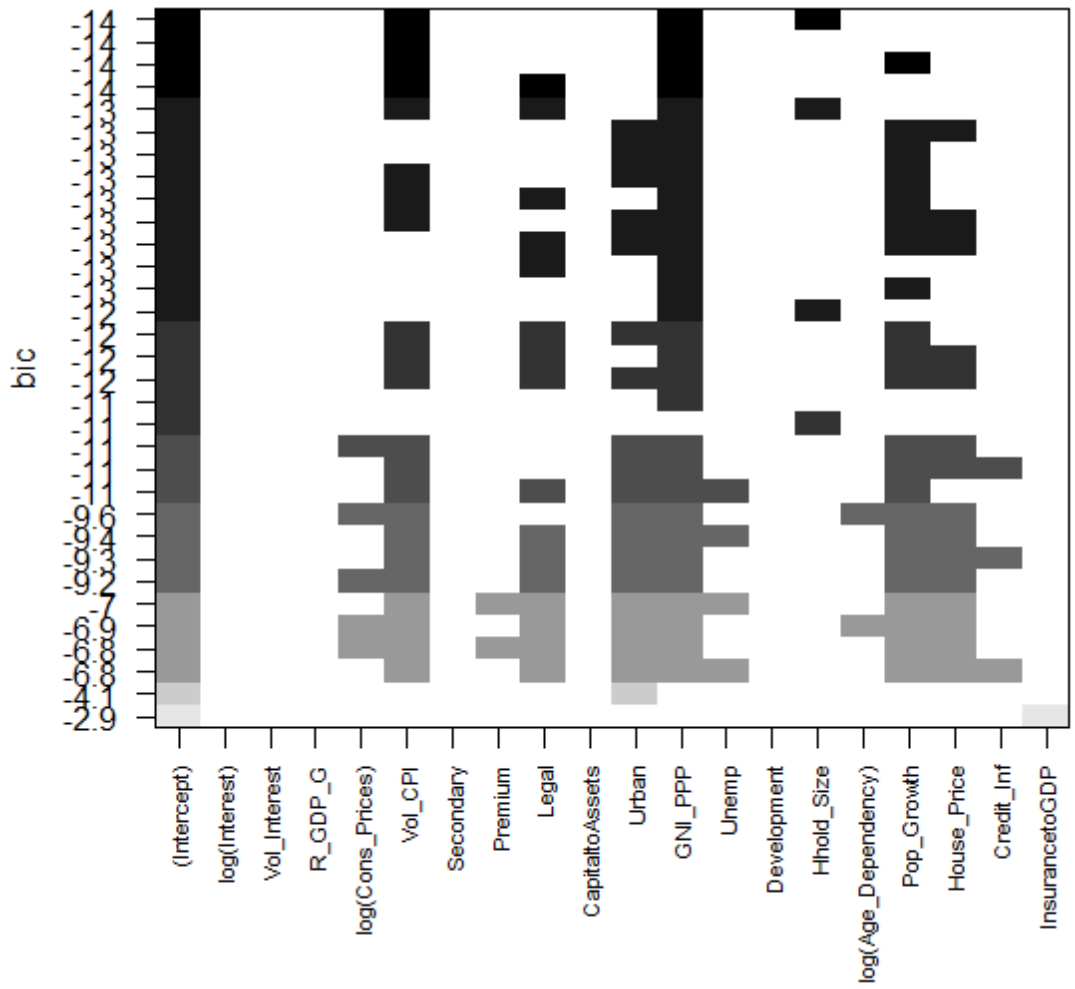


Figure 143: Regsubsets Output with Restricted Dataset (Mortgage Credit to Total Credit)

Appendix C-2: Pooled OLS Results

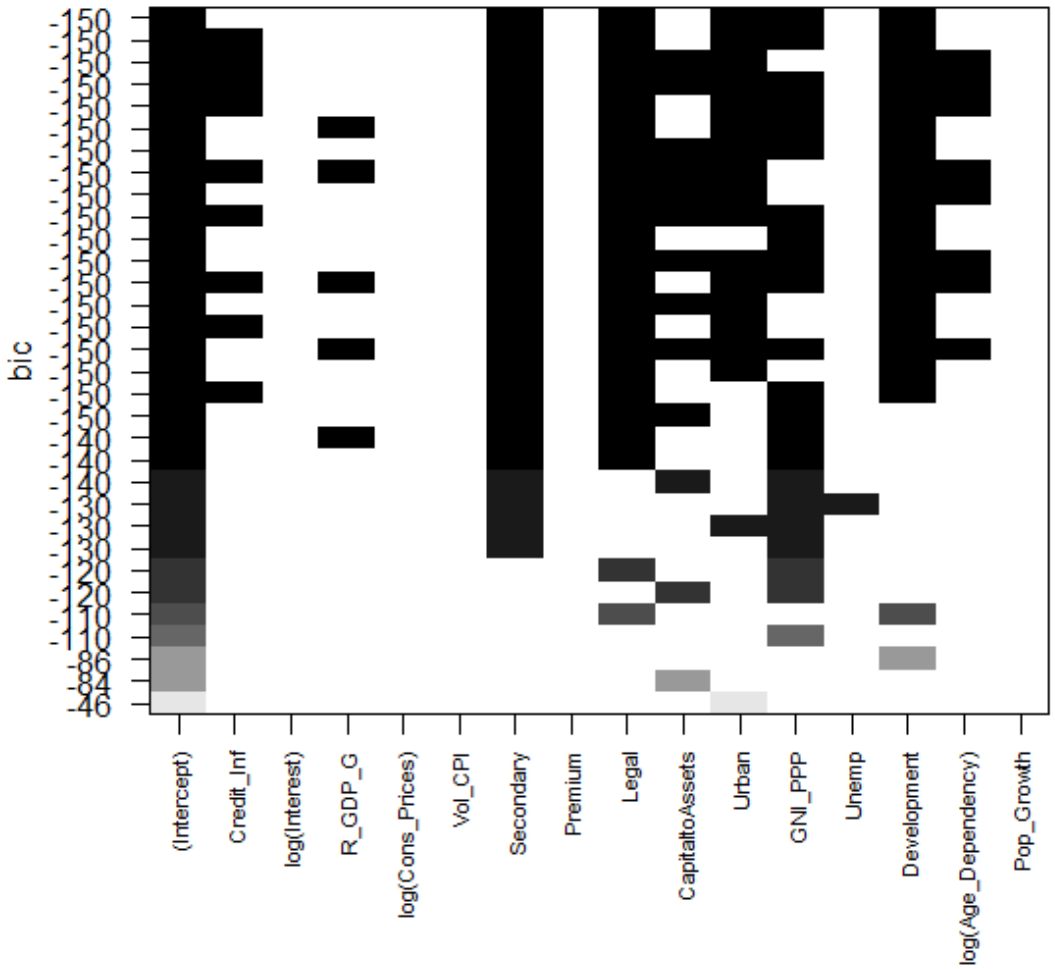


Figure 144: Regsubsets Output with Restricted Dataset (Residential Mortgage Debt to GDP)

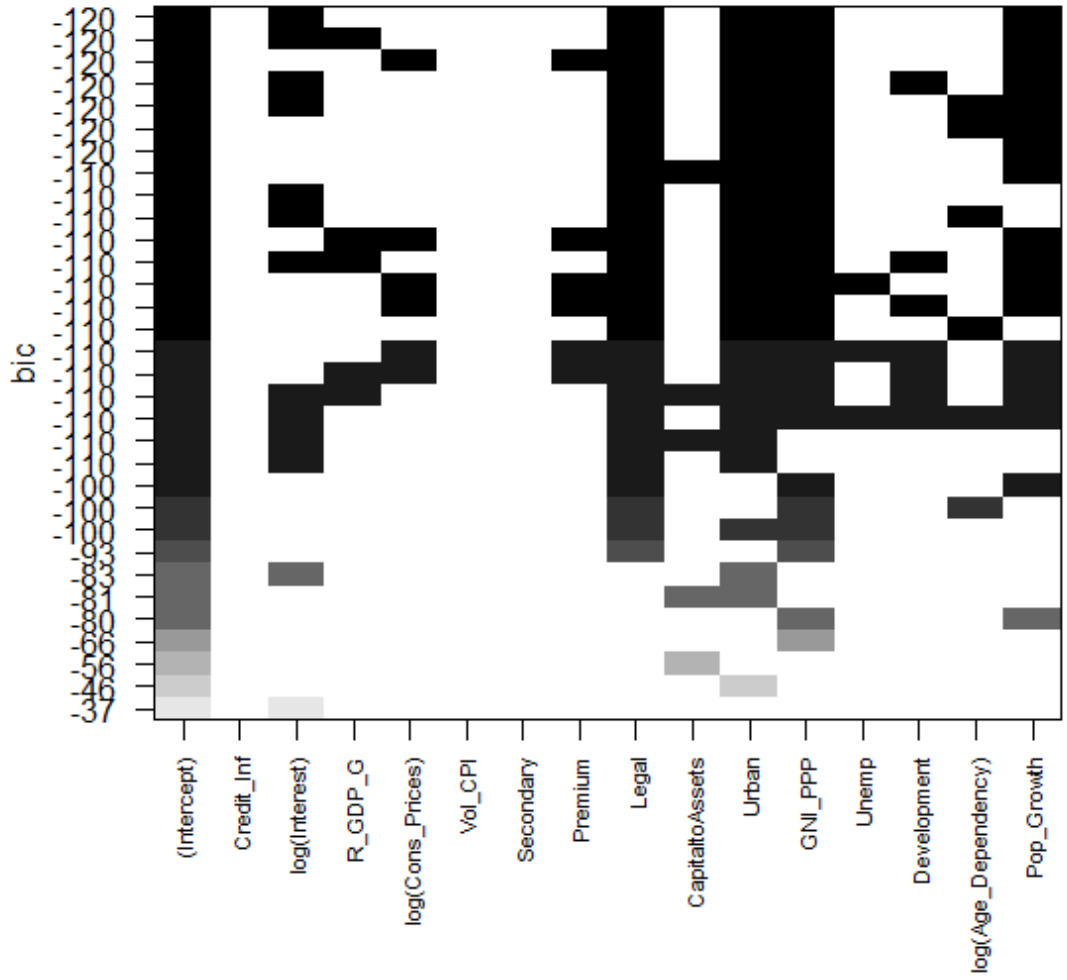


Figure 145: Regsubsets Output with Restricted Dataset (Mortgage Credit to Total Credit)

Appendix C-3: Panel Data Analysis Results

Table 61: Bestglm Output with Restricted Dataset (Residential Mortgage Debt to GDP)

Model	Country	log(Interest)	R_GDP_G	log(Cons_Prices)	Vol_CPI	Secondary	Premium	Legal
1	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
3	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
4	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
5	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
6	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
7	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
8	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE
9	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
10	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE

Model	Credit_Inf	CapitaltoAssets	Urban	GNI_PPP	Unemp	Development	log(Age_Dependency)	Pop_Growth
1	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
2	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
3	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
4	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
5	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	TRUE
6	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE
7	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE
8	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
9	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
10	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE

Table 62: Bestglm Output with Restricted Dataset (Mortgage Credit to Total Credit)

Model	Country	log(Interest)	R_GDP_G	log(Cons_Prices)	Vol_CPI	Secondary	Premium	Legal
1	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
2	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
3	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
4	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE
5	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE
6	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
7	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE
8	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
9	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE
10	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE
	Credit_Inf	CapitaltoAssets	Urban	GNI_PPP	Unemp	Development	log(Age_Dependency)	Pop_Growth
1	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE
2	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
3	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE
4	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE
5	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
6	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
7	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE
8	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE
9	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE
10	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	TRUE

D. COUNTRY FIXED EFFECTS

Table 63: Country Fixed Effects for the Full Model – Residential Mortgage Debt to GDP

