

SIMULATING THE TURKISH ECONOMY UNDER INFORMALITY

A THESIS SUBMITTED TO  
THE GRADUATE SCHOOL OF SOCIAL SCIENCES  
OF  
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZGEN ÖZTÜRK

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR  
THE DEGREE OF MASTER OF SCIENCE  
IN  
THE DEPARTMENT OF ECONOMICS

JULY 2014

Approval of the Graduate School of Social Sciences

---

Prof. Dr. Meliha Altunışık  
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

---

Prof. Dr. Nadir Öcal  
Head of Department

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 Master of Science.

---

Assist. Prof. Dr. Pınar Derin-Güre  
Supervisor

**Examining Committee Members**

Assoc. Prof. Dr. D. Şirin Saracoğlu (METU, ECON) \_\_\_\_\_

Assist. Prof. Dr. Pınar Derin-Güre (METU, ECON) \_\_\_\_\_

Assist. Prof. Dr. M. Kadir Doğan (Ankara Uni., ECON) \_\_\_\_\_

**I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.**

Name, Last name: ÖZGEN ÖZTÜRK

Signature :

## **ABSTRACT**

### **SIMULATING THE TURKISH ECONOMY UNDER INFORMALITY**

ÖZTÜRK, Özgen

M.Sc., Department of Economics

Supervisor: Assist. Prof. Dr. Pınar Derin-Güre

July 2014, 75 Pages

The existence of a large shadow economy is one of the most important problems of developing countries, since informality mitigates tax revenues of governments, causes inefficiency in the economy and disrupts the welfare of the society. The aim of this study is to analyze the effects of the existence of a large informal sector on the macroeconomic variables and welfare of Turkey. The constructed model for this purpose is a two sector overlapping generations (OLG) model. As far as I know, this is the first study in which the model incorporates endogenous labor supply, population growth, bequest motive, Pay-As-You-Go (PAYG) pension system and informality in a 55-period OLG environment for Turkey. Simulation results indicate that, besides the costs to the government, the existence of a large shadow economy is also detrimental to the households and firms of the informal economy and disrupts the welfare of the whole society in Turkey.

**Keywords:** Computable Dynamic General Equilibrium Analysis, Overlapping Generations Models, Informality, Welfare, Simulation

## ÖZ

### KAYIT DIŐILIK VARLIĐINDA TÜRKİYE EKONOMİSİ SİMÜLASYONU

ÖZTÜRK, Özgen

Yüksek Lisans, İktisat Bölümü

Tez Yöneticisi: Yrd. Doç. Dr. Pınar Derin-Güre

Temmuz 2014, 75 Sayfa

Büyük bir kayıt dışı ekonominin varlığı, gelişmekte olan ülkelerin karşılaştığı en önemli problemlerden biridir. Çünkü kayıt dışı ekonomi, devletin vergi gelirlerini azaltır, ekonomide verimsizliğe sebep olur ve ayrıca toplumun refah düzeyine de ciddi zararlar verir. Bu çalışmanın amacı, kayıt dışı ekonominin Türkiye makroekonomik değişkenleri ve toplum refahı üzerindeki etkilerini analiz etmektir. Bu amaçla iki sektörlü ardışık nesiller modeli oluşturulmuştur. Bildiğimiz kadarıyla bu çalışma, 55 dönemlik ardışık nesiller modeli kullanılarak, endojen iş gücü arzı, nüfus büyümesi, kayıt dışılık ve miras motivasyonlarını içeren Türkiye üzerine yapılan ilk çalışmadır. Simülasyon sonuçları, kayıt dışı ekonominin, devlete olan maliyetinin yanı sıra, kayıt dışı olarak varlığını sürdüren hanhalklarına ve firmalara da zararlı olduğunu, ayrıca toplum refahına da zarar verdiğini göstermiştir.

**Anahtar Kelimeler:** Hesaplanabilir Dinamik Genel Denge Analizi, Ardışık Nesiller Modeli, Kayıtdışılık, Refah, Simülasyon

*to my family*

## ACKNOWLEDGEMENTS

First and foremost, I offer my sincerest gratitude to my thesis supervisor, Assist. Prof. Dr. Pınar Derin-Güre for the continuous support to my master thesis, for her patience, motivation, enthusiasm, and immense knowledge. I could not have imagined having a better advisor and mentor for my thesis, since her guidance are enhancing me not only in academic subjects, but also in terms of being a better human.

Besides my advisor, I would like to thank the rest of my thesis committee: Assoc. Prof. Dr. Şirin Saracoglu and Assist. Prof. Dr. M. Kadir Doğan, for their precious contributions, insightful comments, and hard questions.

The Department of Economics of METU has been a very friendly environment to work and to live. In my daily work, I have been blessed with a cheerful group of friends. I would like to thank Aykut Mert Yakut, who was always willing to help and give his best suggestions. My gratitude for Mr. Hakan Güneş has two facet: as a good friend, his willingness to help me and make sure that I have a good time at all is enthusiastic and as a good colleague, the discussions about my study is quite stimulating. I am also very grateful to Mrs. Burcu Özgün for being a dedicated companion throughout the thesis process, without her I could not keep myself in the line.

Finally, I would like to thank my dearest brother, Ali Ziya. He deserves this gratitude for just being existence, since, in my unstable lifestyle, he always provides unwavering support to me. I had the honor to make such a precious friend.

Last but not the least, I would like to thank my parents and my sister. They were always supporting me and encouraging me by letting me know that they are always there to cheer me up and stood by me through the good times and bad.



## TABLE OF CONTENTS

|  |      |
|--|------|
| PLAGIARISM.....  | iii  |
| ABSTRACT .....   | iv   |
| ÖZ.....  | v    |
| DEDICATION.....  | vi   |
| ACKNOWLEDGEMENTS.....  | vii  |
| TABLE OF CONTENTS .....  | ix   |
| LIST OF TABLES.....  | xii  |
| LIST OF FIGURES .....  | xiii |
| CHAPTER  |      |
| 1: INTRODUCTION .....  | 1    |
| 2: LITERATURE REVIEW .....   | 5    |
| 3: INFORMALITY.....  | 11   |
| 3.1 Definition of Informality .....                                | 11   |
| 3.2 The Structure of Informality .....                             | 12   |
| 3.3 The Rationality of Being Informal.....                         | 13   |
| 3.4 Approaches for the Estimation of the Size of Informality ..... | 14   |
| 3.4.1 Direct Approach.....   | 15   |
| 3.4.1.1 Survey Method.....   | 15   |
| 3.4.1.2 Tax Auditing Method .....                                  | 15   |
| 3.4.2 Indirect Approach .....                                      | 16   |
| 3.4.2.1 Accounting statistics .....                                | 16   |
| 3.4.2.2 Monetary statistics .....                                  | 16   |
| 3.4.2.3 Employment statistics .....                                | 17   |

|  |    |
|--|----|
| 3.4.2.4 Physical output statistics .....   | 18 |
| 3.4.3 Model Approach.....  | 18 |
| 3.4.4 A New Approach.....  | 18 |
| 4: THE MODEL.....  | 20 |
| 4.1 Demographic Structure .....  | 20 |
| 4.2 Households Behavior .....  | 21 |
| 4.2.1 Preferences .....  | 21 |
| 4.2.2 Budget Constraints .....   | 22 |
| 4.2.2.1 Formal Sector .....  | 22 |
| 4.2.2.2 Informal Sector.....   | 24 |
| 4.2.3 Choice of Consumption, Leisure and Bequest .....                                   | 24 |
| 4.2.3.1 Optimization Problem of Formal Sector's Household .....                          | 25 |
| 4.2.3.2 Optimization Problem of Informal Sector's Household.....                         | 28 |
| 4.3 Firms Behavior.....  | 30 |
| 4.3.1 The Investment Decision.....   | 31 |
| 4.3.2 The Demand for Labor .....   | 32 |
| 4.4 Government Behavior .....  | 33 |
| 4.4.1. Taxation.....   | 34 |
| 4.4.2. The Government's Budget Constraint.....   | 34 |
| 4.4.3. The Social Security System.....   | 35 |
| 4.5 Equilibrium under Perfect Foresight .....  | 37 |
| 5: SIMULATION AND FINDINGS.....  | 39 |
| 5.1 Solution Methodology .....   | 39 |
| 5.1.1 Initial Steady State .....   | 40 |
| 5.1.2 Final Steady State.....  | 41 |
| 5.2 Model Parameterization and Calibration.....  | 42 |
| 5.3 Findings.....  | 44 |
| 5.3.1 Behavior of the Households .....   | 44 |
| 5.3.1.1 Asset Stock Decisions .....  | 44 |
| 5.3.1.2 Consumption Decisions.....   | 46 |
| 5.3.1.3 Labor Supply Decisions .....   | 47 |
| 5.3.2 Analysis on the Certain Macroeconomic Variables .....                              | 49 |
| 5.3.2.1 Impacts of Various Payroll Tax Rates on Certain Macroeconomic<br>Variables ..... | 49 |

|   |    |
|---|----|
| 5.3.2.2 Impacts of the Size of Informality on Certain Macroeconomic Variables ..... | 50 |
| 5.3.3 Welfare Analysis .....  | 52 |
| 5.4 Resulting Comments.....   | 55 |
| 6: CONCLUSION .....   | 57 |
| REFERENCES .....  | 60 |
| APPENDICES  |    |
| A: TURKISH SUMMARY .....  | 63 |
| B: TEZ FOTOKOPİSİ İZİN FORMU.....   | 75 |

## LIST OF TABLES

### TABLES

|   |    |
|---|----|
| Table 3 1: Size of the Informality of Some Countries as Percentages to the<br>Official GDP..... | 12 |
| Table 5.1: Parameterization.....  | 43 |
| Table 5 2: Impacts of Various Payroll Tax Rates on Certain Macroeconomic<br>Variables.....      | 51 |
| Table 5 3: Impacts of the Size of Informality on Certain<br>Macroeconomic Variables.....        | 53 |
| Table 5 4: Welfare Analysis under Different Payroll Tax Rates.....                              | 54 |
| Table 5 5: Welfare Analysis under Different Size of Informality.....                            | 55 |

## LIST OF FIGURES

### FIGURES

|  |    |
|--|----|
| Figure 5.1: The Model .....  | 41 |
| Figure 5.2: Capital Holdings Choices of the Formal Sector Households ..... | 45 |
| Figure 5.3: Capital Holdings Choices of the Formal Sector Households ..... | 45 |
| Figure 5.4: Consumption Choices of the Formal Sector Households.....       | 46 |
| Figure 5.5: Consumption Choices of the Informal Sector Households .....    | 47 |
| Figure 5.6: Labor Supply Choices of the Formal Sector Households .....     | 48 |
| Figure 5.7: Labor Supply Choices of the Informal Sector Households.....    | 48 |



# **CHAPTER 1**

## **INTRODUCTION**

Informality is a serious problem for developing countries. It is due to the fact that the presence of the informal sector spoils income distribution, causes significant distortions in the statistics of the economy, disrupts welfare and decreases tax revenues of the governments which may decrease the effectiveness of the taxation system. Following De Soto (1989), which is widely accepted among many other definitions, informal sector is defined as the economic activities which do not comply with the regulations and taxes of the government.

In this study, to investigate informality phenomenon, we construct a dynamic life cycle model. The aim of this thesis is to calculate various macroeconomic variables of Turkey under different payroll tax rates and different sizes of the informal sector. As a contribution, this is the first model which is applied to Turkey and incorporates realistic extensions for the conditions of Turkey, such as, endogenous labor supply, population growth, Pay as You Go pension system, bequest motive and informality in a 55-period Overlapping Generations Model.

In fact, informality is not only developing countries' problem, but also developed countries' problem (so far, developed countries have achieved keeping informality at manageable proportions). Although, the concept of informality remains as a problem for both developing and developed countries, many points are still in the dark. For instance, even the term itself have not been settled yet, many terms are put

forward by researchers such as shadow, hidden, underground, informal and invisible economy. Throughout the thesis, all of these terms may be used interchangeably.

Informality can form not only in illegal, but also in legal activities. Generally, all illegal activities are counted in informal sector. For instance, drug dealing, gambling, smuggling etc. In the legal activities, tax evasion is the way to be informal, which means that tax payer completely escapes from paying tax. For example, employing, but not documenting the workers is a form of tax evasion.

Moreover, the reason for why the firms and households consent with these legal restrictions and unsafe conditions is put forward by Loayza (1996) and Ihrig and Moe (2004). The researchers indicate that the reason for emerging of shadow economy is the imposed high tax rates and tight regulations of the government while lacking ability to enforce these policies. As can be deduced, the governments have the most crucial position in the phenomenon of informality. The government has three roles: regulation of the system, collecting the taxes and more importantly, inspection. All of these three roles have to be fulfilled in order to have a healthy taxation system. Loayza (1996) states that corruption of the officials, in other words, receiving any type of profit from the illegality makes informality attractive and consequently, the shadow economy grows.

In the literature, the studies that discuss shadow economy utilize various macroeconomic models. In our study, as the basis, the milestone study of Auerbach and Kotlikoff (1987) is chosen. The researchers create a dynamic, life-cycle model, which consists of 55-period living agents simultaneously. In the model, representative agents are perfectly foresighted which means that the individuals choose the optimal solution set in with perfectly accurate expectations of future.

In addition to the model of Auerbach and Kotlikoff (1987), our model has been extended by bequest motive. Since, the households in Turkey have strong bequest motive it is crucial for a realistic model of Turkey. Bequest motive arises when one cohort's preferences include not only her welfare but also her children's welfare. We utilized the approach of Blinder (1973), in which bequest motive is modeled as "joy of giving". In other words, the individual gets utility from leaving bequest. In our



model, the formulation is based on Altig, Auerbach, Kotlikoff, Smetters and Walliser (2001).

Besides the bequest motive, we incorporate informality into our model. For the informal sector modelling, Schmidt-Hebbel (1997) forms the basis. The author constructs a two sector model which consists of a formal and an informal sector. Then, he utilizes this model to compare the two public pension systems; Pay as You Go (PAYG) and fully funded (FF) system. Finally the author carries out a social welfare analysis. In our study we incorporate informality into our model by imposing the share of the informal sector to the official GDP exogenously. For this purpose, an estimated value of the size of informality in Turkey is utilized, thus, we impose the value from Elgin and Öztunalı (2012). The authors estimated the proportion of the informal sector in Turkey as 27.68 % of the GDP for 2009.

To sum up, in our study, we construct a 55-period OLG model, with endogenous labor supply, constant population growth, a public pension system (PAYG), bequest motive and informal sector. This model is constructed purposefully to investigate the macroeconomic variables of Turkey under different payroll tax rates and different size of informal sector. Moreover, a welfare analysis is also conducted. The model used is based on the study of Auerbach and Kotlikoff (1987), while the extensions as population growth and bequest motive is based on Altig et al. (2001) and informality is based on Schmidt-Hebbel (1997). Our contribution in this thesis is to include all of the extensions i.e. endogenous labor supply, population growth, PAYG pension system, bequest motive and informality in a 55-period OLG model and apply it to Turkey for the first time.

The outline of this study is as follows. In the next chapter, the related literature is briefly reviewed. Chapter 3 discusses informality, since the major extension of this study is the existence of the informal sector. Following the discussion of informality, Chapter 4 elaborately describes the model employed in this study. Under the framework of Chapter 4, the following chapter, Chapter 5 presents all of the analysis which are carried out by simulations. In the final chapter (Chapter 6), the results of the simulations, along with the comments, are briefly presented and as the chapter's

name suggests, all the points of the study are concluded together. As a last remark, some possible routes for future studies are discussed.

## CHAPTER 2

### LITERATURE REVIEW

The literature about the analysis of various fiscal policies using overlapping generations model (OLG) is usually based on the study of Diamond (1965), which is accepted as the ancestor of the OLG models with Samuelson (1958). Samuelson (1958) and Diamond (1965) introduce a model in which individuals live for two periods. An individual who is born at  $t$  has a two period lifetime in which at time  $t$  individual is “*young*” and at time  $t+1$  individual is “*old*”, meanwhile a new individual born and enters to the model at time  $t+1$  as “*young*”. So, as the name of the model suggests, generations overlap in each period. These overlapped generations’ problem is to choose the amount of consumption in each period and saving for the next period in order to maximize their lifetime utility. With the emerging of the OLG model, a completely new area is unfolded for researches.

After Samuelson (1958) and Diamond (1965), the foremost contribution is made by Auerbach and Kotlikoff (1987) who create a dynamic, life-cycle model, which consists of 55-period living agents simultaneously. In fact, the model has a representative perfectly foresighted agent which means that the individuals (and the firm) choose the optimal solution set in accordance with perfectly accurate expectations of future variables. In an irrefutable manner, this model becomes a point of bearings and has been used by many researchers especially who studies fiscal policies such as social security and tax systems.

Following the first milestone of Auerbach and Kotlikoff (1987), many studies, which include models that have multiple period living agents, propound by researchers such as Laitner (1990), Imrohoroğlu, Imrohoroğlu and Joines (1995) and Ferreira (2005). These studies have similar characteristics such that they incorporate a model, which is very similar to the model of Auerbach and Kotlikoff (1987). However, Imrohoroğlu et al. (1995) include uncertain lifespan to their model and investigate the optimal replacement rate and the welfare benefits of the social security system. Ferreira (2005) enriches his model by including endogenous labor supply and a deficit-running government. The purpose of the study is to determine the optimal social security tax rate in which the social security system has a balanced budget. Moreover, the author investigates how the Pay-as-You-Go (PAYG) system affects the welfare gains (in terms of the PAYG tax rates)

Above models are all well structured, but they lack the bequest motive. It may not be so important for the studies in a developed country, however it is crucial for our model, in order to have a more realistic model for the conditions of Turkey. Therefore we incorporate bequest motive in our model. Bequest motive arises when one cohort's preferences include not only her welfare but also her successor's welfare. In other words, parents not only take care of themselves, but also their children. So, they leave some of their asset stock to the children after death. This approach is based on the idea of Blinder (1973), in which bequest motive is formulated as "joy of giving". Namely, the individual simply gets utility from leaving inheritance as she gets from consumption and leisure. While Altig, Auerbach, Kotlikoff, Smetters and Walliser (2001), incorporate the bequest motive as in Blinder (1973), some other researchers carry out different approach like two-sided altruism ((Fuster, Imrohoroğlu and Imrohoroğlu, 2003) and (Fuster et al. 2007)). In this setup, similar to the one sided altruism individuals care about the well-being of the children, but this model differs in the way that children also care about the wellbeing of their parents, but only in case when the parents have longer life than expected. Yet, another approach for the two-sided altruism is conducted by Laitner (1992). In the model, parents and children pool their total income and then share it according to their importance in the family. Particularly speaking for Turkey, two-sided altruism may be a good model especially for past decades when the children

and parents live altogether, but in more recent times, as the traditions change and children move to a different house when they get married (or when they get job), bequest motive would be more likely as one-sided altruism. Also it is much harder to model the two-sided altruism. Therefore for simplicity purposes we will only use one-sided altruism in our model.

Besides the bequest motive, another significant extension for Turkey (also for other developing countries) is the existence of a large informal sector<sup>1</sup>. In this point, it is necessary to state that the terms, informal sector, shadow economy, underground economy are used interchangeably throughout the study and all of these terms refer to the same concept, informality. In the literature, there is no strict definition for informality; nevertheless, De Soto (1989) defines informal sector as the economic activities which do not obey the government's taxes and regulations. Informality is an important problem for both developing and developed countries, since the existence of underground economy mitigates tax revenues of governments, causes inefficiency in the economy and disrupts the welfare of the society. Moreover, since developed countries achieve to keep the size of the shadow economy in manageable levels, they have relatively smaller informal sectors in accordance with developing countries. Thus, informality is much more urgent problem for developing countries. Again, the concept of informality, along with the own literature review are discussed in the informality chapter (Chapter 3).

In the literature, the studies that discuss shadow economy impose informality into their models by utilizing two methods. They either give the proportion of the informal sector exogenously, or calculate it in the model endogenously. However, in order to give the proportion exogenously, an estimated value of the proportion should be used. In our model, the proportion of informal sector in Turkey is imposed to the system exogenously.

For Turkey, many studies are conducted to estimate the size of the underground economy<sup>2</sup>. Kasnakoğlu (1993) is the first study regarding the estimation of the

---

<sup>1</sup> The concept of informality is discussed elaborately in Chapter 3.

<sup>2</sup> Various methods to estimate the size of the informality is briefly overviewed in Chapter 3.

informal sector size. In the study, the author estimates the size of informal sector as a percentage of the gross domestic product by using Currency Ratio and Currency Demand approach. For each approach, the size of the underground economy is estimated to be 5.9% and 7.5%, respectively. Furthermore, Ögünç and Yılmaz (2000) employ GDP, Currency Ratio and Currency Demand approach. Interestingly, in the GDP approach the size comes out as -1.2%, this is due to the fact that the gap between calculated GDP's may originate from measurement or statistical errors. In the latter approaches, the researchers estimate 16.1% in Currency Demand and 15.1% in Currency Ratio approach. Kök and Şapçı (2006), use Tax Auditing approach and get the result as high as 43.9% which is mainly argued to be a result of the sample's biasedness. Schneider and Savaşan (2007) employ Dynamic Multiple Indicator Multiple Cause (DYMIMIC) approach and got the result 33.8%, while Schneider (2013) gets 29.2 % by Multiple Indicator Multiple Cause (MIMIC) approach.

Furthermore, Elgin and Öztunalı, (2012) estimate the size of the underground economy as 27.7% by employing a new approach.<sup>3</sup> In their new approach, the authors form a general equilibrium model which uses a two period dynamic model that consists of two sectors: formal and informal. The researchers solve the model for the steady state values and calibrate the model's parameters for 161 countries for the years 1950-2009 by using the observable data in order to match the characteristics of each examined country. Then, finally the size of the informal economy is backed out from the model which is an unobservable parameter.

In our study, we impose the value from Elgin and Öztunalı (2012) for the proportion of the informal sector which is 27.7 % for the year 2009 to characterize the model for Turkey. The reason for the use of Elgin and Öztunalı (2012) is that among other studies, the researchers construct a new model which is based on some microeconomic foundations such as using two sector model (which is quite similar to our model) and also unlike the other studies, does not give any credit to ad-hoc econometric assumptions.

---

<sup>3</sup> In Chapter 3, the approach of Elgin and Öztunalı (2012) is explained in more detail.

Not only as the estimation of the size, but also as modelling, informality concept is investigated in Turkey. Saracoğlu (2008) constructs a three sector Ramsey model, which consists of formal, informal and agricultural sectors. The author investigate the effects of formal and agricultural sectors on the informal sector. Moreover, the study shows that as the capital accumulates and the economy moves towards the steady state, the proportion of informality in GDP decreases. Besides, the author also points out that reductions on tax on employment mitigates the size of the informal employment.

Although not with the perspective of informality, but OLG models have also been used for Turkey in a number of studies to investigate the impacts of fiscal policies such as public pension and tax reforms. Voyvoda and Yeldan (2005), create a 30-period OLG model with exogenous labor supply and open capital markets in order to examine the effects of the social security reform and IMF-led austerity program. In the study, the authors investigate the effects of IMF-led austerity program on a macroeconomic scope and also the sensitivity of the program when exposed to growth shocks. Like Voyvoda and Yeldan (2005), Değer (2011) also develops a 30-period OLG model which is enriched by the inclusion of different public pension systems and a bequest motive. The purpose of the study is to show the effects of the newly introduced social security system reform in Turkey. The study shows that the reform can mitigate deficits only in the long run, but conversely; in the short run it increases the deficits of the social security system. İleri and Derin-Güre (2014) construct a 55-period OLG model, which incorporates intragenerational heterogeneity to investigate the impacts of tax reforms on the Turkish Tax System. The agents differ by their income levels<sup>4</sup>. The authors analyze the macroeconomic effects of an exogenous shock when introduced to the labor income tax, consumption tax and capital income tax.

In our study, we construct a 55-period OLG model, with endogenous labor supply, constant population growth, bequest motive and informality environment to investigate the effect of different payroll tax rates on the economy. The model used is based on the study of Auerbach and Kotlikoff (1987), while the extensions as

---

<sup>4</sup> There are high income, middle income and low-income individuals.

population growth and bequest motive is based on Altig et al. (2001) and informality is based on Schmidt-Hebbel (1997). In his study, Schmidt-Hebbel (1997) compare the two public pension systems; PAYG and fully funded system, by enriching the 2-period OLG model with the initiation of the informal sector to the economy. Then the author compares several PAYG tax rates and observes social welfare. Our contribution in this thesis is to move one step forward by including all of the extensions i.e. endogenous labor supply, population growth, bequest motive and informality to a 55-period OLG model and apply it to Turkey for the first time.



## CHAPTER 3

### INFORMALITY

This chapter's aim is to shed light on the concept of informality and give brief definitions about the estimation methods of the size of informality in the literature. In either way, studies involving informality which are usually based on developing countries take significant place in the literature. The reason for this is that the existence of a large shadow economy is one of the most significant characteristics of developing countries. In fact, informality is not only developing countries' problem, but it is also developed countries' problem, since informality mitigates tax revenues of governments, causes inefficiency in the economy, and disrupts the welfare of the society. However, compared to developing countries, developed countries can keep informality at reasonable levels<sup>5</sup>.

#### 3.1 Definition of Informality

In the literature, there is no strict definition for informality; in fact the term itself has not been settled yet. The researchers use shadow, underground, informal and invisible economy terms interchangeably. In this study, too, the terms, informal sector, shadow economy, underground economy are used interchangeably to refer the same concept, "informality". Nevertheless, there are some definitions that are widely accepted. For instance, following De Soto (1989), informal sector is defined

---

<sup>5</sup> Elgin and Öztunalı (2012) construct a panel data for the size of informality across 161 countries for the years 1950-2009 and find that the size of informality is much larger in developing countries.

as the economic activities which do not pursue the government's taxes and regulations. However, there are other definitions which did not gain recognition as wide as De Soto's (1989). For example, Schneider (1986) defines underground economy as the economic activities calculated in the GDP, but not fully documented by the governmental officials. Also, Hart (2008) defines it as the economic activities which are outside the boundaries of the bureaucracy of the public and private sector.