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
Austria	-232.700	35.350	-6.583	0.000	***
Belgium	-269.900	45.090	-5.986	0.000	***
Bulgaria	-255.700	37.830	-6.759	0.000	***
Cyprus	-190.100	34.360	-5.534	0.000	***
Czech	-250.000	36.250	-6.898	0.000	***
Denmark	-205.700	40.810	-5.040	0.000	***
Estonia	-224.700	36.030	-6.237	0.000	***
Finland	-251.800	39.760	-6.334	0.000	***
France	-250.500	40.120	-6.245	0.000	***
Germany	-231.400	38.070	-6.078	0.000	***
Greece	-211.700	34.520	-6.132	0.000	***
Hungary	-233.800	36.250	-6.449	0.000	***
Iceland	-188.700	42.650	-4.423	0.000	***
Ireland	-162.000	31.730	-5.105	0.000	***
Italy	-236.900	36.410	-6.508	0.000	***
Latvia	-241.900	36.310	-6.663	0.000	***
Lithuania	-227.500	34.610	-6.573	0.000	***
Luxembourg	-226.500	40.400	-5.607	0.000	***
Malta	-243.700	43.890	-5.553	0.000	***
Netherlands	-174.900	39.260	-4.456	0.000	***
Norway	-207.400	38.240	-5.424	0.000	***
Poland	-222.900	32.930	-6.769	0.000	***
Portugal	-174.000	33.940	-5.125	0.000	***
Romania	-225.700	32.630	-6.918	0.000	***
Russia	-237.500	36.320	-6.540	0.000	***
Slovakia	-208.900	30.500	-6.850	0.000	***
Slovenia	-206.600	31.710	-6.514	0.000	***
Spain	-212.100	37.570	-5.646	0.000	***
Sweden	-225.700	40.500	-5.572	0.000	***
Turkey	-207.500	33.260	-6.239	0.000	***
UK	-206.900	38.700	-5.346	0.000	***

Table 64: Country Fixed Effects for the Final Model – Residential Mortgage Debt to GDP

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
Austria	-258.425	30.339	-8.518	0.000	***
Belgium	-300.472	39.051	-7.694	0.000	***
Bulgaria	-284.253	31.944	-8.898	0.000	***
Cyprus	-215.356	29.478	-7.306	0.000	***
Czech	-276.511	31.112	-8.888	0.000	***
Denmark	-230.773	35.326	-6.533	0.000	***
Estonia	-251.613	30.912	-8.140	0.000	***
Finland	-280.397	34.472	-8.134	0.000	***
France	-278.351	34.565	-8.053	0.000	***
Germany	-257.608	32.630	-7.895	0.000	***
Greece	-235.474	29.478	-7.988	0.000	***
Hungary	-263.912	30.367	-8.691	0.000	***
Iceland	-219.017	37.068	-5.909	0.000	***
Ireland	-184.466	27.387	-6.736	0.000	***
Italy	-262.267	31.217	-8.401	0.000	***
Latvia	-267.900	31.114	-8.610	0.000	***
Lithuania	-254.811	29.651	-8.594	0.000	***
Luxembourg	-256.974	34.506	-7.447	0.000	***
Malta	-274.673	38.221	-7.186	0.000	***
Netherlands	-202.749	33.636	-6.028	0.000	***
Norway	-235.651	32.641	-7.220	0.000	***
Poland	-249.187	27.873	-8.940	0.000	***
Portugal	-197.408	28.890	-6.833	0.000	***
Romania	-250.275	27.233	-9.190	0.000	***
Russia	-268.875	30.788	-8.733	0.000	***
Slovakia	-232.444	26.056	-8.921	0.000	***
Slovenia	-229.746	26.856	-8.555	0.000	***
Spain	-238.344	32.566	-7.319	0.000	***
Sweden	-253.562	34.996	-7.245	0.000	***
Turkey	-240.005	28.215	-8.506	0.000	***
UK	-233.968	33.365	-7.012	0.000	***

Table 65: Country Fixed Effects for the Full Model – Mortgage Credit to Total Credit

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
Austria	26.728	25.404	1.052	0.294	
Belgium	67.580	32.745	2.064	0.041	*
Bulgaria	53.435	27.327	1.955	0.052	.
Cyprus	33.403	24.784	1.348	0.180	
Czech	41.319	26.238	1.575	0.117	
Denmark	63.139	29.539	2.137	0.034	*
Estonia	63.145	26.016	2.427	0.016	*
Finland	57.513	28.721	2.003	0.047	*
France	53.329	29.042	1.836	0.068	.
Germany	50.798	27.431	1.852	0.066	.
Greece	44.124	24.806	1.779	0.077	.
Hungary	54.258	26.199	2.071	0.040	*
Iceland	59.676	30.925	1.930	0.055	.
Ireland	41.622	22.790	1.826	0.070	.
Italy	34.771	26.216	1.326	0.187	
Latvia	51.732	26.168	1.977	0.050	*
Lithuania	55.687	25.030	2.225	0.027	*
Luxembourg	40.594	29.202	1.390	0.166	
Malta	70.901	31.921	2.221	0.028	*
Netherlands	70.501	28.410	2.482	0.014	*
Norway	75.325	27.370	2.752	0.007	**
Poland	43.450	23.741	1.830	0.069	.
Portugal	55.600	24.408	2.278	0.024	*
Romania	22.464	23.412	0.960	0.339	
Russia	44.977	26.358	1.706	0.090	.
Slovakia	31.488	21.947	1.435	0.153	
Slovenia	21.341	22.702	0.940	0.349	
Spain	51.579	27.145	1.900	0.059	.
Sweden	70.684	29.296	2.413	0.017	*
Turkey	44.594	24.175	1.845	0.067	.
UK	52.680	27.907	1.888	0.061	.

Table 66: Country Fixed Effects for the Final Model – Mortgage Credit to Total Credit

	Estimate	Std. Error	t value	Pr(>|t|)	Significance Code
Austria	-19.140	6.900	-2.774	0.006	**
Belgium	2.340	6.201	0.377	0.706	
Bulgaria	6.752	6.204	1.088	0.278	
Cyprus	-13.420	6.770	-1.982	0.049	*
Czech	-7.807	5.206	-1.500	0.136	
Denmark	7.425	7.432	0.999	0.319	
Estonia	17.070	4.991	3.421	0.001	***
Finland	2.441	7.020	0.348	0.729	
France	-3.287	6.064	-0.542	0.589	
Germany	0.414	6.779	0.061	0.951	
Greece	0.908	4.677	0.194	0.846	
Hungary	7.140	5.517	1.294	0.197	
Iceland	-1.578	6.861	-0.230	0.818	
Ireland	-0.495	7.327	-0.068	0.946	
Italy	-12.640	4.936	-2.561	0.011	*
Latvia	8.510	6.605	1.288	0.199	
Lithuania	10.770	4.313	2.497	0.013	*
Luxembourg	-19.320	8.192	-2.358	0.020	*
Malta	7.826	4.334	1.806	0.073	.
Netherlands	14.850	6.618	2.243	0.026	*
Norway	21.420	8.303	2.580	0.011	*
Poland	1.958	5.909	0.331	0.741	
Portugal	13.150	3.999	3.288	0.001	**
Romania	-12.150	6.092	-1.994	0.048	*
Russia	-5.467	4.263	-1.282	0.201	
Slovakia	-6.930	5.966	-1.162	0.247	
Slovenia	-14.960	5.026	-2.977	0.003	**
Spain	-1.213	5.669	-0.214	0.831	
Sweden	14.140	6.857	2.062	0.041	*
Turkey	-5.278	4.549	-1.160	0.248	
UK	0.560	7.905	0.071	0.944	

E. DETAILS ABOUT THE LOAN LEVEL DATA

Table 67: Details about the Data and Manual Changes Applied

Variable	Bank 1	Bank 2	Bank 3	Assessment
Code	-	-	-	A specific code is given to each customer so that comparison with original data will be possible during the course of the study.
Credit_Date	-	-	-	Date was provided in different formats and the data is reformatted accordingly.
Maturity	-	-	Was provided in terms of days. Corrected.	-
Interest_Rate	-	-	-	-
Credit_Amount				
Installment_Amount	-	Installment amount was missing, calculated using data and fixed rate mortgage installment calculation formula.	-	-
Default_Date	Problems in the format is corrected	It was given in a different sheet, matched with relevant exposures.	Inconsistency is observed in default data.	-
Prepayment_Date	-	-	No data is provided	-
Age	-	-	-	-
Gender	-	It was given in a different format, recoded.	-	-
Marital_Status_Current	-	It was given in a different format, recoded.	-	-

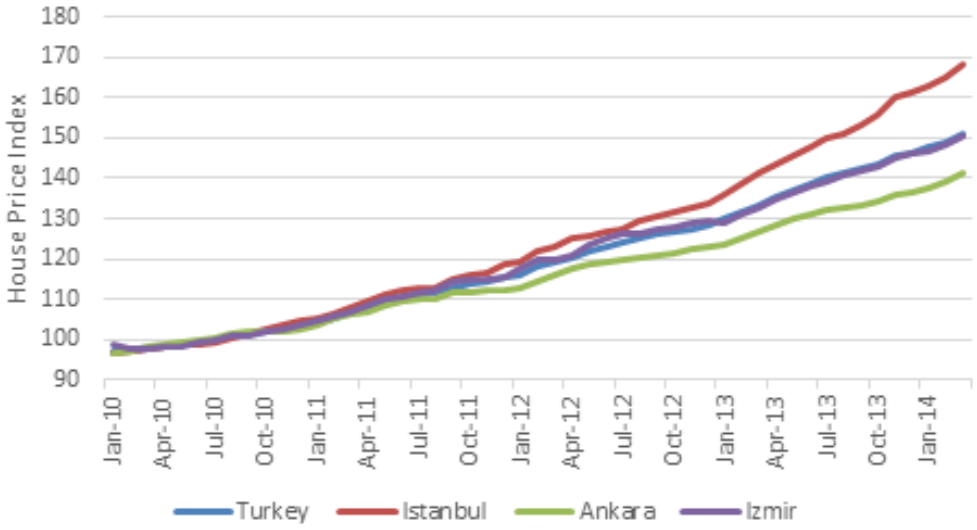
Table 67: Details about the Data and Manual Changes Applied (continued)

Variable	Bank 1	Bank 2	Bank 3	Assessment
Education	-	-	-	Data obtained from all banks were reformatted to align with the current categorization.
Income	-	-	Some crude data is provided, where there were only 2-3 levels of income. Considered missing due to consistency problems.	-
Unemployment	-	-	-	This data could not be provided by any of the banks.
Occupation				Occupation categorization was different at every bank. Data is mapped to relevant categorization.
City	-	-	-	-
Score	-	-	-	Banks have different scoring ranges. Additionally, scoring methodologies of banks changed during the analysis period. Therefore, this data could not be aligned to one scale for all banks.
Purpose	-	-	-	Banks used different indicators and these indicators were aligned with the coding described above.
First_House	Could only be provided by this bank and for small number of observations.	-	-	-
Appraisal_Value	-	-	-	-
LTV	-	Missing for this bank. Calculated from the data using credit amount and appraisal value indicators.	-	-
Lien	Could only be provided by this bank and for small number of observations.	-	-	-

Table 67: Details about the Data and Manual Changes Applied (continued)

Variable	Bank 1	Bank 2	Bank 3	Assessment
Area	-	Missing for this bank.	-	-
C_Age	-	-	Only provided by this bank.	-
Restructuring_Date	Only provided by this bank.			
Delinquency	Provided in a different sheet. Matched with the data.	Provided in a different sheet. Matched with the data.		

F. ADDITIONAL ANALYSIS ON RISKINESS



Data Source: CBRT House Price Index

Figure 146: House Price Indices

Table 68: Occupation Variable – Bank 1

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	p
Poption	-3.828	0.436	0.000	-0.026	0.155	0.870
Poption-Squared	-7.578	1.938	0.000	-2.986	0.930	0.001
Delinquency	1.534	0.074	0.000	0.293	0.042	0.000
Year-2006	0.298	0.101	0.003	-0.027	0.033	0.420
Year-2007	0.444	0.098	0.000	-0.006	0.033	0.870
Year-2008	0.748	0.103	0.000	0.081	0.038	0.036
Year-2009	-0.251	0.143	0.079	-0.234	0.040	0.000
Year-2010	-1.280	0.172	0.000	-0.379	0.039	0.000
Year-2011	-1.018	0.171	0.000	-0.429	0.043	0.000
Year-2012	-1.803	0.316	0.000	-0.584	0.055	0.000
Age	-0.017	0.003	0.000	-0.001	0.001	0.210
Initial Marital Status -Married	-0.094	0.086	0.270	-0.026	0.028	0.350
Marital Status Change - Married	-0.267	0.233	0.250	0.081	0.069	0.240
Marital Status Change - Divorced	0.311	0.712	0.660	0.139	0.227	0.540
log(Credit_Amount)	0.254	0.041	0.000	-0.040	0.016	0.011
Remaining Maturity	0.109	0.008	0.000	-0.065	0.004	0.000
Education -Secondary	-0.105	0.077	0.170	0.082	0.031	0.008
Education -Higher	-0.808	0.092	0.000	0.107	0.032	0.001
Interest Rate	1.651	0.120	0.000	0.418	0.049	0.000
Occupation - Private	0.621	0.099	0.000	0.078	0.023	0.001
Occupation - Self Employed	1.249	0.094	0.000	0.162	0.025	0.000
Likelihood Ratio Test	2510.000			1982.000		
p-value	0.000			0.000		

Table 69: Education Variable – Bank 2

	Default Model			Prepayment Model		
	coef	robust se	p	coef	robust se	p
CEMV	-0.066	0.279	0.810	0.709	0.073	0.000
CEMV-Squared	1.186	0.134	0.000	0.491	0.055	0.000
Poption	-3.816	0.527	0.000	6.172	0.141	0.000
Poption-Squared	-6.619	2.299	0.004	-13.691	0.755	0.000
CLTV	-0.587	0.259	0.023	0.854	0.051	0.000
Year – 2008	0.480	0.097	0.000	0.324	0.023	0.000
Year – 2009	0.111	0.142	0.430	0.443	0.026	0.000
Year – 2010	0.753	0.154	0.000	0.390	0.030	0.000
Year – 2011	0.421	0.171	0.014	0.828	0.033	0.000
Year – 2012	0.962	0.177	0.000	1.295	0.033	0.000
City - Adana	-0.384	0.252	0.130	0.110	0.047	0.019
City - Ankara	-0.524	0.117	0.000	0.140	0.020	0.000
City - Antalya	-0.446	0.138	0.001	0.032	0.028	0.260
City - Bursa	-0.657	0.211	0.002	0.083	0.033	0.014
City - İstanbul	-0.728	0.092	0.000	0.070	0.018	0.000
City - İzmir	-0.750	0.181	0.000	0.254	0.029	0.000
City - Kocaeli	-0.415	0.214	0.052	0.103	0.039	0.008
Delinquency	1.093	0.127	0.000	-0.196	0.030	0.000
log(Income)	0.277	0.062	0.000	0.058	0.014	0.000
Age	-0.017	0.005	0.000	-0.010	0.001	0.000
Gender - Male	-0.067	0.092	0.470	0.041	0.017	0.014
Married	-0.350	0.099	0.000	0.145	0.021	0.000
Occupation - Private	0.940	0.201	0.000	-0.185	0.020	0.000
Occupation - Self Employed	1.327	0.210	0.000	-0.293	0.024	0.000
Remaining Maturity	0.246	0.017	0.000	0.121	0.003	0.000
log(Credit_Amount)	0.830	0.077	0.000	0.269	0.018	0.000
Marital Status Change - Married	-0.613	0.132	0.000	0.180	0.025	0.000
Marital Status Change - Divorced	-0.138	0.171	0.420	0.094	0.030	0.002
Lien	-0.164	0.151	0.280	0.164	0.022	0.000
Interest_Rate	4.149	0.200	0.000	1.699	0.044	0.000
Education - Secondary	0.081	0.107	0.450	0.116	0.022	0.000
Education - Higher	-0.490	0.126	0.000	0.242	0.024	0.000
Likelihood Ratio Test	1869.000			13482.000		
p-value	0.000			0.000		

Table 70: Summary of Default Models

	Bank 1			Bank 2				
	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
CEMV					-	+	+	
CEMV-Squared								+
Poption	+	-	-	+	+		-	-
Poption-Squared			-					-
CLTV				+	-	-	-	-
Year – 2006	+	+	+					
Year – 2007	+	+	+					
Year – 2008	+	+	+		+	+	+	+
Year – 2009	-	-	-		-	-		
Year – 2010	-	-	-		-	-	+	+
Year – 2011	-	-	-		-	-	+	+
Year – 2012	-	-	-		-	-	+	+
City - Adana							-	-
City - Ankara							-	-
City - Antalya							-	-
City - Bursa							-	-
City - İstanbul							-	-
City - İzmir							-	-
City – Kocaeli							-	
Delinquency	+	+	+				+	+
log(Income)							+	+
Age		-	-				-	-
Gender - Male								
Initial Marital Status - Married							-	-
Occupation - Private							+	+
Occupation - Self Employed							+	+
Remaining Maturity		+	+				+	+
log(Credit_Amount)		+	+				+	+
Marital Status Change -Married							-	-
Marital Status Change - Divorced								
Lien								
Interest_Rate		+	+				+	+
Education -Secondary		-	-					
Education -Higher		-	-					

Table 71: Summary of Prepayment Models

	Bank 1			Bank 2				
	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
CEMV				+	+	+	+	+
CEMV-Squared								+
Poption	+	+		+	+	+	+	+
Poption-Squared			-					-
CLTV				+	+	+	+	+
Year – 2006	-	-						
Year – 2007								
Year – 2008		+	+		+	+	+	+
Year – 2009	-	-	-		-	-	+	+
Year – 2010	-	-	-		-	-	+	+
Year – 2011	-	-	-		+	+	+	+
Year – 2012	-	-	-		+	+	+	+
City - Adana							+	+
City - Ankara							+	+
City - Antalya								+
City - Bursa							+	+
City - İstanbul							+	+
City - İzmir							+	+
City – Kocaeli							+	+
Delinquency	+	+	+			-	-	-
log(Income)							+	+
Age							-	-
Gender - Male							+	+
Initial Marital Status - Married		-	-				+	+
Occupation - Private							-	-
Occupation - Self Employed							-	-
Remaining Maturity		-	-				+	+
log(Credit_Amount)							+	+
Marital Status Change -Married							+	+
Marital Status Change - Divorced							+	+
Lien							+	+
Interest_Rate							+	+
Education -Secondary		+	+					
Education -Higher		+	+					

G. CURRICULUM VITAE

PERSONAL INFORMATION

Name	Mahmut KUTLUKAYA
Address	1431. Cad. 10-13 Çukurambar, Çankaya, Ankara, Turkey
Telephone	+90 505 807 08 75
Fax	+90 312 424 08 80
E-mail	mkutlukaya@bddk.org.tr , kutlukaya@gmail.com
Nationality	Turkish
Date of birth	March 1st, 1982

WORK EXPERIENCE

• Dates (from – to)	January 2010-Present
• Name and address of employer	Banking Regulation and Supervision Agency of Turkey (BRSA) Ataturk Bulvarı 191/B Kavaklıdere Ankara Turkey 06680
• Type of business or sector	Governmental Agency – Banking
• Occupation or position held	Coordinator of Basel Committee Subgroups within the BRSA (Regulation Department)
• Main activities and responsibilities	Coordinating over 20 personnel that are representing the BRSA in various Sub-Committees of the Basel Committee on Banking Supervision (BCBS) and reporting directly to the Vice Chairman of the BRSA. -Regularly updating the BCBS on implementation of Basel Standards in Turkey, -Forming the draft BRSA views on BCBS consultative documents, -Preparing intra-agency reports on BCBS related work. Representing the BRSA in the PDG Task Force on Interest Rate Risk in the Banking Book of the Basel Committee on Banking Supervision.

	Represented the BRSA in the SIG Validation Subgroup of the Basel Committee on Banking Supervision (2010-2013). Attended various Financial Stability Board, Standing Committee on Supervisory and Regulatory Cooperation (SRC) meetings on behalf of the BRSA Chairman.
• Dates (from – to)	August 15th , 2009-Present
• Name and address of employer	Banking Regulation and Supervision Agency of Turkey Ataturk Bulvarı 191/B Kavaklıdere Ankara Turkey 06680
• Type of business or sector	Governmental Agency – Banking
• Occupation or position held	Banking Specialist (Risk Management and Regulation Departments)
• Main activities and responsibilities	Member of the international team conducting the Regulatory Consistency Assessment Programme (RCAP[161]) of Canada (Work will be finalized in May 2014). Actively joined preparation of Basel-II-III compliant regulations. Prepared regulation on -Interest rate risk in the banking book (methodology development, impact analysis, designing reporting forms) -Macro-prudential measures to contain excessive credit growth (methodology development, impact analysis, monitoring the effects), -Basel-III capital buffers (methodology, impact analysis), -Systemically important banks (methodology). Actively involved in designing the Pillar-II framework for the BRSA. Designed the regulation on bank's bond issue limits. Prepared several intra-agency research papers; global financial crisis, Basel-II implementation, liquidity risk, stress testing, etc. Actively involved in quantitative impact studies related to Basel-II, Basel-III implementation.

[161] A program that is conducted by the Basel Committee on Banking Supervision which is similar to IMF/Worldbank-FSAP where the focus in RCAP is the compliance of the relevant jurisdictions with Basel Standards.

	Training the BRSA, Central Bank of Republic of Turkey and Capital Markets Board staff on various risk management topics.
• Dates (from – to)	December 15th 2005-August 15th 2009
• Name and address of employer	Banking Regulation and Supervision Agency of Turkey Ataturk Bulvarı 191/B Kavaklıdere Ankara Turkey 06680
• Type of business or sector	Governmental Agency – Banking
• Occupation or position held	Assistant Banking Specialist (Strategy Development and Risk Management Departments)
• Main activities and responsibilities	Contributed to preparation of several external BRSA reports; financial markets reports, structural developments in banking reports, risk bulletins. Evaluating, analyzing and reporting bank's financial soundness and risk profile at the bank level, and sector level. Designed and implemented a data sharing platform with banks (Extranet) for Basel-II implementation.
• Dates (from – to)	September 2005-December 2005
• Name and address of employer	Bilkent University, Ankara
• Type of business or sector	University
• Occupation or position held	Probability Course - Teaching Assistant
• Main activities and responsibilities	Preparation of exams, homeworks, grading, teaching during two recitation hours per week, conducting research.