Table 3-1: Size of Informality of Some Countries as Percentages to the Official GDP

| Country           | Proportion | Country        | Proportion |
|-------------------|------------|----------------|------------|
| Bolivia           | 63,34      | Argentina      | 22,64      |
| Zimbabwe          | 62,75      | Spain          | 22,01      |
| Haiti             | 57,05      | Belgium        | 21,08      |
| Nigeria           | 49,64      | Israel         | 20,68      |
| Cote d'Ivoire     | 46,93      | Chile          | 18,50      |
| Congo Dem. Rep.   | 46,56      | Norway         | 17,81      |
| Tajikistan        | 40,97      | Iran           | 16,95      |
| Russian Fed.      | 40,25      | Denmark        | 16,70      |
| Rwanda            | 37,97      | Germany        | 15,23      |
| Ghana             | 37,42      | Canada         | 15,08      |
| Brazil            | 36,42      | France         | 14,63      |
| Ethiopia          | 34,26      | Hong Kong      | 14,55      |
| Colombia          | 32,84      | Australia      | 13,23      |
| Egypt             | 32,36      | Singapore      | 12,13      |
| Venezuela         | 30,90      | United Kingdom | 12,02      |
| Turkey            | 28,63      | New Zealand    | 11,85      |
| Mexico            | 28,49      | China          | 11,53      |
| Italy             | 26,65      | Japan          | 10,26      |
| Poland            | 25,50      | United States  | 8,32       |
| South Africa Rep. | 24,87      | Switzerland    | 8,08       |

(Source: Elgin and Öztunali, 2012)

### 3.2 The Structure of Informality

Informality can take place in both legal and illegal activities in a very broad perspective. In fact, as mentioned in the first section, one of the reasons of this

unsettlement in the definition of the underground sector is that the boundaries of the sector are not clear. Roughly speaking, all illegal activities such as drug dealing, gambling, smuggling, prostitution, fraud, and bribery can be included to the underground economy. Moreover, legal activities in the informal sector are relatively clear; there are only two ways to enter the shadow economy: tax evasion and tax avoidance. Tax evasion means that one completely escapes from paying tax. For instance, any type of unreported income is a tax evasion. As it is indicated in the definition of De Soto (1989), all of the examples given above (legal or illegal) is a demonstration of not complying with government's regulations and taxes.

### **3.3 The Rationality of Being Informal**

Evading the taxes and regulations are not only detrimental to the government, but also to the very people in the underground economy. First of all, any firm or anyone who carries out their work in the shadow economy accepts the risk of being caught and having the required penalties fulfilled. More importantly, due to the illegal status, both firms and households (which operate in the informal sector) suffer from lacking any governmental protection. For instance, since they are no longer contributing to the pension system, households do not take any retirement benefits. Also, the firms no longer have the right to enter the safe garden of laws, so the firms are deprived of accessing fully to capital and labor markets. Thus, informal sector firms are fully exposed to the outside shocks and they are not capable of optimizing their profits (Loayza, 1996).

Under these circumstances why are the firms and households willing to give up their governmental rights and consent with the unsafe environment of informal sector? How does the shadow economy arise? Following De Soto (1989)'s definition, Loayza (1996) and Ihrig and Moe (2004) answer the question that underground economies emerge when the government imposes high tax rates and tight regulations while lacking ability to enforce these policies. However, the answers may not be as straightforward as the researchers put forward. Because, the correlation between the size of informality and the high tax rates and tight regulations may be bidirectional. Namely, the reason for the imposing high tax rates and tight regulations might also be the tax evasion itself. In other words, it is like chicken and egg story, imposing high tax rates and tight regulations may be both the reason and result of the existence

of the shadow economy. They also point out that any increment in the size of the informal sector will mitigate the growth rate of the economy. Ihrig and Moe (2004) also indicate that reducing the tax rates or relaxing regulations are not a solution on their own; in fact, these policies must be reinforced with intensified enforcement. To do so, governments may increase penalties for any illegality in taxing.

Now, we come to another crucial point: the government. The government has three roles in this framework. First one is the regulation, such that the government enforces regulations, penalties and the related laws. Secondly, the government is also responsible for the inspection of these regulations and enforcements. The last role of the government is collecting taxes. It can be seen that government officials are the key point of this system. If those officials are corrupted in a way and profit from the situation<sup>6</sup> they will make the informal sector attractive. Consequently, under these circumstances, existence of the informal sector benefits the corrupted officials and the constituents of the underground sector, not the society.

Another question that comes to mind when studying the misty environment of the informal economy is the determination of wages in each sector. Since there are two separate sectors and one of them does not comply with any regulation, this question is not easy one to answer. However, Schmidt-Hebbel (1997) and Cuff, Marceau, Mongrain and Roberts (2011) suggest that net of the formal wages and informal wages have to be equal in the steady state under the assumption that households can choose to work in the formal sector or in the informal sector. This makes sense since in the informal sector, firms are exposed to the many factors, which formal sector firms do not confront. Furthermore, they do not have the chance to fully optimize, so they have to pay the exact amount of net wage of formal sector (in that case no one would possibly want to work in the informal sector given that they have the opportunity to work in the formal sector).

### **3.4 Approaches for the Estimation of the Size of Informality**

Estimating the size of the shadow economy is an important research question for the researchers who study informality. Roughly speaking, in the literature there exist

---

<sup>6</sup> Taking bribe, misuse of political influence etc.

three approaches to determine the size of the informal sector: direct approaches, indirect approaches and model approaches. Moreover, in the last section, apart from these three approaches, a new approach by Elgin and Öztunalı (2012) which employs general equilibrium methodology is overviewed.

### **3.4.1 Direct Approach**

Direct approach, as its name suggests, means that researchers confront directly with the components of shadow economy by using microeconomics methods such as survey or by directly auditing them. Major advantage of this approach is that this method can give information not only the size but also the structure of the underground economy (unlike the other approaches). In the direct approach, there are two methods: survey method and tax auditing method.

#### **3.4.1.1 Survey Method**

This method consists of using surveys at the micro level which has advantage of collecting the information from the first hand about the motivation of individuals why they escape to the underground economy (Schneider and Buehn, 2013). Major deficiency of survey method is the success of method heavily depends on the accuracy and honesty of the answers of the individuals who participate the survey. But, the researchers who used this method utilized some methods to overcome this problem, such as the respondents are accommodated to the progress of the survey step by step.

#### **3.4.1.2 Tax Auditing Method**

In the tax auditing approach, the size of the informal sector can be estimated by using the sample data of discrepancy between the declared income of taxpayers and the investigated amount by the tax audits. In this method, the problem is that the audited sample may not denote all the characteristics of the population and the sample itself may be a biased one. In case of the audits in Turkey, nearly 3% of the income earners have been investigated. So, we can say that this method works for only the fraction which is audited (Öğünç and Yılmaz, 2000). Besides, it is assumed that 3% of the population is audited randomly but it might not be random especially in a developing country setting.

### **3.4.2 Indirect Approach**

The second approach to measure the size of the economy is the indirect approach, which is also called as macro approach. As the “macro” phrase suggests, in this approach researchers use macroeconomic data to evaluate the size of the underground economy. The biggest advantage of this approach is, the weakest point of direct approach, honesty of the agents. People usually try to cover up their informal activities, hence the information they give would be flawed. But, in this approach, researchers are not dealing with individuals; instead they look to the “whole” economy, to determine the size of the economy. But, on the other hand, there is an important inadequateness of this method, as the approach can give information about the “size” of the informal economy, not the “structure” of informality.

Indirect approach can be divided into four different sub-categories: accounting statistics, employment statistics, monetary statistics and physical output i.e. electrical consumption.

#### **3.4.2.1 Accounting statistics**

Firstly, in accounting statistics the informal sector is evaluated by the discrepancy between the two different processes of GDP calculation: expenditure method and production method (Schneider and Buehn, 2013). This method is based on the notion that the informal sector can avoid production based taxes but not consumption based taxes. One shortcoming of this method is that the observed difference between the two macroeconomic data used in this method, may be estimated by using wrong techniques or by simply the measurement errors.

#### **3.4.2.2 Monetary statistics**

Monetary statistics method is based on the idea that shadow economy uses cash as a medium of transaction to avoid documentation. The two foremost methods which can be categorized under the monetary statistics are the currency ratio approach and the currency demand approach. In the currency ratio approach, it is assumed that unless there is informality, currency ratio has to remain constant over time. However,

there are many shortcomings in this approach, such as currency ratio needs not to be constant whether there is informality, or not. Also, Giles (1999) indicates that this method focuses on only one signal of the shadow economy, “demand for currency”. Moreover the medium of exchange may not be the cash only.

Currency demand approach which is propounded by Cagan (1958) and extended by Tanzi (1983) based on the idea that there is a relation between the demand for cash and the tax burden. This approach consists of two separate regressions. In the first regression, weighted mean tax rate ( $T_t$ ), the ratio of total wage to income ( $S/Y_t$ ) interest rate ( $r_t$ ) and GDP per capita ( $Y/P_t$ ) are independent variables while the ratio of currency to the money supply ( $Cu_t$ ) is the dependent variable. Second regression is quite similar to the first one, but this time explanatory variables are the ratio of total wage to income, interest rate and GDP per capita (notice that weighted mean tax rate is missing), however explained variable remains same as the ratio of currency to the money supply.

Briefly, this approach is based on the idea that regressing the same certain independent variables, with and without weighted mean tax rate on the same dependent variable. Hence, the procedure is:

- i. Run the equation (3.1) and obtain the fitted values  $\ln(Cu_t)^1$ 

$$\ln(Cu_t) = \beta_0 + \beta_1 \ln(1+T)_t + \beta_2 \ln(S/Y)_t + \beta_3 \ln(r_t) + \beta_4 \ln(Y/P)_t + u_t \quad (3.1)$$
- ii. Then run this equation (3.2) and obtain the fitted values  $\ln(Cu_t)^2$ 

$$\ln(Cu_t) = \beta_0 + \beta_1 \ln(S/Y)_t + \beta_2 \ln(r_t) + \beta_3 \ln(Y/P)_t + u_t \quad (3.2)$$
- iii. The gap between these two fitted values (i.e.  $\ln(Cu_t)^1 - \ln(Cu_t)^2$ ) of dependent variables gives us currency circulation rate of informal sector.
- iv. Multiply the value found in (iii) with velocity of money to calculate the size of the underground economy.

### 3.4.2.3 Employment statistics

Employment statistics method is based on the assumption that the level of official labor force participation is constant and so any decline in this participation level must

be due to the growing informal sector. This method's flaw is the ignorance of the fact that an individual can work in both formal and informal sectors.

#### **3.4.2.4 Physical output statistics**

The last method in the indirect approach is the "physical output" method. This method is based on the idea that electrical consumption is the best proxy for total production activity, namely formal plus informal sectors (Kaliberda and Kauffman, 1996). The biggest inadequateness of this method is, production in the underground economy may not need electricity, which leads to an underestimation problem.

#### **3.4.3 Model Approach**

The last approach to measure the size of the economy is the model approach. This approach is introduced by Frey and Weck (1983). The main idea behind this approach is that, shadow economy (due to the hidden status) is not an observable variable like any other variable. Thus, to measure the size of the shadow economy, some mathematical models should be constructed in which the causes and the indicators are employed as the inputs.

Thus, as the name suggests, Multiple Indicator Multiple Cause Models (MIMIC) are developed since then. MIMIC has two separate parts<sup>7</sup>. First part consists of obtaining the indicators. Here, notice that indicator refers to the observable indicators which are related to the shadow economy. In the second part, the causal relationships between these indicators are determined by running a structural model. The main criticism to this approach is that the model depends on too many econometric assumptions (Elgin and Öztunalı, 2012).

#### **3.4.4 A New Approach**

Elgin and Öztunalı, (2012) introduced a new approach to estimate the size of the shadow economy. In this new approach, the researchers construct a two period, dynamic, general equilibrium model. The model consists of two sectors: formal and

---

<sup>7</sup> In the literature there is also another approach as DYMIMIC, which is nothing but the dynamic version MIMIC approach. Hence, there is no significant between these two methods.



informal. In the study, the researchers solve the model for the steady state and characterize the model by calibrating the model's parameters using the observable data of the examined country to match each country's characteristics. Then, in the last step, the size of the informal economy, which is not observable at all, is backed out from the model. Elgin and Öztunalı (2012) repeats this procedure for 161 countries and for the years 1950-2009. Hence, it can be concluded that the observable data has to vary year to year and country by country.

In our study, to calibrate the model for Turkey, we utilize the results of Elgin and Öztunalı (2012) as the proportion of the informal sector which is 27.68 % in the year 2009. The reason is that unlike the other approaches, the model in Elgin and Öztunalı (2012) is based on some microeconomic foundations such as using two sector model (which is quite similar to our model) and also does not give any credit to ad-hoc econometric assumptions.