EDUCATION AND TRAINING

• Dates (from – to)	September 2009-Present Passed the comprehensive exam in 2012.
• Name and type of organisation providing education and training	Department of Economics, Middle East Technical University

• Principal subjects/occupational skills covered	Financial Economics, Microeconomic Theory, Macroeconomic Theory, Econometric Methods, Development Economics Thesis Title: Turkish Mortgage Market: An Assessment of Its Potential and Riskiness
• Title of qualification awarded	Ph.D. in Economics (Candidate) - (CGPA: 3.87/4.00)
• Dates (from – to)	September 2004-September 2005
• Name and type of organisation providing education and training	Department of Statistical Science, University College London, University of London.
• Principal subjects/occupational skills covered	Robust statistics, Stochastic Modeling, Statistical Modeling, Statistical Computing, Bayesian Statistics, Medical Statistics.
• Title of qualification awarded	MSc. in Statistics – Distinction (CGPA: 82/100) Dissertation Topic: Robust Regression Analysis of Store Performance in the UK
• Dates (from – to)	September 1999-June 2004
• Name and type of organisation providing education and training	Department of Statistics, Middle East Technical University
• Principal subjects/occupational skills covered	Principles of Statistics, Principles of Economics, Econometrics, Statistical Data Processing, Calculus, Linear Algebra, Differential Equations, Mathematical Statistics, Applied Statistics, Time Series Analysis.
• Title of qualification awarded	BSc. in Statistics – (CGPA: 3.82/4.00)
• Dates (from – to)	September 2002-June 2004
• Name and type of organisation providing education and training	Department of Industrial Engineering, Middle East Technical University
• Principal subjects/occupational skills covered	Engineering Statistics, Operational Research, Network Flows and Project Management, Simulation.
Title of qualification awarded	Minor Major in Operations Research – (CGPA: 3.59/4.00)

PERSONAL SKILLS AND COMPETENCES

MOTHER TONGUE	Turkish
OTHER LANGUAGES	English TOEFL(IBT)-2014: 107/120 YDS-2015: 90/100
• Reading skills	Proficient
• Writing skills	Proficient
• Verbal skills	Proficient
OTHER LANGUAGES	German
• Reading skills	Beginner
• Writing skills	Beginner
• Verbal skills	Beginner
ORGANIZATIONAL / MANAGERIAL SKILLS	Coordinating over 20 personnel that are representing the BRSA in various Sub-Committees of the Basel Committee on Banking Supervision (BCBS). Intra-agency communication with respect to risk management and BCBS related work. Contact person for the communication with Basel Committee on Banking Supervision. Actively involved in the design and organisation of the International Conference on Banking Supervisors (2012) and Euromoney Eurasia Forum (2013). Representing Turkey (BRSA) in various international platforms and meetings with BRSA counterparts (banks, rating agencies, IMF, other supervisory institutions).
JOB RELATED SKILLS	In depth knowledge on harmonisation of Turkish banking sector regulation with international standards, designing and functionalizing macro-prudential measures, assessing risks, writing internal and external BRSA reports, lecturing in various educational programmes, seminars.

COMPUTER SKILLS

Statistical Programming Languages: R
Statistical/Data Analysis Softwares: SPSS, Minitab
Programming Languages: Matlab
Data Sources: Reuters, Bloomberg
Database: SQL, Business Objects, MS Access
MS Office Applications: Word, Excel, PowerPoint, Outlook
Project Management Package: MS Project

ADDITIONAL INFORMATION

PUBLICATIONS

Kutlukaya, M., Delikanli, I., Uslu Kutlukaya, E., Liquidity Stress Testing in Banks and an Application for Turkish Banking Sector (in Turkish), Iktisat Isletme ve Finans, vol. 28, Nr. 326, 2013.

Kutlukaya, M., Credit Growth in Turkey (in Turkish), Iktisat ve Toplum, vol. 17, pp. 72-77, 2012.

Delikanlı,I, Kutlukaya,M., FX Position Preference of the Real Sector in Turkey and an Evaluation of its FX Risk Awareness from Cost Perspective (in Turkish), Journal of Turkish Bankers Association, March 2012.

Modeling Counterparty Credit Risk, BRSA Dissertation Thesis, 2009.

Yayla,M., Hekimoğlu,A., Kutlukaya,M., Financial Stability of the Turkish Banking Sector, Journal of Banking and Financial Markets, Volume:2, Number:1, 2008.

Hennig, C., Kutlukaya, M., Some Thoughts about the Design of Loss Functions, REVSTAT – Statistical Journal, vol. 5, pp. 19–39, 2007.

Robust Regression Analysis of Store Performance-MSc Dissertation Thesis-2006.

PRESENTATIONS (PERFORMED)

Presentation to the Financial Stability Committee (chaired by Deputy Prime Minister Ali Babacan), RCAP and FSAP Processes of Turkey, February 2015, Ankara.

Presentation to the Financial Stability Committee (chaired by Deputy Prime Minister Ali Babacan), Corporate Sector’s Net FX Position and BRSA’s Actions, January 2015, Ankara.

Presentation to the Heads of Regional Supervisory Agencies on Basel-III and Its Effects to Developing Countries, June 2013, Istanbul.

Presentation to the CEOs of Turkish Banks on the effects of Basel III on Turkish Banking Sector, August 2010, Istanbul.

Paper Presentation, "A Comparative Analysis of the Economic Policies of Turkey and Romania in the Face of the 2008 Global Financial Crisis" at the 11th International Postgraduate Conference 'Crisis: Interruptions, Reactions and Continuities in Central and Eastern Europe' at UCL School of Slavonic and East European Studies, February 2012, London.

PROJECTS

Abolishing Prejudices, EU Funded Youth Project, 2004

CONFERENCES (ATTENDED)

IMF/WorldBank and IIF Annual Meetings (2012, 2013)
International Conference of Banking Supervisors (2012)
Various local conferences in Istanbul and Ankara on banking and risk management

SEMINARS (PERFORMED)

Seminar, "Global Financial Crisis and the Changing Role of Statisticians", METU-Department of Statistics Seminars (December 2012)
Several training sessions and seminars on risk management and Basel-II, Basel-III for;
-Banking Regulation and Supervision Agency, Undersecretariat of Treasury, Capital Markets Board staff.
-Experts of Competent Authorities from Kosovo, Palestine and Kazakhstan
-METU – Statistics Society

HONOURS AND AWARDS

GARP - FRM Certificate Exam – First Quartile in all Fields.
-Credit Risk Measurement and Management
-Market Risk Measurement and Management
-Operational Risk and Integrated Risk Management
-Quantitative Analysis
-Risk and Investment Management
University College London- MSc in Statistics -

Distinction-2005.
University College London-Department of Statistical Science - Richard Berry Price for Best Project (Robust Regression Analysis of Store Performance)-2005.
Ranked first in the National Level Turkish Public Personnel Selection Examination – 2004.
University of York-Canada- MSc in Mathematics and Statistics – Acceptance with Scholarship-2004.
METU – Department of Statistics – Graduated in the First Rank – 2004.
European Commission Jean Monnet Scholarship (2004-2005).

CERTIFICATES

Global Association of Risk Professionals (GARP)-Financial Risk Manager (FRM)-2007.
TOBB-International Accounting Standards Certificate Programme-2007.
Ankara University-ATAUM –The European Union Certificate Programme -2007.

H. TURKISH SUMMARY

Konut finansman sistemi finansal sistem üzerinden fon fazlası olan tarafların fonlarının fon ihtiyacı olan taraflara ev sahipliği sağlanması amacıyla aktarıldığı bir aracılık mekanizmasıdır. Son yıllarda ipotek teminatlı konut finansman sistemlerinin geliştirilmesi gerekliliği sıkça vurgulanır hale gelmiştir. Ancak, günümüzde dünya nüfusunun yaklaşık üçte biri gecekondularda yaşamaktadır ve iyi çalışan bir konut finansman sisteminin bulunmaması nedeniyle yaşanabilir konutlar nüfusun geniş bir kısmı için ne ulaşılabilir ne de yeterli durumdadır (Warnock ve Warnock, 2008).

Son yıllarda finansal piyasalardaki büyümeye paralel şekilde, ipotek teminatlı konut finansmanı piyasaları da önemli değişimler göstermiştir. Bu süreçte, ürün çeşitliliği ve piyasa derinliğinde hızlı bir büyüme görülmüştür. Değişken faizli ve sabit faizli konut kredileri piyasada en yaygın şekilde kullanılan ürünler olmakla birlikte, gelişmiş ülke piyasalarında çok sayıda farklı ürün de görmek mümkündür. Örneğin, menkul kıymetleştirme (ikincil piyasa) piyasalarının gelişmesiyle ipotek teminatlı konut kredisi varlık havuzları üzerine kurulu pek çok ürün oluşturulmuştur.

Çeşitli ülkelerdeki ipotek teminatlı konut kredisi stokunun gayrisafi yurtiçi hasılaya oranı incelendiğinde bahse konu oranın gelişmiş ülkelerin çoğunda %20 seviyesinin üzerinde olduğu görülmüştür. Danimarka ve Hollanda gibi ülkelerde söz konusu oran %100 seviyesindedir. Avrupa Birliğine yeni katılan bazı Orta ve Doğu Avrupa ülkelerinde bu oranın 2000 yılında %5 seviyesinden 2007 yılında %25 seviyesine ulaştığı görülmüştür (Beck ve diğerleri, 2010). Dolayısıyla uygun altyapı oluşturulduktan sonra ipotek teminatlı konut finansmanı sistemlerinin çok hızlı büyüme gösterebildiği anlaşılmaktadır.

Günümüzde konut politikası ve bu kapsamda ipotekli konut finansmanı piyasalarının önemi büyük ölçüde kabul edilmiştir. Konut politikası, daha özelde ipotekli konut

finansmanı piyasasına ilişkin politika hükümetler için ekonomik ve sosyal yönleri dolayısıyla oldukça önemlidir. İpotek teminatlı konut kredisi, konutun teminat olarak alınması suretiyle kredi tahsisi yapılan ve kredi müşterisinin geri ödemelerini sözleşme şartlarına uygun olarak yapmaması durumunda (temerrüt) borç verene teminat olan konutu satmak dâhil muhtelif haklar tanıyan bir kredi türüdür. İpotekli konut finansmanı piyasaları ise sadece gelişmiş ülkeler için değil, Türkiye gibi gelişmekte olan ülkeler için de büyük önem arz etmektedir. Gelişmekte olan ülkeler bakımından ipotekli konut finansmanı piyasalarının önemi daha çok yoksullukla mücadele ve ev sahipliği oranının arttırılması gibi hedeflerden kaynaklanmaktadır. Gelişmiş ülkelerde ise güncel politika tartışması makro-ihtiyatlı araçlara ve bu kapsamda ipotekli konut finansmanı piyasasının konjonktür karşıtı olarak kullanılması üzerine odaklanmaktadır.

Bu tezde Türkiye ipotekli konut finansmanı piyasasına ilişkin yazın bahse konu önem dikkate alınarak incelenmiştir. Çalışma sonuçları söz konusu yazının oldukça sığ olduğunu göstermektedir. Tezde sunulan analizler ve değerlendirmeler, iki ana başlık altında ele alınabilecek hususlardaki soruları cevaplamayı hedeflemektedir; Türkiye ipotekli konut finansmanı piyasasının potansiyeli ve bu piyasanın riskliliği.

Son yıllarda Türkiye'de faiz oranlarının düştüğü, konut fiyatlarının yükseldiği ve hanehalkı borçluluk oranlarının arttığı gözlemlenmektedir. Ayrıca, kentleşme trendi ve hanehalkı sayısının yüksekliği gibi faktörler ipotek teminatlı konut piyasasının gelişmesini destekleyebilecek unsurlardır. Dolayısıyla önümüzdeki yıllarda bu piyasanın gelişmesi beklenmekledir.

Diğer taraftan, ipotek teminatlı konut kredilerinin temerrüdü sadece borç veren finansal kuruluşlar ve borç alan müşteriler açısından değil, merkez bankaları ve finansal sektör denetim kuruluşları açısından da önem arz etmektedir. Geçmiş örnekler bu piyasanın önemli sosyal etkileri olabileceğini göstermiştir. Özellikle global finansal kriz döneminde düşen konut fiyatlarının temerrüt oranlarını önemli ölçüde arttırabildiği, bunun da konut sektörüne yatırımları daha da kısarak bu sektör için sağlanan fonların azalmasına neden olmak suretiyle bir kısırdöngü yaratarak

finansal istikrarı tehlikeye atabildiği görülmüştür. Bu kapsamda ulusal otoritelerin ipotek teminatlı konut finansmanı piyasasını finansal istikrar perspektifi ile yakından takip etmesi oldukça önemlidir.