# CHAPTER 4

## THE MODEL

The model in this study is based on Auerbach and Kotlikoff (1987) which is a dynamic 55-period life cycle simulation model. Our model consists of households, firms and government. The economy is closed, households are assumed to be homogenous while the firms are heterogeneous in accordance with their formality status. Furthermore, it is assumed that formal sector firms are capital intensive, while the informal sector firms are labor intensive. Moreover, government has a separate social security system. The workers in the formal sector are included in the public pension system, they pay taxes and get retirement benefits in return, but in the informal sector, since they are excluded from the pension system, the workers do not pay any taxes and get no benefits. For the whole economy, there are non-linear systems of equations which connect all the actors: households, formal and informal firms and government. All of the equations are solved simultaneously to find the solution set.

### 4.1 Demographic Structure

The household sector consists of 55 cohorts which overlap at any given period. In the model, one period accounts for one year, henceforth we can conclude an agent enters the economy at first period (age 21 in real life) and since lifetime uncertainty is not included in the model, all agents die at the end of 55 periods (age 75 in real life). Furthermore, there is no intragenerational heterogeneity, so individuals at the same age are identical. Thus, a single representative agent's behavior mimics the aggregate behavior of the generation that she belongs to. Moreover, there is no

complexity in the family structure, such as gender difference, children etc. Population grows at rate  $n = 1.37\%$  which is imposed to the model exogenously<sup>8</sup>. That is to say, each generation is  $(1+n)$  times larger than the previous one.

## 4.2 Households Behavior

### 4.2.1 Preferences

Each agent is assumed to have personal preferences that can be represented by a utility function which includes consumption ( $c$ ), leisure ( $l$ ) and bequest ( $b$ ). In accordance with the utility function, each household maximizes her lifetime utility by choosing perfectly foresighted lifetime paths of consumption and leisure, and also the amount of the bequest that she leaves at the last period of her life. Utility function is time separable and has the constant elasticity of substitution (CES) form as below:

$$U_t = \frac{1}{1 - \frac{1}{\gamma}} \left[ \left\{ \sum_{t=1}^{55} (1 + \delta)^{-(t-1)} \left( c_t^{\left(\frac{1-\frac{1}{\rho}}{\rho}\right)} + \alpha l_t^{\left(\frac{1-\frac{1}{\rho}}{\rho}\right)} \right)^{\left(\frac{1-\frac{1}{\gamma}}{\gamma}\right)} \right\} + (1 + \delta)^{-54} (\mu)(b_{t+54})^{\left(\frac{1-\frac{1}{\gamma}}{\gamma}\right)} \right] \quad (4.3)$$

where  $\gamma$ ,  $\rho$ ,  $\delta$ ,  $\alpha$  and  $\mu$  are taste parameters that characterize the preferences of the individuals and  $t$  stands for the period. The parameter  $\rho$  is the elasticity of substitution between  $c_t$  and  $l_t$ , namely the responsiveness of the ratio  $l$  to  $c$  to the wage rate. The parameter  $\alpha$  shows the intensity of household preferences for leisure. That is as  $\alpha$  increases, household takes more utility from leisure.  $\delta$  is the pure rate of the time preference. The higher the  $\delta$ , the more eagerness to spend today and the less motive to save.  $\gamma$  is intertemporal elasticity of substitution of consumption in consecutive years. The parameter  $\mu$  is the weighting coefficient of bequest motive.<sup>9</sup>

---

<sup>8</sup> The value of the population growth rate is taken from the Turkish Statistical Institute (TurkStat).

<sup>9</sup> Bequest motive is modeled as the simpler version of Blinder (1973). In the study, bequest motive is formulated as “joy of giving”. Namely, the individual simply gets utility from leaving inheritance to the successor as she gets from consumption and leisure.

The higher the  $\mu$ , the more utility household gets utility from leaving bequest to the successor.

As a final remark, since the households are homogenous, utility function does not differ between the workers of formal and informal sector.

#### 4.2.2 Budget Constraints

Households choose how much to work, how much to consume and how much to leave to the successor (after death) as bequest in each period. However, given that households have the ability of perfect foresight, each year “decisions” must be consistent with all future years. Namely, the households optimize their utility each year but it must also be consistent with the previous year’s choices. So, we can conclude that entire path of consumption, leisure and the amount of bequest are determined at the first period from a single optimization, when there is no accumulated capital.

Furthermore, households save the excess amount which comes from income less consumption<sup>10</sup>. Due to the assumption of closed economy, households loan these savings as capital to the formal and informal firms and receive payment from this rental at a level which equals to interest rate,  $r$ . We can formulate this loaning procedures as:

$$a_t = k_t \tag{4.4}$$

From now on, throughout the study,  $a_t$  (asset stock) and  $k_t$  (capital holdings) can be used interchangeably.

##### 4.2.2.1 Formal Sector

In the existence of taxation and a social security system, the sequence which constructs the lifetime budget constraint of a formal sector worker is:

---

<sup>10</sup> Here, income concept consists of capital income, labor income and received inheritance from the predecessor.

$$a_{t+1}^f = (1 + r_t(1 - \tau_k))(a_t^f + \eta_t g_t^f) + w_t^f(1 - \tau_w)(1 - l_t^f) - (1 + \tau_c)c_t^f - \zeta_t b_t^f + \phi_t pen_t \quad (4.5)$$

where  $f$  superscript denotes the formal sector.  $a_t^f$  is the capital holdings of the household,  $r_t$  is the return on savings before tax,  $w_t^f$  is the wage of the formal sector,  $g_t^f$  is the inheritance that is received from predecessors,  $b_t^f$  is the bequest that is left to the successors and lastly  $pen_t$  is the retirement benefit at year  $t$ . Also,  $\tau_k$ ,  $\tau_c$  and  $\tau_w$  denotes capital income tax, consumption tax and payroll tax, respectively.

Moreover, for simplicity we assumed that households work for 55 periods, in other words if they want, they can continue to work, even after their retirement. So, consequently after 40 periods households receive both wage income and retirement benefits.

In case of bequests and inheritances, it is assumed that the bequests can be left only in the last period and the inheritances can be received only in the first period. Moreover, for the sake of simplicity, the transfer of bequests and inheritances are carried out through a fictional intermediary institution which collects all of the bequest left from the individuals who are at their final period of their life and equally distribute the total amount as the inheritances to the young people who are at the first period of their life.

Therefore, we have calibrated the coefficients of Equation (4.3) with respect to;

$$\zeta_t = \begin{cases} 0 & \text{for } t = 1, 2, \dots, 54 \\ 1 & \text{for } t = 55 \end{cases}$$

$$\eta_t = \begin{cases} 1 & \text{for } t = 1 \\ 0 & \text{for } t = 2, 3, \dots, 55 \end{cases}$$

$$\phi_t = \begin{cases} 0 & \text{for } t = 1, 2, \dots, 40 \\ 1 & \text{for } t = 41, \dots, 55 \end{cases} \quad (4.4)$$

where  $\zeta_t$ ,  $\eta_t$ , and  $\phi_t$  denotes the coefficients of bequest, inheritance and retirement benefits, respectively.

#### 4.2.2.2 Informal Sector

Budget constraint of the households of the informal sector is slightly different than those in the formal sector. The households in the informal sector still choose how much to work, how much to consume and how much to leave to the successor (after death) as bequest in each period, but now since they are excluded from the social security system, they no longer pay the payroll tax or receive the retirement benefits. Thus, the sequence which forms the lifetime budget constraint of informal sector worker is:

$$a_{t+1}^i = (1 + r_t(1 - \tau_k))(a_t^i + \eta_t g_t^i) + w_t^i(1 - l_t^i) - (1 + \tau_c)c_t^i - \zeta_t b_t^i \quad (4.7)$$

where  $i$  superscript denotes informality. All other parameters refer to the same concept as in the formal sector budget constraint.

#### 4.2.3 Choice of Consumption, Leisure and Bequest

Households choose their lifetime consumption, leisure and bequest in accordance with some constraints. Firstly, lifetime expenditures must be equal to lifetime earnings. Since the budget constraints of formal sector and informal sectors workers are different, this equality also differs for households. The equilibrium condition for formal sector workers are given below:

$$\textit{lifetime expenditures} = \textit{lifetime earnings} \quad (4.8)$$

where

$$\textit{lifetime expenditures} = \frac{b_t^f}{(1 + r_t(1 - \tau_k))^{T-1}} + \sum_{t=1}^T \frac{c_t^f(1 + \tau_c)}{(1 + r_t(1 - \tau_k))^{t-1}} \quad (4.9)$$

$$\textit{lifetime earnings} = g_t^f + \sum_{t=41}^T \frac{pen_t}{(1 + r_t(1 - \tau_k))^{t-1}} + \sum_{t=1}^T \frac{w_t^f(1 - l_t)(1 - \tau_w)}{(1 + r_t(1 - \tau_k))^{t-1}} \quad (4.8)$$

For informal sector workers, lifetime expenditures are the same as in the formal sector, but lifetime earnings differ, due to their payroll tax evasion. The lifetime earning formula for informal sector workers are as below:

$$\textit{lifetime earnings} = g_t^i + \sum_{t=1}^T \frac{w_t^i (1-l_t^i)}{(1+r_t(1-\tau_k))^{t-1}} \quad (4.11)$$

Furthermore, since leisure is denoted as a unit of time, there are also some restrictions on the leisure term. To begin with, leisure values are normalized so cannot exceed one. Also, we must impose the restriction of non-negativity, since it is impossible to have a negative leisure time. These constraints on leisure can be expressed as,

$$0 \leq l_t \leq 1 \quad \textit{for all } t \quad (4.12)$$

Last constraint on households' lifetime is that all agents enter the economy without initial asset and have no remaining asset after one period of death. One may wonder about inheritances and bequests. In that case, an agent receives the bequest in the first period and leaves the bequest at the last period as another source of income. So, we can impose the restriction below:

$$a_1 = a_{s6} = 0 \quad (4.13)$$

Also, it is assumed that the households cannot leave negative bequest to their children, therefore the following restriction is imposed:

$$a_{s5} \geq 0 \quad (4.14)$$

#### 4.2.3.1 Optimization Problem of Formal Sector's Household

Now, we are ready to present the optimization problem of the households subject to all constraints mentioned above. Since the budget constraints differ between the formal sector workers and informal sector workers, for each type of household there are two different budget constraints which means that we have two separate

optimization problems. The households which work in the formal sector have the optimization problem as follows:

$$\begin{aligned} \max_{c_t^f, l_t^f, b_t^f} U_t^f = & \frac{1}{1-\frac{1}{\gamma}} \left[ \sum_{t=1}^{55} (1+\delta)^{-(t-1)} \left( (c_t^f)^{\left(1-\frac{1}{\rho}\right)} + (\alpha l_t^f)^{\left(1-\frac{1}{\rho}\right)} \right)^{\left(\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}\right)} \right] \\ & + \frac{1}{1-\frac{1}{\gamma}} \left[ (1+\delta)^{-54} (\mu)(b_{t+54}^f)^{\left(1-\frac{1}{\gamma}\right)} \right] \end{aligned} \quad (4.15)$$

subject to

$$a_{t+1}^f = (1+r_t(1-\tau_k))(a_t^f + \eta_t g_t^f) + w_t^f(1-\tau_w)(1-l_t^f) - (1+\tau_c)c_t^f - \zeta_t b_t^f + \phi_t pen_t$$

$$0 \leq l_t^f \leq 1$$

$$a_1^f = a_{56}^f = 0$$

$$a_{55}^f \geq 0 \quad \text{for } t=1, \dots, T \quad (4.16)$$

Maximization of the utility function (Equation 4.13) subject to the constraints (Equation 4.14) gives the Euler equations which governs the behavior of the households who work in the formal sector.

$$c_{t+1}^f = \left( \frac{1+(r_t(1-\tau_k))}{1+\delta} \right)^\gamma \left( \frac{v_{t+1}^f}{v_t^f} \right) c_t^f \quad (4.17)$$

where



$$\frac{v_{t+1}^i}{v_t^i} = \frac{\left(1 + \left(\alpha \rho \frac{w_{t+1}^f (1 - \tau_w)}{1 + \tau_c}\right)^{(1-\rho)}\right)^{\left[\frac{(\rho-\gamma)}{(1-\rho)}\right]}}{\left(1 + \left(\alpha \rho \frac{w_t^f (1 - \tau_w)}{1 + \tau_c}\right)^{(1-\rho)}\right)^{\left[\frac{(\rho-\gamma)}{(1-\rho)}\right]}} \quad (4.18)$$

In the steady state, wages do not change over time. So, we can write the equality:

$$w_{t+1}^f = w_t^f \quad (4.19)$$

Thus, Equation (4.15) becomes:

$$c_{t+1}^f = \left(\frac{1 + (r_t(1 - \tau_k))}{1 + \delta}\right)^\gamma c_t^f \quad (4.20)$$

The next Euler equation which connects leisure and consumption decision is:

$$l_t^f = \left(\frac{w_t^f (1 - \tau_w)}{\alpha}\right)^{-\rho} c_t^f \quad (4.21)$$