İpotek teminatlı konut kredisi kullandırımı finansal kuruluşlar açısından pek çok riskin oluşmasına da neden olmaktadır. Bunlardan en önemli ikisi kredi (temerrüt) ve erken ödeme riski olarak sayılabilir. Kredi riski borçlunun yükümlülüklerinin sözleşme hükümleri çerçevesinde yerine getirememesi nedeniyle zarar oluşması ihtimali olarak tanımlanabilir. İpotek teminatlı konut kredilerinde kredinin teminatı olarak konut bulunduğunda bu krediler düşük riskli olarak sayılmakta ve Basel sermaye standardı kapsamında avantajlı bir risk ağırlığına tabi tutulmaktadır. Kredi riskine ilişkin analizlerde beklenen kayıp ve beklenmeyen kayıp dikkate alınması gereken iki önemli konsepttir. Beklenen kayıp kredi portföyü nedeniyle ortaya çıkabilecek muhtemel zarar olarak tanımlanmaktadır ve bu unsur genel olarak kredi fiyatlamasının bir parçasıdır. Diğer taraftan, beklenmeyen kayıp ise beklenen tutarların çok ötesine geçebilen ekstrem zararlar olarak tanımlanabilir. Finansal kuruluşlar bu kayıplarla karşı karşıya kalacaklarını bilmekte ancak bunun zamanlamasını ve büyüklüğünü kestirememektedir (BCBS, 2005i:2). Bankaların beklenen zararları karşılayacak düzeyde genel karşılık bulundurmaları, beklenmeyen zararlarla karşılaştıklarında da faaliyetlerine devam edebilmeleri için yeterli bir sermaye yeterliliği seviyesinde faaliyetlerini sürdürmeleri gerekmektedir.

Erken ödeme riski ise kullanılan kredinin sözleşmeden belirtilen zamandan önce tamamen geri ödenmesi şeklinde tanımlanabilir (Krainer ve Laderman, 2011). Erken ödemenin iki temel nedeni olabilmektedir. Bunlar; temin edilen konutun satılması ve yeniden finansman şeklinde sıralanabilir. Kredi ve erken ödeme riskine ilave olarak finansal kuruluşlar ipotek teminatlı konut kredisi kullandırımı kaynaklı pek çok risk ile karşı karşıya kalmaktadır. Bu riskler operasyonel risk, likidite riski, yasal risk olarak sayılabilir. Tezde kredi riski ve erken ödeme riskine odaklanılmış olup sayılan diğer riskler dikkate alınmamıştır.

Finansal kuruluşlarca tutturulması gereken sermaye yeterliliği rasyolarına ilişkin standart belirleme açısından tek yetkili otorite Basel Bankacılık Denetim Komitesidir (BCBS). BCBS'e üye olmayan ülkelerce söz konusu standartların uygulanmasına dönük bir zorunluluk bulunmamakla birlikte, BCBS tarafından yayımlanan Basel-I ve Basel-II standartlarının 100'den fazla ülkede kabul edilerek uygulanmış olduğu görülmektedir. Türkiye ise 2009 yılında BCBS'in üyesi olmuştur.

Basel I, BCBS tarafından 1988 yılında oluşturulan ilk sermaye yeterliliği standardıdır ve bu standart bankalarca sadece kredi riskine ilişkin sermaye bulundurulması zorunluluğu getirmiştir. 1996 yılında Basel-I standardına piyasa riski entegre edilmiştir. 1999 yılında yürütülmeye başlanan bir programın sonucu olarak ise 2006 yılında Basel-II sermaye yeterliliği standardı yayımlanmıştır (BCBS, 2006). Basel-II, kredi ve piyasa riskinin yanı sıra operasyonel risk için de sermaye bulundurulması zorunluluğu getirmiştir.

Basel-II ile Basel-I standardının içeriği kapsamlı biçimde değiştirilmiştir. Yeni çerçevede finansal kuruluşlara taşıdıkları riskleri en iyi ölçebilecek yaklaşımı seçme fırsatı tanınmış, faaliyetleri karmaşık olmayan bankaların standart yaklaşımları, diğer bankaların ise gelişmiş yaklaşımları kullanmaları öngörülmüştür. Global finansal kriz sonrasında ise Basel-II çerçevesindeki sorunları gidermeye dönük olarak Basel-II.5 ve Basel-III standartları yayımlanmıştır. Bahse konu Basel-II.5 ve Basel-III standartlarının tez çalışmasının kapsamı ile doğrudan ilişkisi olmadığından bu standartlar tezde ele alınmamış, sadece bu standartların varsa ilgili hükümlerine referans verilmiştir.

Basel standartlarının ipotek teminatlı konut kredileri açısından önemi belirtilen krediler için öngörülen risk ağırlıklarından kaynaklanmaktadır. Basel-I çerçevesinde tüm kredi türleri %100 risk ağırlığına tabi tutulurken, ipotek teminatlı konut kredileri için avantajlı %50 risk ağırlığı getirilmiştir. Basel-II ise standart yaklaşım altında bu kredilere %35 risk ağırlığı uygulanmasına izin vermiştir. İçsel Derecelendirme Bazlı

yaklaşımı kullanan bankalar ise portföylerinden kaynaklı kredi riskini modelleyerek tutulması gereken sermaye miktarını kendileri hesaplamaktadır.

Genel karşılık oranlarının belirlenmesi ve genel karşılık ayrılması ise daha çok muhasebe standartları ile ilişkilidir. Uluslararası Muhasebe Standartları 39 ve bu standardın Türkiye uygulaması olan Türkiye Muhasebe Standartları 39 geriye dönük bir bakış açısı ile gerekli karşılık oranlarının belirlenmesini öngörmektedir. Global finansal kriz sonrası dönemde ise 2017 yılından itibaren uygulanmak üzere IFRS 9 standardı oluşturulmuştur. Bu standart belirtilen geriye dönük bakış açısını kaldırmakta ve karşılık gereksinimlerini beklenen kayıp ile ilişkilendirmektedir (BCBS, 2015).

Bu tez Türkiye ipotekli konut finansmanı piyasasının, Avrupa bölgesi çerçevesinde potansiyelinin ortaya konulmasına, ipotekli konut finansmanına ilişkin temerrüt ve erken ödeme gibi sona erme risklerinin ele alınmasına ve son olarak da ipotekli konut finansmanı piyasasına ilişkin ulusal otoritelerce belirlenmiş olan güncel politika tercihlerinin kapsamlı bir biçimde değerlendirilmesine yönelik bir girişimdir. Mevcut çalışma öncelikle makroekonomik bir perspektifle Türkiye ipotekli konut finansmanı piyasasının potansiyelini 31 Avrupa ülkesinin verilerini kapsayan bir model üzerinden incelemektedir. İkinci olarak ise çalışmada mikroekonomik bir yaklaşım sunulmakta ve indirgenmiş form modeller vasıtasıyla temerrüt ve erken ödeme riskleri eşanlı olarak modellenmektedir. Bu tezin Türkiye ipotekli konut finansmanı piyasasının potansiyelini mukayeseli olarak ele alan ve indirgenmiş form modelleri vasıtasıyla ipotekli konut finansmanı piyasasına ilişkin erken sona erme risklerini kredi düzeyinde veri ile inceleyen ilk çalışma olduğu değerlendirilmektedir.

Tezin ikinci bölümünde ipotekli konut finansmanı piyasalarına ilişkin bazı temel bilgilere yer verilmiştir. Ayrıca piyasadaki ürünler nedeniyle finansal kuruluşların karşı karşıya kalabileceği riskler ele alınmıştır. Diğer taraftan, Basel Bankacılık Denetim Komitesince yayımlanan standartlar ile finansal raporlama standartlarının bu çalışmayı ilgilendiren yönleri yine söz konusu bölümde tartışılmıştır.

Üçüncü bölüm temel olarak Türkiye ipotekli konut finansmanı piyasasının potansiyeli üzerine odaklanmaktadır. Bahse konu çalışma üç sacayağı üzerine inşa edilmiştir. Bunlar; Türkiye ipotekli konut finansmanı piyasasının tarihi gelişiminin ele alınması, geçmişte hızlı büyüme yaşayan gelişmekte olan ekonomilerin incelenmesi ve bu analizleri desteklemek üzere bir karşılaştırmalı değerlendirme modeli oluşturulması şeklinde sıralanabilir.

Türkiye ipotekli konut finansmanı piyasasının potansiyeline ilişkin bu tezin ilgilendiği temel soru önümüzdeki dönemde Türkiye ipotek teminatlı konut finansmanı piyasasının önemli bir büyüme potansiyeline sahip olup olmadığıdır. Pek çok gelişmiş ve gelişmekte olan piyasasının derinlik olarak gerisinde kalmış olan Türkiye piyasası bu kapsamda kapsamlı biçimde ele alınmıştır. Bu değerlendirme sırasında ise iki soruya cevap aranmıştır; a) ipotekli konut finansmanı piyasalarının gelişmesinin arkasındaki faktörler nelerdir? b) Türkiye ipotekli konut finansmanı piyasasının geliştirilmesi için neler yapılabilir?

Bahse konu bölüm kapsamında Türkiye ipotekli konut finansmanı piyasasının geçmişi, Türkiye Cumhuriyetinin kuruluşundan günümüze kadar süreçteki konut politikası da değerlendirilerek ele alınmıştır. Bu kapsamda piyasanın gelişmesine etki edebilecek ve konut politikası açısından önem arz eden önemli kanun ve düzenlemelere yer verilmiştir. Daha sonra seçilmiş ülkelerdeki (Malezya, Şili, Kore ve Güney Afrika) ipotekli konut finansmanı piyasalarının gelişimi, söz konusu ülkelerde piyasa gelişimini etkileyen önemli unsurlar üzerinden incelenmiştir. Son olarak ise 31 Avrupa ülkesine ilişkin veriler üzerinden bir karşılaştırmalı değerlendirme modeli oluşturulmuş, oluşturulan model tarafından ortaya konulan eşik (frontier) ile piyasanın mevcut durumu ve belirli senaryo analizleri kapsamında piyasanın ulaşabileceği büyüklük dikkate alınarak çeşitli analizler gerçekleştirilmiştir. Belirtilen analizlerin gerçekleştirilmesi için gerekli olan temel piyasa derinliği (ipotek teminatlı konut finansmanı sistemi büyüklüğün gayri safi yurtiçi hasılaya oranı) verisi Avrupa İpotek Teminatlı Konut Finansmanı Federasyonunca yayımlanan Hypostat yayınlarından temin edilmiştir. Ayrıca,

modellerde kullanılan diğer değişkenler Dünya Bankası, Ekonomik Kalkınma ve İşbirliği Örgütü ve Uluslararası Para Fonu gibi çok sayıda kuruluşun veri tabanından veya yayınlarından derlenmiştir. İpotek teminatlı konut finansmanı piyasalarının derinliğinin modellenmesinde teorik bir çerçeve bulunmamaktadır. Tezde konuya ilişkin daha önce gerçekleştirilmiş olan çalışmalardan farklı olarak değişken seçimine ilişkin bir yaklaşım sunulmuştur.

Tezin ikinci ana başlığı olan Türkiye ipotekli konut finansmanı piyasasının riskliliğine ilişkin olarak ise üç farklı ticari bankadan alınan ipotekli konut finansmanı verisi üzerinden değerlendirmelerde bulunulmuştur. Bahse konu üç bankadan ikisi özel ticari banka biri ise katılım bankasıdır. Söz konusu bankalarca 2002 yılına kadar uzanan bir dönemi kapsayan geniş bir veri seti sağlanmıştır. Ancak yabancı para cinsinden kullandırılan krediler ile değişken faizli krediler çalışma kapsamı dışında tutulmuştur.