The third element in the utility function is bequest, so the Euler which connects consumption and bequest is shown below:

$$b_t^f = \left(\frac{1}{\mu}\right)^{-\gamma} \left( (c_t^f)^{\left(1 - \frac{1}{\rho}\right)} + (\alpha l_t^f)^{\left(1 - \frac{1}{\rho}\right)} \right)^{\left(\frac{\rho-\gamma}{\rho-1}\right)} (c_t^f)^{\left(\frac{\gamma}{\rho}\right)} \quad (4.22)$$

In addition, although it is not necessary to solve the whole non-linear equation system, we can give another Euler equation which links leisure through time:

$$l_{t+1}^f = \left(\frac{1 + (r_t(1 - \tau_k))}{1 + \delta}\right)^\gamma \left(\frac{v_{t+1}^f}{v_t^f}\right)^{-\rho} \left(\frac{w_{t+1}^f (1 - \tau_w)}{w_t^f (1 - \tau_w)}\right)^{-\rho} l_t^f \quad (4.23)$$

Again, using Equation (4.17), at the steady state, Equation (4.21) shrinks to:

$$l_{t+1}^f = \left( \frac{1 + (r_t(1 - \tau_k))}{1 + \delta} \right)^\gamma l_t^f \quad (4.24)$$

#### 4.2.3.2 Optimization Problem of Informal Sector's Household

The households which work in the informal sector have a different optimization problem, since they have no social security contribution or no retirement benefits. Hence, the utility maximization of informal sector's worker is characterized as follows:

$$\begin{aligned} \max_{c_t^i, l_t^i, b_t^i} U_t^i = & \frac{1}{1 - \frac{1}{\gamma}} \left[ \sum_{t=1}^{55} (1 + \delta)^{-(t-1)} \left( (c_t^i)^{\left(\frac{1-\frac{1}{\rho}}{\rho}\right)} + (\alpha l_t^i)^{\left(\frac{1-\frac{1}{\rho}}{\rho}\right)} \right)^{\left(\frac{1-\frac{1}{\gamma}}{\gamma}\right)} \right] \\ & + \frac{1}{1 - \frac{1}{\gamma}} \left[ (1 + \delta)^{-54} (\mu)(b_{t+54}^i)^{\left(\frac{1-\frac{1}{\gamma}}{\gamma}\right)} \right] \end{aligned} \quad (4.25)$$

subject to

$$a_{t+1}^i = (1 + r_t(1 - \tau_k))(a_t^i + \eta_t g_t^i) + w_t^i(1 - l_t^i) - (1 + \tau_c)c_t^i - \zeta_t b_t^i$$

$$0 \leq l_t^i \leq 1$$

$$a_1^i = a_{56}^i = 0$$

$$a_{55}^i \geq 0 \quad \text{for } t = 1, \dots, T \quad (4.26)$$

Maximization of the utility function (Equation 4.23) subject to the constraints (Equation 4.24) gives the following Euler set for the workers of informal sector.<sup>11</sup>

---

<sup>11</sup> It can be noticed that the Euler equation set of informal sector is similar, but differs in terms of taxation and benefits.

$$c_{t+1}^i = \left( \frac{1 + (r_t(1 - \tau_k))}{1 + \delta} \right)^\gamma \left( \frac{v_{t+1}^i}{v_t^i} \right) c_t^i \quad (4.27)$$

where

$$\frac{v_{t+1}^i}{v_t^i} = \frac{\left( 1 + \left( \alpha \rho \frac{w_{t+1}^i}{1 + \tau_c} \right)^{(1-\rho)} \right)^{\left[ \frac{(\rho-\gamma)}{(1-\rho)} \right]}}{\left( 1 + \left( \alpha \rho \frac{w_t^i}{1 + \tau_c} \right)^{(1-\rho)} \right)^{\left[ \frac{(\rho-\gamma)}{(1-\rho)} \right]}} \quad (4.28)$$

At the steady state, wages do not change through time in the informal sector, too. So, we can write the equality:

$$w_{t+1}^i = w_t^i \quad (4.29)$$

Thus, Equation (4.25) shrinks to:

$$c_{t+1}^i = \left( \frac{1 + (r_t(1 - \tau_k))}{1 + \delta} \right)^\gamma c_t^i \quad (4.30)$$

The Euler equation of leisure and consumption decision:

$$l_t^i = \left( \frac{w_t^i}{\alpha} \right)^{-\rho} c_t^i \quad (4.31)$$

Also, the Euler equation for bequest is:

$$b_t^i = \left( \frac{1}{\mu} \right)^{-\gamma} \left( (c_t^i)^{\left(1 - \frac{1}{\rho}\right)} + (\alpha l_t^i)^{\left(1 - \frac{1}{\rho}\right)} \right)^{\left( \frac{\rho-\gamma}{\rho-1} \right)} (c_t^i)^{\left( \frac{\gamma}{\rho} \right)} \quad (4.32)$$

The Euler equation of leisure is:

$$l_{t+1}^i = \left( \frac{1 + (r_t(1 - \tau_k))}{1 + \delta} \right)^\gamma \left( \frac{v_{t+1}^i}{v_t^i} \right)^{-\rho} \left( \frac{w_{t+1}^i}{w_t^i} \right)^{-\rho} l_t^i \quad (4.33)$$

Again, due to the Equation (4.27), Equation (4.31) shrinks to:

$$l_{t+1}^i = \left( \frac{1 + (r_t(1 - \tau_k))}{1 + \delta} \right)^\gamma l_t^i \quad (4.34)$$

### 4.3 Firms Behavior

The model has two production sectors: formal and informal. Each sector consists of one representative firm which employs capital and labor in a competitive environment. In both sectors, capital and labor are assumed to be homogenous. However, each representative firm differentiates in the way that formal sector firm is capital intensive and informal sector firm is labor intensive. Prices are set to be numeraire, since the commodities of each sector are identical.

In the existence of constant population growth, government debt ( $D$ ), capital ( $K$ ) and labor ( $L$ ) are aggregated by summing individual assets ( $a_t$ )<sup>12</sup> and individual supply of labor ( $1-l_t$ ), respectively. Capital and labor at time  $t$  is shown in the below equations:

$$K_t = \left( \sum_{j=f,i} \sum_{s=1}^{55} (1+n)^{-(s-1)} a_{s,t}^j \right) - D_t \quad (4.35)$$

$$L_t = \sum_{j=f,i} \sum_{s=1}^{55} (1+n)^{-(s-1)} (1-l_{s,t}^j) \quad (4.36)$$

where  $s$  denotes the age of the individual and  $j$  denotes the sector, i.e. formal as (1) and informal as (2).

---

<sup>12</sup> Due to Equation (4.2), individual asset stock ( $a_t$ ) and capital holdings ( $k_t$ ) are assumed to be referring to same concept.

Total output of the economy equals to summation of formal and informal sector's production and the production function is in the constant elasticity of substitution (CES) form:

$$Y_t = \sum_{j=f,i} A \left[ \varepsilon_j K_{j,t}^{\left(1-\frac{1}{\sigma_j}\right)} + (1-\varepsilon_j) L_{j,t}^{\left(1-\frac{1}{\sigma_j}\right)} \right]^{\left(\frac{1}{1-\frac{1}{\sigma_j}}\right)} \quad (4.37)$$

where  $Y_t$  is the national income at time  $t$ ,  $A$  is a scaling constant which is assumed to be constant overtime, so it can be concluded that in the model there is no technological progress. The parameter  $\varepsilon$  denotes the intensity of the use of capital in the production process.  $\sigma$  is the elasticity of substitution in production which means the responsiveness of the ratio  $K/L$  to the ratio  $w/r$ .

#### 4.3.1 The Investment Decision

In our model, we assumed that the cost of capital is imposed to the both formal and informal firms and then firms adjust the marginal product of capital to the interest rate,  $r$ .

Given these assumptions and conditions; the interest rate can be calculated by simply taking the first order derivative of the Equation (4.35) with respect to  $K$ . In order to carry out this procedure, we have to plug below equalities into the respective positions in Equation (4.35).

$$K_t^f = K_t \theta$$

$$K_t^i = K_t (1-\theta)$$

$$L_t^f = L_t \theta$$

$$L_t^i = L_t (1-\theta) \quad (4.36)$$

where  $\theta$  denotes the proportion of the formal sector to the total output<sup>13</sup>.

$$r_t = A\theta\varepsilon_f (K_t\theta)^{\left(\frac{-1}{\sigma_f}\right)} \left[ \varepsilon_f (K_t\theta)^{\left(1-\frac{1}{\sigma_f}\right)} + (1-\varepsilon_f)(L_t\theta)^{\left(1-\frac{1}{\sigma_f}\right)} \right]^{\left(\frac{1}{\sigma_f-1}\right)} + A(1-\theta)\varepsilon_i (K_t(1-\theta))^{\left(\frac{-1}{\sigma_i}\right)} \left[ \varepsilon_i (K_t(1-\theta))^{\left(1-\frac{1}{\sigma_i}\right)} + (1-\varepsilon_i)(L_t(1-\theta))^{\left(1-\frac{1}{\sigma_i}\right)} \right]^{\left(\frac{1}{\sigma_i-1}\right)} \quad (4.39)$$

### 4.3.2 The Demand for Labor

Analyzing the labor market conditions are a bit tricky since there are two optimization procedures simultaneously. The model incorporates the assumption that formal sector can maximize its profit without any restriction, due to the fact that formal firm can adjust the amount of labor costlessly. So, these circumstances give us the standard formula of the wage rates of the formal sector as:

$$w_t^f = A(1-\varepsilon_f) \left[ \varepsilon_f (K_t\theta)^{\left(1-\frac{1}{\sigma_f}\right)} + (1-\varepsilon_f)(L_t\theta)^{\left(1-\frac{1}{\sigma_f}\right)} \right]^{\left(\frac{1}{\sigma_f-1}\right)} (L_t\theta)^{\left(\frac{-1}{\sigma_f}\right)} \quad (4.40)$$

In the informal sector, profit maximization cannot be achieved perfectly. Since, informality means evasion from government, the firms in the shadow economy do not have the ability to set the wage rates. Instead, as proposed by Schmidt-Hebbel (1997) and Cuff, Marceau, Mongrain and Roberts (2011) the informal sector firms are forced to pay the wages which must satisfy below equality:

---

<sup>13</sup> Here,  $\theta$  coefficient requires more explanation. As mentioned before, we impose the proportion of the informal sector exogenously. Elgin and Öztunalı (2012) states that the proportion of informality to the GDP is 27.68 %. So,  $\theta$  is calculated as below:

$$\frac{1-\theta}{\theta} = 0.2768 \Rightarrow \theta = 0.7832$$

Moreover, throughout the study, all the proportions of informality is converted and imposed to the model in the same way.

$$\begin{aligned}
\underbrace{\sum_{s=1}^T \frac{w_t^i}{(1+r)^{s-1}}}_{\substack{\text{Lifetime Earnings} \\ \text{of the Informal Sector} \\ \text{Worker}}} &= \underbrace{\sum_{s=1}^T \frac{w_t^f}{(1+r)^{s-1}}}_{\substack{\text{Lifetime Earnings} \\ \text{of the Formal Sector} \\ \text{Worker}}} - \underbrace{\sum_{s=1}^T \frac{(w_t^f)(\tau_w)}{(1+r)^{s-1}}}_{\substack{\text{Contribution to} \\ \text{PAYG System}}} + \underbrace{\sum_{s=41}^T \frac{(w_t^f)(RR)(\tau_w)}{(1+r)^{s-1}}}_{\substack{\text{Benefit Received from the} \\ \text{PAYG System}}} \quad (4.41)
\end{aligned}$$

where  $RR$  is the replacement rate. Replacement rate can be defined as the percentage of a worker's average lifetime income that is paid out by social security after retirement<sup>14</sup>.

The right hand side in the Equation (4.39) gives the net wage that a formal sector worker receives throughout her lifetime. It is actually the gross wage of the formal sector worker less the present value of the net income from the PAYG system (present value of the total contribution to the system less total benefits received). Furthermore, left hand side of the Equation (4.39) gives the lifetime wage of the informal sector worker. Consequently, lifetime wage of the informal sector worker equals the net of the lifetime wage of the formal sector worker.

Since there is no skill heterogeneity between the households, labor who works in the informal sector have the same capacity of the labor formal sectors. Thus, unless informal sector pays below the amount in the Equation (4.39), probably no one will want to work in the informal sector given that the labor flow between the sectors is allowed.

#### 4.4 Government Behavior

The government in the model, finances its own spending by collecting taxes. Here, note that informal sector evades taxes, so total revenue of the government comes out less than what it should be. Also, for the sake of this model's simplicity, it is assumed that there is no indirect effect of the government spending on household's and firms' behavior. Thus, government expenditures are unproductive and are not generating any utility to the households.

---

<sup>14</sup> Replacement rate concept is elaborately expressed by its formulations in section 4.3.

Moreover, the model includes a separate social security system which has its own budget constraint. Apart from the government's spending and revenues, the social security system has to balance its budget in each period.

#### 4.4.1. Taxation

Taxation affects households by lowering their disposable income or changing the relative price of goods and leisure. This situation is, of course, distorting the analysis of the economy and needs to be taken care of carefully. Specifically for our model, a remarkable thing to remember is that formal sector contributes to the tax system in all channels, while informal sector evades income taxes (yet contributes in other channels).

Government collects taxes in three different ways. Firstly, labor income tax ( $\tau_w$ ), in which government suffers most, due to the informal sector's evasion. Next one is consumption tax ( $\tau_c$ ) in which both sectors pay their taxes. It is because, consumption taxes are collected from the purchased goods, namely informal sector does not have any way to evade the consumption tax. Last one is capital income tax ( $\tau_k$ ) that is both formal and informal sectors are contributing (informal sector do not have the chance to evade capital income tax, since it is collected through the interest rate).<sup>15</sup>

#### 4.4.2. The Government's Budget Constraint

At each period, the government collects taxes ( $TR_t$ ) and issues debt ( $D_{t+1}$ ) to finance the government purchases ( $G_t$ ) and the interest rate payments of the previous period's debts ( $D_t$ ). Given this framework, Equation (4.40) and (4.41) characterizes the budget of the government:

---

<sup>15</sup> In this study, we model the economy as informal sector evades only from the payroll tax. The economy can be modelled that informal sector evades also from the capital income tax. Furthermore, more complicated models can be constructed; and even formal sector avoids some parts of the capital income tax. But, in that case the model will be too complicated for simulation.



$$D_{t+1} + TR_t = G_t + (1+r)D_t \quad (4.42)$$

$$TR_t = \tau_k r_t (K_t^f + K_t^i) + \tau_c (C_t^f + C_t^i) + \tau_w w_t^f L_t^f \quad (4.43)$$

In the Equation (4.41),  $C_t$  is the aggregate consumption and aggregated in the same way of aggregating capital ( $K$ ) and labor ( $L$ ), such that:

$$C_t = \sum_{j=f,i} \sum_{s=1}^{55} (1+n)^{-(s-1)} c_{s,t}^j \quad (4.44)$$

In addition, it is assumed in the model that in the steady state debt stock is constant which brings us to another constraint:

$$D_{t+1} = D_t \text{ for all } t \quad (4.45)$$

Combining Equations (4.40), (4.41), (4.42) and (4.43), we now have the final version of the government budget constraint:

$$G_t = TR_t - r_t D_t \quad (4.46)$$

Note that, in the model, the government spending affects total revenues (namely, the tax rates) on a one-to-one basis. So, we can conclude that any reduction (*or increase*) in the government spending affects households directly by lower (*or higher*) tax rates.

#### 4.4.3. The Social Security System

In our model, the social security system follows the structure of the PAYG system, which is the social security system in Turkey. Every year, the PAYG system collects contributions through the payroll tax of formal sector workers and simultaneously, pays out the retirement benefits. The social security system does not save (hence, does not accumulate any capital) and does not have any debt.

As mentioned, only the formal sector workers enter to the social security system and only they get retirement benefits. The formal sector workers start to receive these benefits at period 41 (age 61 in real life) and continues to receive until period 55 (age

75 in real life), in other words until the death of individual. Moreover, for simplicity, we assumed that households work through lifetime (for 55 periods), in other words they continue to work, even after their retirement.

In the social security system, every individual gets retirement benefits related to their average wages<sup>16</sup>. Average wage of a worker is calculated in the model as:

$$AIME_t = \frac{1}{T} \sum_{s=1}^T w_t^f (1 - l_{t-40+s}^f) \quad (4.47)$$

where  $AIME_t$  stands for average wage of the individual through the lifetime. The retirement benefits, which are received by individuals, are linked to  $AIME_t$  through the indicated equation:

$$pen_t = (AIME_t)(RR) \quad (4.48)$$

where  $RR$  stands for the replacement ratio which is imposed by the government. As we mentioned before, the social security system has its own budget constraint which has to be balanced every year. In other words, social security system finances the retirement benefits from the taxes which is levied on labor income (payroll tax). In the existence of population growth, this can be shown as:

$$\tau_w \sum_{s=1}^T \frac{w_t^f (1 - l_{t-40+s}^f)}{(1+n)^{s-1}} = \sum_{s=41}^T \frac{pen_{t-40+s}}{(1+n)^s} - D_t^{soc} \quad (4.49)$$

In the equation sets of (4.45), (4.46) and (4.47), all variables are solved simultaneously, except tax rate on labor income ( $\tau_w$ ) and the replacement rate  $RR$  which are imposed by government as part of their fiscal policy.

---

<sup>16</sup> In Turkey, retirement benefits are calculated in accordance with the lifetime monthly earnings. However, Social Security Institution calculates the benefits using different weightings (i.e. first 3600 days of the career are weighted differently, the following 5400 days are weighted differently and the remaining days of the career are weighted differently). Since these weightings are close to each other, in the model, for the sake of simplicity, we assume that all of the wages can be treated as equal, hence the arithmetic average of the wages are utilized in the calculations.

As a last remark, by means of the Equation (4.39), government's fiscal policy affects not only formal sector's wage rates but also informal sector's wage rates.

#### 4.5 Equilibrium under Perfect Foresight

In the dynamic models, the concept of equilibrium involves that households, firms and government behave consistently with current values, as well as future values. Our model is no exception, so that given the interest rate, wage rate, tax rates and replacement rate, households maximize their lifetime utility by choosing optimal paths of consumption and leisure and the proper amount of bequest. In the aspect of firms, both formal and informal sector maximizes its profits. Given the capital markets and labor markets clearing condition, government balances its budget and lastly, given all of the above conditions, the social security system balances its budget each year.

More formally, we can define the competitive equilibrium conditions as follows:

Given the government's social security policy  $\{RR\}$ , tax rates of all kind  $\{\tau_{s,t}\}$  and the proportion of formal sector to the national income  $\{\theta\}$ , the equilibrium for our model consists of sequence of consumption choice  $\{c_{s,t}\}_f$ ,  $\{c_{s,t}\}_i$  leisure choice  $\{l_{s,t}\}_f$ ,  $\{l_{s,t}\}_i$ , saving  $\{k_{s,t}\}_f$ ,  $\{k_{s,t}\}_i$ , retirement benefits  $\{pen_t\}$ , bequests  $\{b_{s,t}\}_f$ ,  $\{b_{s,t}\}_i$ , factor prices  $\{w_{s,t}\}_f$ ,  $\{w_{s,t}\}_i$ ,  $\{r_t\}$  and the production plans  $\{y_{s,t}\}_f$ ,  $\{y_{s,t}\}_i$  such that

- i. Given wage rates  $\{w_{s,t}\}_f$ ,  $\{w_{s,t}\}_i$ , interest rate  $\{r_t\}$  households maximize their lifetime utility by choosing consumption path  $\{c_{s,t}\}_f$ ,  $\{c_{s,t}\}_i$ , leisure path  $\{l_{s,t}\}_f$ ,  $\{l_{s,t}\}_i$ , bequest  $\{b_{s,t}\}_f$ ,  $\{b_{s,t}\}_i$ , and asset stock sequence  $\{k_{s,t}\}_f$ ,  $\{k_{s,t}\}_i$ .
- ii. Given factor prices  $\{w_{s,t}\}_f$ ,  $\{w_{s,t}\}_i$ ,  $\{r_t\}$ , formal and informal sector firms maximize their profits.
- iii. Government budget is balanced at every period.
- iv. Given  $\{pen_t\}$  social security system's budget is balanced at every period.

- v. All markets clear.
- vi. The behaviors in both individual and aggregate level is consistent.

# CHAPTER 5

## SIMULATION AND FINDINGS

A dynamic, life cycle model that is elaborately described in Chapter 4 is employed for the simulations in this chapter. All of the simulations are carried out in the MATLAB environment. Moreover, “fsolve” function from the MATLAB library is utilized to solve the systems of non-linear equations.

### 5.1 Solution Methodology

Given that the related constraints and the parameterization, steady state is characterized as two different forms: the initial and final steady state. Here, initial steady state means the long run equilibrium of the economy before the shock in fiscal policy is introduced, while final steady state refers to the long run equilibrium of the economy after the policy implication.

As discussed in chapter 4, the households and the firms (both formal and informal) are perfectly foresighted before and after an exogenous shock. However, they do not anticipate the change in fiscal policy. If they could do anticipate the shock, they will optimize their lifetime utility by taking the shock into account. In other words, the analysis will be meaningless, since households and firms optimize themselves including the information of policy change. In that case, we do not have the chance to observe the effects of the fiscal policy change.

Both in the initial and final steady state; the solution set for all unknown variables are found by simultaneously solving the systems of non-linear equations which are

formed in the framework of the consistent behavior all the elements in the economy; the households, the formal and informal firms and the government.

### 5.1.1 Initial Steady State

Since our model is dynamic, the solution for the initial steady state entails that households, firms and government behave consistently over time. It is true that households and firms make their decisions every year, however, since the households and firms are assumed to be perfectly foresighted, each years' choices have to be consistent with previous and future years. Namely, the households optimize their utility and firms maximize their profit each year, but these choices have to be consistent not only with the previous years' but also the future years' choices. So, it can be concluded that the entire paths of consumption, leisure, capital holdings, pensions and the amount of bequest are solved at the first period from a single optimization set, when there is no accumulated capital.

The solutions are obtained by employing an iterative technique called Gauss-Seidel method. The schema that denotes this iterative technique, the model and the solutions are presented in Figure 5.1. The algorithm starts with the initial guesses, which have to be chosen reasonably<sup>17</sup>. These initial guesses belong to the some endogenous variables, moreover only for the first iteration the software accept these guesses as exogenous and run all the system once. After running the system once, the guesses are updated and these new guesses enter to the system instead of initial guesses. System runs again once more and updates the guesses. This procedure continues until the newly obtained guesses become equal to the former guesses. When this equality ensured, the algorithm breaks and the true solution set is found. To meet the convergence criteria, in a single run, approximately 5000 iteration is needed.

---

<sup>17</sup> The major disadvantage of the “fsolve” function is that function algorithm is very dependent to the initial values. In our model, if the initial guesses are not chosen in a plausible distance to the steady state values, the algorithm may not calculate to the steady state before reaching the maximum number of iteration.

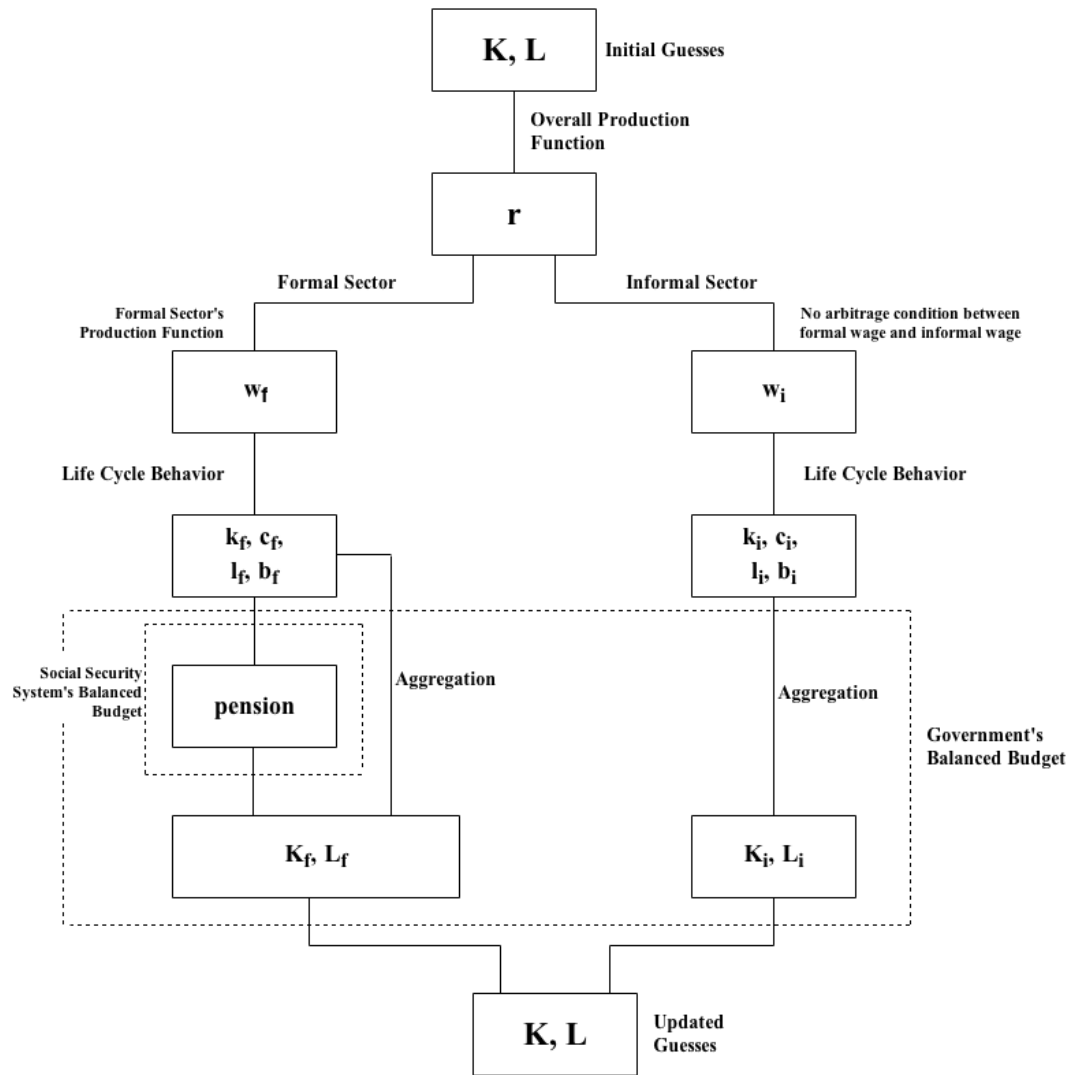


Figure 5.1: The Model

### 5.1.2 Final Steady State

The solution methodology for the final steady state is exactly the same with the solution of the initial steady state. However, in order to investigate the impacts of the shock to the economy, final steady state has to be calculated with exact terms and parameters of initial steady state except only the exogenous shock. In the

simulation, our experiment is as follows: for a given size of informality, we calculate some macroeconomic indicators of the economy under different levels of payroll taxes. Namely, for each level of payroll tax, we calculate another steady state. Likewise, for a given payroll tax rate, same macroeconomic indicators are calculated under different sizes of informal sector. Moreover, a welfare analysis is conducted for both simulations.