Tezin muhtelif bölümlerinde finansal kuruluşlarca tutulması gereken sermaye ve karşılıklar ile alınan riskler arasında hassas bir denge kurulması gerekliliğine vurgu yapılmıştır. Daha açık ifade etmek gerekirse, risklerin olduğundan daha düşük tahmin edilmesi bir finansal kuruluşun temerrüdüne neden olabilecekken, olduğundan daha yüksek tahmin edilmesi ise finansal kuruluşlarca ekonomiye gerekenden daha az kredi arz edilmesine ve dolayısıyla sektörün daha az kar edip daha az büyümesine ve bu durum da ekonomik büyümede yavaşlamaya neden olabilecektir. Bu nedenle, finansal sisteme ilişkin politika tercihlerinin risklilik göz önünde bulundurularak gözden geçirilmesi büyük önemi haizdir. Bu çerçevede dördüncü bölümde yer alan analizler ipotek teminatlı konut finansmanı sistemini doğrudan etkileyen risk ağırlıkları, karşılık oranları ve erken ödeme cezası gibi pek çok politika aracının uygunluğuna odaklanmaktadır. Bir diğer ifade ile tezin bu bölümünde şu sorulara cevap aranmaktadır; a) Türkiye ipotekli konut finansmanı sisteminde temerrüt ve erken ödeme risklerinin belirleyicileri nelerdir? b) mevcut düzenlemeler piyasanın etkin biçimde işlemesi için uygun mudur? İkinci soruya ilişkin analizlerde bankaların sermaye yeterliliği ve karşılık mevzuatı ile erken ödeme cezaları dikkate alınmıştır. Bu minvalde cevap aranan sorular şu şekilde

sıralanabilir; i) mevcut uygulamadaki %1'lik genel karşılık oranı uygun mudur? ii) mevcut uygulamadaki ipotek teminatlı konut kredileri için öngörülmüş olan %50 risk ağırlığı uygun mudur? iii) Tüketici Yasası ile getirilmiş olan ve kredinin vadesine 36 aydan az kalmış olması durumunda %1, 36 aydan fazla kalmış olması durumunda ise %2 şeklinde belirlenmiş olan erken ödeme cezaları uygun mudur?

Rakip riskler olarak değerlendirilebilecek temerrüt ve erken ödeme riski için yazında sağkalım analizleri yoğun şekilde kullanılmaktadır. Bu nedenle dördüncü bölüme ilişkin analizler sağkalım analizi yöntemi ile gerçekleştirilmiştir. Modellemeye geçmeden önce ise veri seti model Geliştirme ve doğrulama örneklemleri olmak üzere iki eşit parçaya ayrılmıştır. Doğrulama örneklemi muhtelif modellerin örneklem dışı performanslarının ölçülmesine olanak tanımıştır. Model performanslarının ölçülmesinde bir yıllık temerrüt ve erken ödeme olasılıkları üzerinden hesaplanan İşlem Karakteristik Eğrisi kullanılmıştır. Daha sonra Basel-II'nin kredi riskinin ölçümünde öngördüğü gelişmiş yaklaşım olan İçsel Derecelendirmeye Dayalı Yaklaşıma ilişkin risk ağırlıklandırma fonksiyonu kullanılarak ipotek teminatlı konut kredileri nedeniyle tutulması gereken sermaye miktarı ve yine aynı portföyler kapsamında tutulması gerekli olan genel karşılık oranları hesaplanmış, bu hesaplamalar ile mevcut düzenlemeler karşılaştırılarak çeşitli politika önerileri geliştirilmiştir. Son olarak ise geçmiş ortaya çıkan faiz oranı değişimleri kaynaklı erken ödeme zararlarının ortaya çıkardığı ekonomik zararlar incelenerek erken ödeme cezasının uygunluğu değerlendirilmiştir.

Tez çalışması sonucunda ortaya konulan temel sonuçlar şu şekilde özetlenebilir; i) Türkiye ipotekli konut finansmanı piyasası önemli bir büyüme potansiyeline sahiptir, ii) Türkiye ipotekli konut finansmanı piyasasında temerrüt olasılığı düşüktür ve bu nedenle temerrüt olasılığı ile ilişkili politika tercihlerinin aşırı ihtiyatlı olduğu sonucuna ulaşılmıştır. Ayrıca erken ödeme riskinin oldukça yüksek olduğu tespit edilmiştir.

Türkiye ipotekli konut finansmanı piyasasının potansiyeline ilişkin analizler Türkiye'nin diğer Avrupa ülkeleri ile kıyaslandığında düşük bir eşik değerine sahip olduğunu ortaya koymaktadır (GSYH'nin %10'u kadar). Bunun da ötesinde,

piyasanın mevcut derinliği bu eşik değerin de gerisindedir (GSYH'nin %6'sı). Buna ilave olarak piyasanın büyüyen ekonomi, artan kentleşme ve düşen hane halkı sayıları gibi faktörler nedenleriyle önemli bir büyüme potansiyeline sahip olduğu değerlendirilmiştir. Yapılan senaryo analizleri ise ipotekli konut finansmanı piyasasının derinliğinin önümüzdeki 10 yıllık dönemde en muhtemel/olası senaryo altında %20-%30 gibi bir orana ulaşabileceğini, bir diğer ifadeyle 3-5 kat büyüme gösterebileceğini ortaya koymuştur.

Üçüncü bölümde sunulan modeller dikkate alındığında, gelişmekte olan ülkelerdeki politika belirleyicilerin ipotek teminatlı konut finansmanı piyasasının geliştirilmesi için kredi kullandırımı, tüketicinin korunması ve borç veren kuruluşların haklarının korunması bağlamında hukuki ve düzenleyici altyapının geliştirilmesine odaklanması gerektiği değerlendirilmiştir. Ayrıca, planlı kentleşmenin de ipotekli konut finansmanı piyasasının gelişmesinde önemli olduğu tespitine yer verilmiştir.

Türkiye'de konut finansmanına 90'lı yıllara kadar daha çok kamu kurumlarınca aracılık edilmiştir. Günümüzde ise pek çok banka ipotek teminatlı konut kredisi kullandırmaktadır. Son yıllarda sağlanan makroekonomik stabilite ve düşen faiz oranları neticesinde bahse konu piyasada önemli büyüme görülmüştür. Ancak ipotek teminatlı kredi stoku/GSYH oranı halen %6 civarında ve gelişmiş pek çok ülkenin gerisindedir.

Ülke örnekleri incelendiğinde, her bir ülkede belirli karakteristiklerin söz konusu piyasanın büyümesine önemli destek verdiği görülmüştür. Örneğin, Malezya'da iyi yapılandırılmış bir ikincil ipotek teminatlı konut finansmanı sistemi birincil piyasanın gelişimine önemli katkı sağlamıştır. Şili ve Güney Afrika gibi ülkelerde sosyal yardım programları ipotek teminatlı konut finansmanı sistemindeki büyümenin motoru olmuştur. Kore örneğinde ise hızlı kentleşme süreci bu gelişimi destekleyen ana etken konumundadır.

Gelişmekte olan ülke örnekleri ipotek teminatlı konut finansmanı sisteminin geliştirilmesinde ve piyasada istikrarın sağlanmasında devlet desteğinin önemine vurgu yapmaktadır. Türkiye özelinde gerçekleştirilmiş çalışmalarda da devlet desteği vurgusu sıkça yapılmaktadır. Özellikle ikincil piyasanın kurulması sürecinde

bu desteğin gerekli olduğu görülmektedir. İpotekli konut finansmanı piyasasının derinleşmesine ilişkin yazın da ikincil piyasanın önemine vurgu yapmakta olup bu değerlendirmeler üçüncü bölümde sunulan modellerle de kısmi olarak desteklenmektedir.

İkincil piyasanın geliştirilmesi finansal kuruluşların daha fazla fon sağlamasına yardımcı olabilecektir. Ülkemiz tasarruf oranlarının mevcut düzeyi dikkate alındığında bahse konu fonlamaya gelecekte duyulacak ihtiyaç daha net görülebilecektir. Türkiye'de ipotek teminatlı konut finansmanı sistemine ilişkin ikincil piyasa henüz yeni oluşma sürecindedir. Diğer taraftan, ikincil piyasanın oluşturulabilmesi için derin ve sağlam bir birincil piyasa oluşumuna ihtiyaç bulunmaktadır. Konut Finansmanı Kanununun yardımı ile bu alanda önemli mesafe kat edilmiştir ancak mevcut birincil piyasa derinliğinin ikincil piyasanın oluşumu için yeterli olmadığı görülmektedir. Yazın ve ülke örnekleri bu noktada devlet desteğine ihtiyaç bulunduğuna işaret etmektedir. Bu kapsamda ulusal otoritelerce böyle bir devlet desteğinin fayda ve olası zararlarının analizinin yapılarak politika oluşturulmasına ihtiyaç bulunduğu sonucuna ulaşılmıştır.

Gelişmekte olan pek çok ülke için uygun maliyet/ulaşılabilirlik politika yapıcıların en çok üzerinde durdukları unsurlardan birisidir. Türkiye'de faiz oranlarındaki gerileme bu anlamda olumlu bir ortam oluşmasına ilişkin altyapı hazırlamıştır. Türkiye'de düşük gelir gruplarına ilişkin devlet desteği çoğunlukla Toplu Konut İdaresi (TOKİ) vasıtasıyla yürütülmektedir. Ancak, ipotek teminatlı konut finansmanı sistemi üzerine odaklanan ve uygun maliyet/ulaşılabilirlik temelli ve ev sahipliği oranının arttırılmasını hedefleyen bir politikanın tercih edilmediği görülmektedir.

Malezya, Şili ve Güney Afrika gibi ülke örnekleri bu bağlamda incelenebilecek önemli vaka analizleri konumundadır. Örneğin, Kore'de devlet destekli olarak kurulmuş olan bir kuruluşun devreye girmesi ile kontratların vadelerinin önemli ölçüde uzaması sağlanmıştır. Gelişmiş ülkelere kıyasla faiz oranlarının Türkiye'de hala yüksek seviyelerde olduğu söylenebilir. Bu nedenle uzun vadeli ipotek teminatlı konut kredisi kullanımı ekonomik olarak anlamlı olmamaktadır. Bu süreçte devlet

desteği düşük gelir gruplarının söz konusu piyasaya ulaşımını kolaylaştırabilir. Ayrıca, konut piyasasına odaklanan Emlakbank'ın faaliyetlerinin 2001 yılında durdurulduğu ve bu bankanın yokluğunda oluşan boşluğun da doldurulamadığı dikkate alındığında, yeni kurulacak ve düşük gelir gruplarının piyasaya dâhil edilmesine odaklanacak bir devlet bankasının faydalı olabileceği değerlendirilmektedir.

Türkiye'de pek çok coğrafi bölge, özellikle de İstanbul, deprem tehdidi altındadır. Bu tehdide rağmen konut stokunun kalitesinde oldukça düşük seviyededir. Dolayısıyla, ipotekli konut finansmanı sisteminin desteklenmesi sadece düşük gelir grupları için değil toplumun geneli için de önemlidir. Bu bakımdan vergilendirme oldukça önemli bir araç konumundadır. Türkiye'de birincil piyasanın desteklenmesi açısından vergi indirimlerinin önemi yazında sıkça vurgulanmaktadır. Diğer taraftan Amerika Birleşik Devletlerinde ikincil piyasanın gelişmesine rağmen ev sahipliği oranında kayda değer bir gelişme olmaması da dikkate alınması gereken bir husustur. Bu bakımdan ulusal otoritelerin aldıkları kararlarda birincil piyasanın desteklenmesi ile ikincil piyasanın desteklenmesi arasında da hassas bir denge gözetmesine ihtiyaç bulunduğu değerlendirilmektedir. Bununla birlikte, konut finansmanı sistemine devlet desteği sağlanması konut fiyatlarındaki volatiliteyi arttırmak gibi negatif dışsallıkları beraberinde getirebilmektedir. Bu nedenle, devlet desteğinin piyasanın oluşumu sürecinde bir itici güç olarak değerlendirilmesi gerekmekte ve global finansal kriz döneminden alınan derslerle piyasa geliştikçe devlet desteğinin de azaltıldığı bir süreç tesis edilmesine ihtiyaç bulunmaktadır. Yine Kore örneğinde olduğu gibi, ipotekli konut finansmanı sisteminin geliştirilmesinin tek başına gelir eşitsizliğinin azaltılmasına katkı sağlamayabileceği de göz önünde bulundurulmalıdır.

Türkiye'de ipotek teminatlı konut finansmanı sisteminin gelişimini sınırlayan çeşitli faktörler bulunmaktadır. Kredi derecelendirme kuruluşlarınca verilen derecelendirme notları bu faktörlerden biridir. Türkiye Hazinesince gerçekleştirilen ihraçlara derecelendirme kuruluşlarınca halen oldukça düşük derecelendirme notları verilmektedir. Uygulamada ise ülke hazinesinin derecelendirme notu aynı ülkede

gerçekleştirilen diğer ihraçlar için de bir üst sınır olmaktadır. Dolayısıyla, bu durum Türkiye'de menkul kıymet piyasasının gelişimini ve bu yönden ikincil piyasa gelişimini, sınırlayan önemli bir etken durumundadır.

İpotek teminatlı konut finansmanı sisteminin gelişimi kadar bu gelişimin yakından takip edilmesi de oldukça önemlidir. Bu süreçte ulusal otoritelerce piyasanın riskliliğine ilişkin tahsili gecikmiş alacaklar rasyosu gibi muhtelif risk göstergelerinin yakından takip edilmesi bir gerekliliktir. Ayrıca global finansal kriz süreci ipotek teminatlı konut finansmanı sisteminin konjontür-karşıtı bir şekilde etkin bir araç olarak da kullanılabileceğini göstermiştir. Özellikle Kore'nin bu bakımdan kullandığı araçlar pek çok gelişmekte olan ülke açısından politika geliştirme sürecinde dikkate alınabilecek niteliktedir.

Piyasanın gelişimi açısından önem arz eden bir diğer husus ise bu gelişimden sorumlu tek bir ulusal otorite olması veya ilgili otoritelerin etkin bir koordinasyon içerisinde faaliyetlerini sürdürmesidir. Türkiye'de Sermaye Piyasası Kurulu, Bankacılık Düzenleme ve Denetleme Kurumu, Türkiye Cumhuriyet Merkez Bankası ve Hazine Müsteşarlığı gibi pek çok kurumun bu anlamda açık veya örtük görevleri olduğu görülmektedir. Bu nedenle bu kurumlar arasında piyasanın geliştirilmesi hedefi doğrultusunda koordinasyon sağlanması ipotek teminatlı konut finansmanı piyasasının büyütülmesi açısından önemlidir. Son yıllarda Türkiye bankacılık sektörü hızlı bir büyüme göstermişken, aynı büyüme sermaye piyasaları açısından gözlemlenememiştir. Bu durum da, ikincil piyasanın oluşmasını olumsuz etkilediğinden, ipotek teminatlı konut finansmanı piyasasının büyümesinin önündeki önemli engellerden birisidir.

Bahse konu tartışmalar sonrasında tezin dördüncü bölümü Türkiye ipotek teminatlı konut piyasası üzerinde etkisi olan bazı politika tercihlerine odaklanmaktadır. Tezde yoğun şekilde vurgulandığı gibi, ipotek teminatlı konut kredilerinin temerrüdü sadece kredi kullandıran kuruluşlar açısından değil, merkez bankaları ve bankacılık denetimi ve gözetiminden sorumlu kurum ve kuruluşlar açısından da önemlidir. Geçmiş tecrübeler, ipotekli konut finansmanı sisteminin etkin çalışmamasının önemli sosyal etkileri de olabileceğini ortaya koymuştur. Özellikle global finansal

kriz sürecinde düşen konut fiyatları önemli ölçüde ipotekli konut kredisi temerrüdüne neden olmuş, bu durum da tüketiciler için konut kredisi arzının kısılmasına neden olarak konut sektörüne yatırımları daha da azaltan bir kısır döngü oluşturmuştur. Dolayısıyla, global finansal kriz düşen konut fiyatlarının finansal istikrar üzerinde önemli olumsuz etkileri olabileceğini ortaya koymuştur. Bu nedenle ulusal otoritelerin ve Uluslararası Para Fonu, Dünya Bankası gibi uluslararası kuruluşların ipotek teminatlı konut finansmanı piyasasını finansal istikrar bakış açısı ile izlemesinin gerekli olduğu görülmektedir. Ayrıca ulusal otoriteler temerrüt ve erken ödeme modelleri yardımıyla değişen makroekonomik koşulların etkilerini değerlendirme, ev sahipliğini arttırmaya dönük makul planlar yapabilme ve ikincil piyasanın gelişmesini destekleme fırsatı bulabilmektedir.

Bu çerçevede dördüncü bölüm Türkiye ipotek teminatlı konut finansmanı piyasasında riskliliği detaylı biçimde ele almaktadır. Temerrüt ve erken ödeme modelleri kurulmasında kullanılabilecek nitelikteki iki ayrı banka portföyü çalışma kapsamında ayrı ayrı analiz edilmiştir. Model sonuçları söz konusu bankaların ipotek teminatlı konut kredisi portföylerinin önemli ölçüde farklılaştığını ve doğrudan sektörel düzeyde yapılacak analizlerin tüm bankalara genellenmesinin doğru sonuçlar vermeyebileceğini ortaya koymuştur. Model sonuçları değerlendirildiğinde kullandırım tarihindeki kredi faiz oranındaki artışın hem temerrüt riskini hem de erken ödeme riskini arttırdığı görülmüştür. Ayrıca, ödeme gecikmesi temerrüt için oldukça önemli bir gösterge konumundadır. Öte yandan, model sonuçları temerrüt riskinin yüksek eğitim almış borçlularda daha düşük olduğunu ortaya koymuştur. Erken ödeme riski ise ortaokul ve üzeri eğitim almış grupta ilkokul eğitimi almış gruba kıyasla daha yüksektir. Meslek grupları bazında risklilik ele alındığında ise, özel sektör ve serbest meslek gruplarında temerrüt riskinin daha yüksek olduğu, erken ödeme riskinin ise daha düşük olduğu görülmektedir. Kredi vadesi uzadıkça ve kredi kullandırım tutarı arttıkça temerrüt oranı artarken, müşterinin yaşıyla bu risk azalmaktadır.

Banka 1 verisi üzerinden kurulan modelde kredi kullandırımında medeni durumun ve sonrasında medeni durum değişiminin temerrüt ve erken ödeme riski üzerinde

önemli etkisi görülmezken, Banka 2 verisi ile oluşturulan modelde, kredi kullandırımından sonra evlenmenin temerrüt riskini azalttığı ve erken ödeme riskini arttırdığı görülmüştür.

Deng ve diğerleri (2005)'te de belirtildiği gibi Türkiye'de de borçlu karakteristikleri temerrüt ve erken ödeme riskinin önemli belirleyicileridir. Dolayısıyla bankalar ipotek teminatlı konut kredilerinin performansını başvuru ve davranışsal modeller kullanarak iyileştirebilirler. Bu kapsamda yüksek riskli borçlu karakteristiklerinin tespit edilmesi ve bunlar için uygun bir şekilde risk-bazlı fiyatlama yapılması, banka finansal performanslarının arttırılması açısından faydalı olacaktır. Tezin dördüncü bölümünde sunulan analizler veri sağlayan iki bankada kısmi olarak risk bazlı fiyatlama yapıldığını ortaya koymuştur.

Modelleme sonuçlarının ortaya koyduğu bir diğer sonuç opsiyon değişkenlerine (mevcut özsermaye/piyasa değeri ve erken ödeme opsiyonu değişkenleri) ilişkindir. Model sonuçları bahse konu değişkenlerin tek başına düşük İşlem Karakteristik Eğrisi skorları ürettiğini göstermiştir. Dolayısıyla, Türkiye ipotek teminatlı konut finansmanı piyasasında opsiyon değişkenlerinin yazında vurgulandığı kadar erken ödeme ve temerrüt risklerini ölçmede tek başına yüksek başarı gösteremediği görülmüştür. Ancak, ödeme gecikmesi eklendikten sonra temerrüt modellerinin tahmin güçleri oldukça artmıştır. Müşteri karakteristikleri de modellerin ayrıştırma gücüne önemli pozitif katkı sağlamıştır.

Çalışma kapsamında risk ağırlıklı varlıklara ilişkin olarak yapılan analizler ipotek teminatlı konut kredileri için uygulanan mevcut %50 risk ağırlığının aşırı ihtiyatlı olduğunu ortaya koymuştur. Alacak büyüklüğü ile ağırlıklandırılmış ortalama risk ağırlığı, bir yıllık temerrüt oranlarının uzun dönem ortalaması dikkate alınarak hesaplanmıştır. Bu kapsamda Banka 1 için uygun risk ağırlığının %28,76 ve Banka 2 için uygun risk ağırlığının da %27,45 olduğu görülmüştür. Bu oranların mevcut durumda uygulanan %50 risk ağırlığının yaklaşık olarak yarısı seviyesinde olduğu dikkate alındığında Türk bankalarının ipotek teminatlı konut kredisi portföyleri nedeniyle gerekli olanın yaklaşık olarak iki katı sermaye tutmak zorunda oldukları

görülmüştür. Her ne kadar denetim otoritelerinin beklenmeyen zararlar için bankalarda yeterli sermaye bulundurulması için ihtiyatlı şekilde bu katsayıyı belirlemesi gerekli olsa da aşırı katı uygulamaların da piyasanın gelişiminin önünde bir engel olduğu açıktır. Bu nedenle Basel-II uyumlu sermaye yeterliliği düzenlemesi kapsamında standart yaklaşım altında Basel Bankacılık Denetim Komitesince de izin verilen %35 risk ağırlığının Türk bankacılık sektörü için daha uygun olduğu sonucuna ulaşılmıştır.

Yine bu sonuçlardan anlaşılacağı üzere, bankalarca Basel-II'nin gelişmiş kredi riski ölçüm yaklaşımı olan İçsel Derecelendirmeye Dayalı yaklaşımın kullanılması durumunda bankaların önemli düzeyde sermaye avantajı elde edeceği görülmektedir. Bu nedenle, diğer portföyler için de benzer bir avantajın bulunması durumunda Bankacılık Düzenleme ve Denetleme Kurumunca sektördeki büyük bankaların İçsel Derecelendirme Dayalı yaklaşım kullanımına yönlendirilmesi faydalı olacaktır.

İpotek teminatlı konut kredileri için mevzuatın öngördüğü genel karşılık oranlarında da risk ağırlıklarına benzer bir problem söz konusudur. Beklenen zarar bazlı karşılık oranları Banka 1 ve Banka 2 için sırasıyla %0,19 ve %0,24 olarak hesaplanmıştır. Bu oranların bankaların sadece en güncel kredi portföyleri yerine küresel finansal kriz dönemini de kapsayan bir uzun dönem ortalama şeklinde (Banka 1 için 2005-2013 ve Banka 2 için 2007-2013) hesaplanmış olması nedeniyle yeterince ihtiyatlı olduğu değerlendirilmektedir. Bahse konu tahminler mevcut genel karşılık oranlarının da risklilik ile kıyaslandığında (tüm kredi türleri için %1) oldukça yüksek olduğunu göstermektedir. Bu durum bankaların karlılıklarını düşürmek suretiyle banka bilançoları üzerinde negatif bir etki doğurmaktadır. Diğer taraftan, ödeme gecikmesi bulunan ve karşılık mevzuatında ikinci grup olarak sınıflanan krediler için ise sonuçlar banka bazında farklılık göstermektedir. Öyle ki, ikinci grup krediler için risk bazlı genel karşılık oranı %3,46 olarak hesaplanmıştır. Bu oran mevcut %2'lik genel karşılık yükümlülüğünün üzerindedir. Banka 2 için ise söz konusu oran %1,25 olarak tahmin edilmiştir. Bu banka için hesaplanan oran da karşılık yönetmeliğindeki karşılık gereksiniminden daha düşüktür.