## **5.2 Model Parameterization and Calibration**

Parameter values for the model are chosen to fulfil the consistency throughout the simulation and to match the certain fiscal indicators of Turkish economy which belong to year 2013<sup>18</sup>.

For the sake of the model integrity, nearly all of the parameters are taken from Schmidt-Hebbel (1997). Due to the fact that calibration of Schmidt-Hebbel (1997) is based on the characteristic of a developing country, we can assume that the parameters fit quite well for Turkey. Moreover, the production parameters are chosen purposefully to satisfy that formal sector is capital intensive, while the informal sector is labor intensive. A few of the parameters (which are preference parameters) are chosen to match the some certain indicators of the Turkish economy for the year 2013. Table 5.1 presents the whole parameterization of the model.

Moreover, real macroeconomic variables of Turkey, population growth (1.37 % per year) value is taken from Turkish Statistical Institute (TurkStat). Replacement rate (RR) is taken from OECD, Pensions at a Glance 2013 as 64.5 %. The ratio of government spending to the GDP is taken from the World Bank database. Table 5.1 also presents the fiscal variables which are imposed to the system exogenously.

One final remark for the parameterization is the time unit of the model. In order to construct a realistic framework, following Auerbach and Kotlikoff (1987), it is calibrated as one period denotes one year.

---

<sup>18</sup> Except the size of informality, all fiscal indicators of Turkey belong to 2013. The reason for this inconsistency is that the most recent estimate of Elgin and Öztunalı (2012) is for the year 2009.



Table 5-1: Parameterization

| <b>Symbol</b>           | <b>Definition</b>   | <b>Value</b> |
|-------------------------|---|--------------|
| <b>Preferences</b>      |   |              |
| $\alpha$                | Utility weight on leisure                                       | 1.25         |
| $\delta$                | Rate of time preference rate                                    | 0.01         |
| $\gamma$                | Intertemporal elasticity of substitution                        | 0.25         |
| $\mu$                   | Utility weight placed on bequest                                | 0.02         |
| $\rho$                  | Elasticity of substitution between leisure and consumption      | 1.20         |
| <b>Demographics</b>     |   |              |
| $n$                     | Population Growth Rate  | 0.0137       |
| $T$                     | Lifetime Horizon  | 55           |
| <b>Technology</b>       |   |              |
| $A$                     | Technology Parameter  | 1            |
| $\sigma_f$              | Elasticity of substitution in production (Formal Sector)        | 0.87         |
| $\sigma_i$              | Elasticity of substitution in production (Informal Sector)      | 1.34         |
| $\varepsilon_f$         | Intensity of use of capital in production (Formal Sector)       | 0.5          |
| $\varepsilon_i$         | Intensity of use of capital in production (Informal Sector)     | 0.3          |
| $\theta$                | Proportion of the size of the formal sector to the total output | 0.783        |
| <b>Fiscal Variables</b> |   |              |
| $RR$                    | Replacement rate  | 0.645        |
| $\tau_w$                | Payroll tax rate  | 0.20         |
| $\tau_c$                | Consumption tax rate  | 0.18         |
| $\tau_k$                | Capital income tax rate   | 0.10         |
| $o$                     | The ratio of the government spending to the GDP                 | 0.15         |

## **5.3 Findings**

### **5.3.1 Behavior of the Households**

Since the households are homogenous, we expect them to behave in a same manner. It may seem like that they are facing different budget constraints which may lead them to behave differently. However, with the Equation (4.39) we force the households to have same lifetime income. Besides, we assume that households are perfectly foresighted, so combining these circumstances, both informal and formal households know that they will face the same lifetime budget constraint. So, all of the behaviors (i.e. asset stock choices, consumption choices and leisure choices) come out as same.

#### **5.3.1.1 Asset Stock Decisions**

As mentioned, asset stock decisions of formal and informal sector which can be seen from the Figure 5.2 and Figure 5.3, respectively, show that formal and informal sector workers behave exactly in a same manner. Individuals begin to accumulate capital as soon as they receive wage and continues to accumulate until they reach their maximum wealth around 60 years old. After that point, the accumulated wealth is melting gradually until the death.

An interesting point which can be seen from the Figure 5.2 and Figure 5.3, the graph of the capital holdings of the individuals are kinked at period 1 (age 21 in real life) and period 55 (age 75 in real life). The reason for this kinked curve is the existence of the bequest motive. At the beginning, the individuals receive the inherited amount from their parents and at the end of their life they leave bequest to their children. The gap between the levels of the received inheritance and the bequest left is due to the fact that population growth. Namely, every individual has to leave more than she receives.

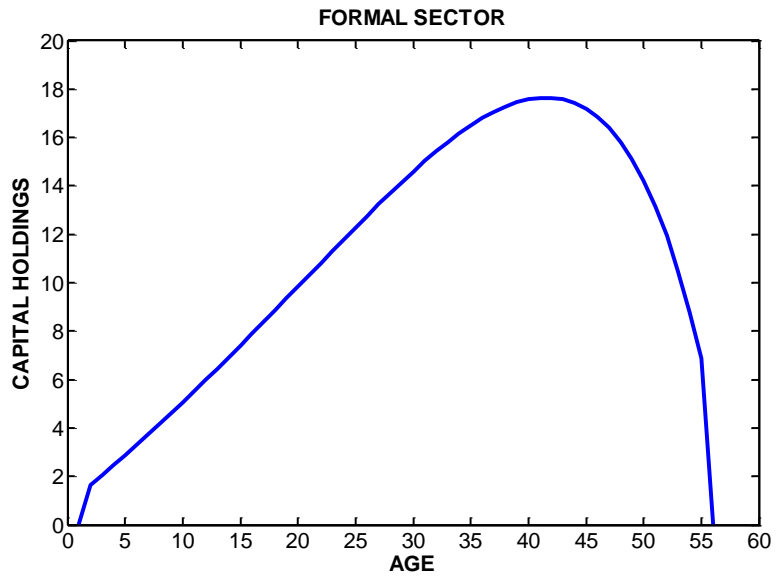


Figure 5.2: Capital Holdings Choices of the Formal Sector Households

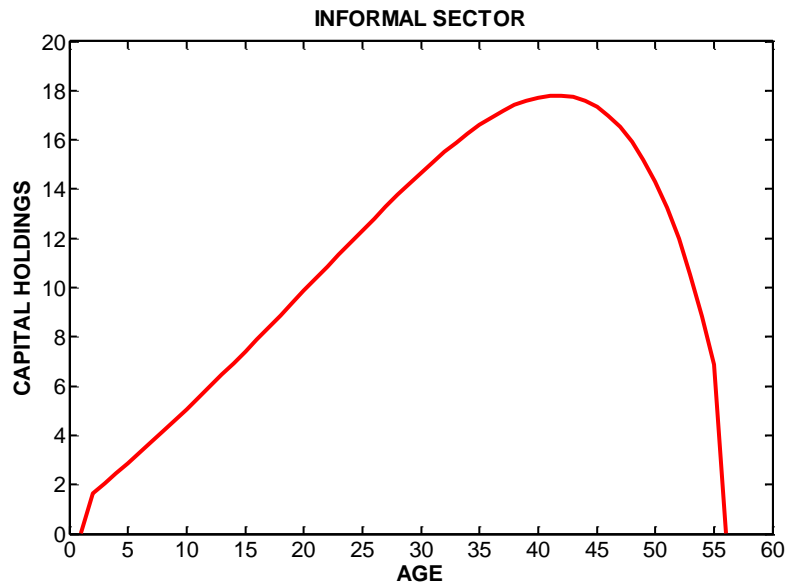


Figure 5.3: Capital Holdings Choices of the Formal Sector Households

### 5.3.1.2 Consumption Decisions

Again, we expect from both formal and informal sector households consume exactly the same amount. In fact, as can be seen from the Figure 5.4 and Figure 5.5 which are belong to consumption choices of the formal and informal sector households there is no interesting point to emphasize in the graphs of consumption. Consumption is at the lowest level at the beginning of the life and increases throughout the lifespan as the accumulated wealth grows. Then, the consumption reaches its maximum level at the very last period.

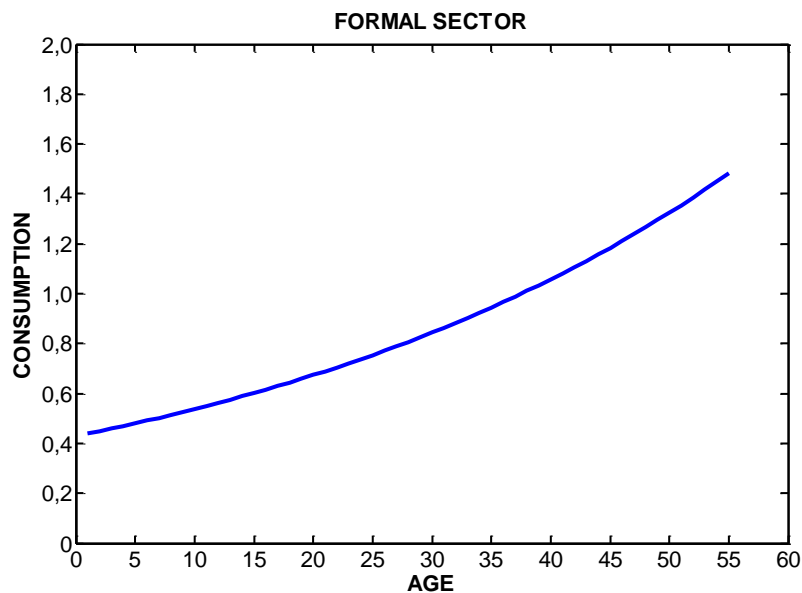


Figure 5.4: Consumption Choices of the Formal Sector Households

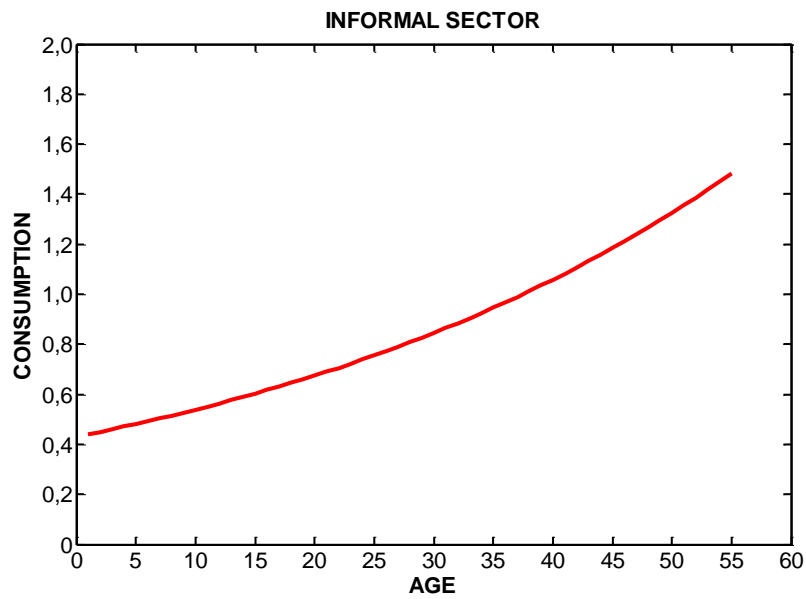


Figure 5.5: Consumption Choices of the Informal Sector Households

### 5.3.1.3 Labor Supply Decisions

The graph of the labor supply decisions of formal and informal sector workers are depicted in Figure 5.6 and Figure 5.7, respectively. Here, notice the assumption that formal workers can work even after the retirement. Thus, as can be seen from the graphs, both households supply labor until death. Moreover, the level of supply is at lifetime maximum at the beginning of the life and decrease gradually as the wealth accumulated. The reason for that at the early years of life, cost of leisure is too much and also individual needs to accumulate wealth. Furthermore, as years pass, the individual can afford leisure more and as the end of the life approach, labor supply is getting close to zero and at the very last period, reaches to zero level.