Bu değerlendirmelere ilave olarak dördüncü bölümde yer alan sonuçlar aynı zamanda erken ödeme riskinin ölçüm ve yönetiminin bankalar için önemine de işaret etmektedir. Geçmişte erken ödeme oranlarının bazı kredi dönemleri için (vintage) %70'ler seviyesine ulaştığı görülmüştür. Erken ödeme oranı finansal kuruluşların sağlamlığının izlenmesinin yanı sıra ikincil piyasanın oluşması sürecinde de önemle takip edilmesi gerekli bir göstergedir.

Erken ödeme cezasının uygunluğuna ilişkin yapılan hesaplamalar ise Tüketici Kanununda belirtilen cezaların (kalan vadesi 36 aydan kısa olan krediler için %1, 36 aydan uzun olan krediler için %2) geçmişte ortaya çıkmış en yüksek kayıpların yaklaşık olarak üçte birini tüketicilere üçte ikisini ise finansal kuruluşlara aktardığını göstermektedir. Mevcut durumda banka bilançolarında ipotek teminatlı konut kredilerinin payının küçük olması nedeniyle bahse konu zararlara bankalarca kolaylıkla katlanılabilmektedir. Ancak, Türkiye ipotek teminatlı konut finansmanı sisteminin hızlı bir büyüme göstermesi durumunda bahse konu cezaların finansal istikrarı da gözetecek şekilde yeniden belirlenmesine ihtiyaç duyulabilecektir. Söz konusu erken ödeme cezasının bir diğer etkisi de sözleşme vadeleri üzerindedir. Konut kredilerinin erişilebilir olması açısından uzun vade önemli bir gereksinimdir. Diğer taraftan tezde yapılan hesaplamalar vadenin uzaması ile bankaların erken ödeme durumunda daha büyük zararlar ile karşı karşıya kalabileceğini göstermektedir. Bu durumda piyasada faiz oranlarının artmasını veya vadelerin uzamamasını tetikleyen faktörlerden birisi olarak değerlendirilmektedir.

İpotekli konut finansmanı sisteminin geliştirilmesine ilişkin önerilerde ele alındığı üzere erken ödeme cezasının belirlenmesi konusunda da birden fazla yetkili kuruluş olduğu görülmektedir. Bankacılık sektörünün sağlamlığından sorumlu olan Bankacılık Düzenleme ve Denetleme Kurumu açısından önceliğin ilgili ceza miktarının bankacılık sektörünün istikrarını tehlikeye atmayacak şekilde belirlenmesi olması gerektiği, tüketicinin korunmasından sorumlu Gümrük ve Ticaret Bakanlığı gibi kurumların önceliğinin ise yüksek erken ödeme cezaları ile tüketicilerin mağdur edilmemesi olması gerektiği değerlendirilmektedir. Bu çerçevede mevcut durumda uygulanan kalan vadenin 36 aydan kısa olması

durumunda %1 kalan vadenin 36 aydan uzun olması durumunda ise %2 şeklinde belirlenmiş olan erken ödeme cezasının daha çok tüketicileri koruyacak şekilde kalibre edilmiş olduğu söylenebilir. Ancak ulusal otoritelerce bahse konu oranların özellikle aşırı hızlı faiz oranı hareketlerinin görüldüğü dönemlerde finansal kuruluşları korumak açısından yeniden kalibre edilmesine ihtiyaç duyulabilecektir. Bu bağlamda tezde sunulan analizlerin önemli bir altyapı oluşturduğu düşünülmektedir.

Tezin dördüncü bölümündeki analizler erken ödeme cezası tanımının daha iyi belirlenmesi gerektiğine de işaret etmektedir. Yürürlükteki Tüketicinin Korunması Hakkında Kanun erken ödeme tanımında bir veya birden fazla ödemenin erken yapılmış olmasına durumunda erken ödeme cezası uygulanabileceğine vurgu yapmaktadır. Ancak Kanunda kredinin tamamen ödenmiş olması gerektiği açıkça belirtilmemiş olduğundan bazı finansal kuruluşlarca taksit ödemelerini vadesinden önce gerçekleştiren müşterilere erken ödeme cezası uygulamasına dönük işlemler tespit edildiği görülmektedir.

Belirtilen hususlar birlikte değerlendirildiğinde Türkiye'de ipotek teminatlı konut finansmanı sisteminin geliştirilmesine dönük düzenleme alanında atılabilecek pek çok adım olduğu tespit edilmiştir. Mevcut düzenleme setinin piyasanın gelişmesi açısından oldukça kısıtlayıcı olduğunu belirtmek yanlış olmayacaktır. Bu bakımdan, finansal istikrardan sorumlu Türkiye Cumhuriyet Merkez Bankası ve finansal sistemin sıhhatinden sorumlu Bankacılık Düzenleme ve Denetleme Kurumu gibi ulusal otoritelerin politika tercihlerine ilişkin mevcut kalibrasyonu yeniden gözden geçirmesi faydalı olabilecektir.

Tez çalışması sırasında tezin ana araştırma sorularına ilave olarak pek çok önemli sonuca da ulaşılmıştır. Örneğin tezin üçüncü bölümünde geliştirilen model ile farklı ülkelerin ipotek teminatlı konut finansmanı sistemlerinin derinliğinin model tarafından ortaya konulan eşik değer ile kıyaslanması vasıtasıyla ilgili piyasanın beklenenden daha fazla veya daha az büyümüş olduğu değerlendirilebilecektir. Bu sayede küresel finansal kriz süreci sonrası üzerinde önemle durulan piyasanın

makroekonomik istikrar problemlerine yol açma potansiyelini de değerlendirmek mümkündür.

Diğer taraftan, tezde de belirtildiği üzere Türkiye ipotek teminatlı konut finansmanı piyasası son yıllarda önemli bir büyüme göstermiştir. Tez çalışması kapsamında bankalardan alınan veriler bu büyümenin arkasındaki ürün ve müşteri bazlı değişimlerin de izlenmesine olanak sağlamıştır. Türkiye piyasasına ilişkin yazında kapsamlı bir biçimde bahse konu analizleri gerçekleştiren bir çalışmaya rastlanmamıştır.

Türkiye'de ipotek teminatlı konut kredilerine ilişkin nicel analizler şu sonuçları ortaya koymuştur;
-Türkiye'de ipotek teminatlı konut kredilerinin vadesi uzamaktadır (2007 yılında 5,7 yıldan 2013 yılında 7,6 yıla),
-İpotek teminatlı konut kredisi faiz oranları örneklemdeki her üç bankada da paralel şekilde azalmaktadır,
-Türkiye'de konut fiyatları artarken banka portföylerinde büyüklüğü 100.000 TL ve altında olan kredilerin payı azalmaktadır,
-Kredi kullandırım tarihi itibarıyla bakıldığında, müşterilerin %80'i evlidir ve yaklaşık olarak %25'i kadındır,
-Müşterilerin eğitim seviyeleri açısından bankalar arasında önemli farklılıklar bulunmaktadır. Katılım bankasının müşterilerinin en yüksek ortalama eğitim düzeyine sahip olduğu görülmüştür,
-Müşterilerin mesleki profilleri incelendiğinde kamu görevlilerinin banka portföylerindeki payı azalırken özel sektör çalışanları ve serbest meslek mensuplarının paylarının arttığı gözlemlenmiştir.

Söz konusu analizlere ilave olarak Türkiye'de ipotek teminatlı konut kredilerinin erişilebilirliğinin arttığı tespitinde bulunulmuştur. Örneğin, kredi kullananların ortalama yaşı gerilemekte, teminat olarak verilen konutların büyüklüğü (metrekare cinsinden) azalmakta ve yeni kullandırılan kredilerde konutların değerleme şirketlerince belirlenen değerleri düşmektedir. Bu durum Türkiye ekonomisi için de

olumlu olarak değerlendirilebilir. Ayrıca, tezde Türkiye'deki genç nüfus, kentleşme trendi ve ortalama hane halkı sayısının yüksekliği dikkate alındığında ipotek teminatlı konut finansmanı sisteminin daha etkin biçimde desteklenmesine ihtiyaç bulunduğu değerlendirmesi yapılmıştır.

Tezin üçüncü ve dördüncü bölümlerinde sunulan analizler Türkiye'de konut kredisi faiz oranlarının gerilediğini göstermekle birlikte bu oranların gelişmiş ülkelere kıyasla oldukça yüksek olduğunu da ortaya koymaktadır. Bunun arkasındaki temel etkenin enflasyonun mevcut seviyesi ve oynaklığı olduğu düşünülmektedir. Bu bakımdan konut kredisi faiz oranlarında daha fazla gerileme sağlanması için enflasyonun daha düşük seviyelere çekilmesinin bir önkoşul olduğu değerlendirilmektedir.

Deng ve diğerleri (2005)'te Çin için verilen tavsiyeye paralel şekilde ipotek teminatlı konut finansmanı sisteminin geliştirilmesine katkı sağlayacak unsurlardan birisi risk bazlı fiyatlamadır. Bu sayede toplumun daha geniş kesimlerinin bu piyasaya dâhil olması mümkün olacaktır. Tezin dördüncü bölümünde sunulan analizler Türkiye piyasasında belirli düzeyde risk bazlı fiyatlama olduğuna işaret etmektedir. Yine de, tahmin edilen risk ağırlıklarının çarpık dağılımı, bankaların borç verme uygulamalarını iyileştirerek uygulanan risk ağırlıklarını önemli ölçüde düşürebileceklerini ortaya koymaktadır.

Türkiye sisteminde kredi teminat oranı (LTV) kesin bir üst sınır şeklinde (%75 üzeri KTO yasaklanmıştır) uygulanmaktadır. Bunun yerine bahse konu yasağın kaldırılarak, %75 üstü kullanımların konut finansman sigortası koşuluna bağlanması faydalı olabilecektir. Bu yaklaşımın hem konut finansman sisteminin hem de sigortacılık sektörünün gelişmesine katkı sağlayabileceği düşünülmektedir. Sigortacılık bakımından sistemin gelişimine ilişkin olarak değerlendirilebilecek bir diğer yaklaşım ise Kanada'dakine benzer bir devlet garantisi uygulamasıdır. Bu kapsamda tüm ipotek teminatlı krediler, oluşturulacak bir devlet kuruluşu tarafından küçük bir prim karşılığında sigortalanarak Basel-II kapsamında %0 risk ağırlığına

tabi tutulabilecektir. Ancak böyle bir yaklaşımın tercih edilmesi durumunda kurulacak kuruluşun risk odaklı olması sağlanmalıdır.

Diğer taraftan, Türkiye'de devam eden gecekondudan planlı kentleşmeye geçiş sürecinde kültürel olarak önem arz eden bölgelerin yok edilmesine dönük olarak önemli itirazlar da oluştuğu görülmektedir. Bu bakımdan da artan itirazlara kulak verilmesi ulusal konut politikasının oluşturulması bakımından mühimdir.

Son olarak, ipotek teminatlı konut finansmanına ilişkin sayısal analizlerin gerçekleştirilebilmesi açısından en önemli sorunun veri problemi olduğu görülmüştür. Örneğin üçüncü bölümde sunulan modellere vergi indirimlerinin etkisi, kredi teminat oranları gibi pek çok değişken veri eksikliği sebebiyle eklenememiştir. Dördüncü bölümde yapılan analizler ise temerrüt ve erken ödeme riskinin modellenmesine ilişkin verinin kalitesinin arttırılması gerekliliğini ortaya koymuştur. Her ne kadar bankalar bu alanda önemli mesafe kat etmiş olsalar da, veri kalitesinin arttırılması açısından ilgili otoritelerin daha teşvik edici olmasının gerekli olduğu ve bankaların bu alanda daha fazla yatırım yapmasına ve akademi ile daha fazla ortak proje geliştirmesine ihtiyaç olduğu değerlendirilmiştir.

I. TEZ FOTOKOPİSİ İZİN FORMU

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