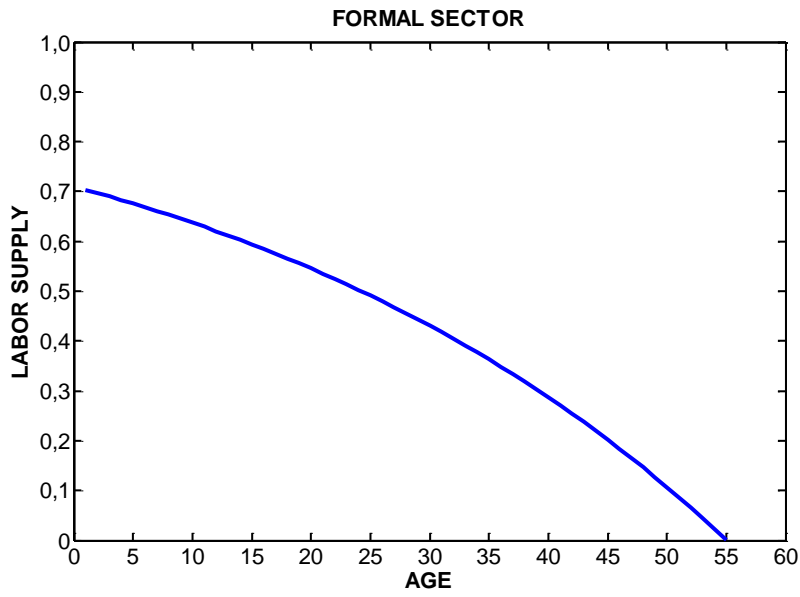


Figure 5.6: Labor Supply Choices of the Formal Sector Households

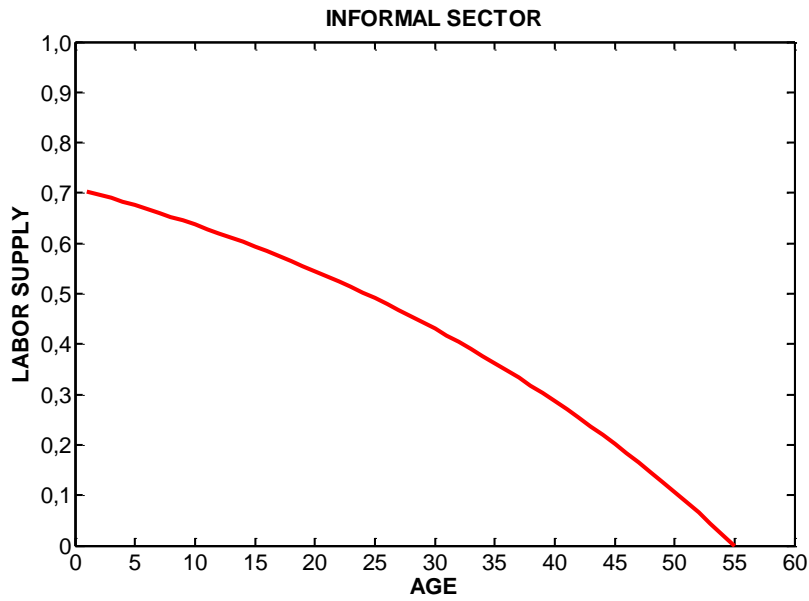


Figure 5.7: Labor Supply Choices of the Informal Sector Households

### **5.3.2 Analysis on the Certain Macroeconomic Variables**

In this section, steady state solutions of the whole model are calculated by simulation in order to investigate the various macroeconomic variables under different circumstances. The results of the simulation consist of capital stock, labor and consumption as aggregated, and also GDP, wages of both sectors, PAYG revenue, interest rate and welfare of the society.

Through the simulation, the answers are sought to these questions: How do the payroll tax rates affect the economy? How does the size of informality affect the economy? Also, may be the most important question: what are consequences of these payroll tax rates and the size of informality on the society welfare?

The simulation results which are obtained from the complete model compare the steady state equilibrium of the same economy under different circumstances.

#### **5.3.2.1 Impacts of Various Payroll Tax Rates on Certain Macroeconomic Variables**

The simulation results which are exhibited in Table 5.1 represents the steady state values of various macroeconomic variables under the adoption of many payroll tax rate levels<sup>19</sup>. Starting with the discussion of consumption, since an increase in the payroll tax rates mitigates disposable income of an individual, a reduction in the demand is an expected reaction. Thus, as can be seen from the consumption line of the Table 5.1, as the payroll tax rate increases, the level of consumption decreases.

Moreover, decrease in the disposable income also decrease the saving. This reduction in the level of saving causes less capital supply and eventually it can be deducted that increase in the tax rate leads to a decrease in the aggregate capital stock. We mentioned that the decrease in consumption causes reduction in aggregate demand, so GDP will fall as a consequence. As GDP falls, production falls and as a result; production factors have to drop. As can be seen from the Table 5.1, labor supply also falls along with the capital stock (with very small decrements). Interest

---

<sup>19</sup> The reason for choosing the range 5 % - 35 % is that after 35 % tax rate, the model gives absurd results.

rate also decreases as payroll tax increases. Another point is that increment in the payroll tax rates, also increases the gap between the formal wages and informal wages, since they are connected each other through the Equation (4.39). Namely, the increase in the tax rate, decreases the received net wage of the formal sector worker which leads to a reduction in the wages of the informal sector worker. Final remark of the increasing payroll tax rates is that, (as expected) increases the PAYG revenue of the government.

However, what is the cost of this increment in the total PAYG revenue? When these changes in the macroeconomic variables examined as a percentage, the scene becomes clearer. First of all, if the tax rates are increased from 5% to 35%, PAYG revenue of the government increases from 0.2980 to 0.5175. In other words, if the tax rates increased by 30%, PAYG revenues increase by 73%. But at what expense? After the increment of the tax rates the level of GDP decreases from 2.9829 to 1.2573 (i.e. reduces by 57%). Moreover, the capital stock decreases from 16.3093 to 7.6071, namely a reduction by 53%. Also, net wages of both formal and informal sector workers fall substantially. Consequently, it is true that the PAYG revenue of the government increases by 73%, but this increase, comes with reductions at crucial macroeconomic variables, GDP decreases by almost 60%, capital stock falls by 53%, and wages also fall. It does not seem a logical policy to increase the payroll tax rates, as this policy causes more harm than it cures.

### **5.3.2.2 Impacts of the Size of Informality on Certain Macroeconomic Variables**

In Table 5.2, “what if” scenario is demonstrated<sup>20</sup>. Behaviors of some important macroeconomic variables are calculated under the different proportions of informality which varies between 10% and 50%. All parameters and fiscal variables remain same from the previous analysis in the section 3.2.1. Payroll tax rate is chosen as 10% to extend the analysis range.

---

<sup>20</sup> In the simulation, some important macroeconomic variables are calculated to investigate the conditions if Turkey had different informality sizes.



Table 5-2: Impacts of Various Payroll Tax Rates on Certain Macroeconomic Variables

|                             | <b>Payroll Tax Rate</b> |            |            |            |            |            |            |
|-----------------------------|-------------------------|------------|------------|------------|------------|------------|------------|
|                             | <b>5%</b>               | <b>10%</b> | <b>15%</b> | <b>20%</b> | <b>25%</b> | <b>30%</b> | <b>35%</b> |
| <b>Consumption</b>          | 1,8135                  | 1,6968     | 1,5818     | 1,4686     | 1,3572     | 1,2413     | 1,1273     |
| <b>GDP (Formal)</b>         | 2,9829                  | 2,6533     | 2,3576     | 2,0912     | 1,8515     | 1,5398     | 1,2573     |
| <b>Capital</b>              | 16,3093                 | 14,6565    | 13,1681    | 11,8214    | 10,5975    | 9,0330     | 7,6071     |
| <b>Labor</b>                | 1,4439                  | 1,4249     | 1,3938     | 1,3783     | 1,3563     | 1,3269     | 1,3027     |
| <b>Interest Rate</b>        | 0,0529                  | 0,0523     | 0,0517     | 0,0510     | 0,0503     | 0,0497     | 0,0490     |
| <b>Formal Sector Wage</b>   | 1,7766                  | 1,7914     | 1,8075     | 1,8251     | 1,8444     | 1,8598     | 1,8767     |
| <b>Informal Sector Wage</b> | 1,6889                  | 1,6145     | 1,5400     | 1,4652     | 1,3900     | 1,3156     | 1,2409     |
| <b>PAYG Revenue</b>         | 0,2980                  | 0,3209     | 0,3638     | 0,4060     | 0,4412     | 0,4703     | 0,5175     |

For the sake of clarity, total output row in the graph denotes the summation of formal sector output and informal sector output, while GDP denotes the formal output. As can be expected, as the proportion of informality grows, GDP falls, however the crucial point here is that not only GDP, but also the total output declines.

Consistently with the assumption that formal sector is capital intensive and the informal sector is labor intensive; as the proportion of informality increases, the ratio of the capital to labor ( $K / L$ ) decreases, since the economy is becoming more and more labor intensive. Interest rates are also lower, if the informal sector is bigger.

Maybe the most crucial result of this analysis is that the higher the ratio of informality, the lower PAYG revenue of the government. When we combine the two simulation results of the sections 3.2.1 and 3.2.2, it can be seen that the low levels of the PAYG revenue is mainly originated from the existence of the large informal sector. A fiscal policy which increases the payroll tax rates is not a solution at all. The government has to mitigate the size of the informal sector, hence smaller informal sector means higher PAYG revenues even at the lower tax rates.

### **5.3.3 Welfare Analysis**

Besides the macroeconomic variables which are simulated in section 5.3.2.1 and 5.3.2.2, a welfare analysis is carried out to evaluate the impact of the various payroll tax rates and size of the informal sector on the welfare of the whole society.

Following Altig et al. (2001), total utility of the society, which consists of the sums of the felicity of the 55 cohorts, is calculated. Here, an important thing to remember is, since each cohort at time  $t$ , has different populations (due to the population growth); all of these felicities have to be weighted with the population growth rate.

Table 5-3: Impacts of the Size of Informality on Certain Macroeconomic Variables

|                                    | <b>Proportion of Informal Sector</b> |            |            |            |            |
|------------------------------------|--------------------------------------|------------|------------|------------|------------|
|                                    | <b>10%</b>                           | <b>20%</b> | <b>30%</b> | <b>40%</b> | <b>50%</b> |
| <b>Consumption</b>                 | 1,7303                               | 1,7118     | 1,6921     | 1,6711     | 1,6485     |
| <b>Total Output</b>                | 3,7071                               | 3,6856     | 3,6638     | 3,6419     | 3,6159     |
| <b>GDP</b>                         | 3,3364                               | 2,9485     | 2,5647     | 2,1851     | 1,8099     |
| <b>Capital</b>                     | 14,7828                              | 14,7297    | 14,6708    | 14,6072    | 14,5395    |
| <b>Labor</b>                       | 1,2309                               | 1,2552     | 1,2811     | 1,3087     | 1,3385     |
| <b>Capital - Labor Ratio (K/L)</b> | 12,0097                              | 11,7349    | 11,4517    | 11,1616    | 10,8625    |
| <b>Interest Rate</b>               | 0,0525                               | 0,0524     | 0,0523     | 0,0521     | 0,052      |
| <b>Formal Sector Wage</b>          | 1,8144                               | 1,8017     | 1,7881     | 1,7735     | 1,7578     |
| <b>Informal Sector Wage</b>        | 1,6353                               | 1,6239     | 1,6116     | 1,5985     | 1,5844     |
| <b>PAYG Revenue</b>                | 0,6011                               | 0,5508     | 0,5129     | 0,4593     | 0,3976     |

Finally, all these total utilities are compared in order to observe the impacts of different circumstances (i.e. different payroll tax rates and different sizes of informality). The formula which is employed during the calculation of the society welfare is given below:

$$U_t = \frac{1}{1 - \frac{1}{\gamma}} \left[ \sum_{j=f,t} \left( \sum_{s=1}^{55} (1+\delta)^{-(s-1)} (1+n)^{-(s-1)} (u_{s,t}^j)^{\left(\frac{1-\frac{1}{\gamma}}{\rho}\right)} + (1+\delta)^{-54} (\mu)(b_{t+54}^j)^{\left(\frac{1-\frac{1}{\gamma}}{\rho}\right)} \right) \right] \quad (5.1)$$

where

$$u_{s,t}^j = \left( c_{s,t}^j \left(\frac{1-\frac{1}{\rho}}{\rho}\right) + \alpha l_{s,t}^j \left(\frac{1-\frac{1}{\rho}}{\rho}\right) \right)^{\frac{1}{1-\frac{1}{\rho}}} \quad (5.2)$$

Recall that in the section 3.2.1, it is examined that the impacts of the different payroll tax rates on the some important macroeconomic variables. Here is the results of the welfare analysis of the simulation at 3.2.1<sup>21</sup>:

Table 5-4: Welfare Analysis under Different Payroll Tax Rates

| <b>Payroll Tax Rate</b> | <b>Welfare</b> |
|-------------------------|----------------|
| <b>5%</b>               | 1.1669         |
| <b>10%</b>              | 1.1109         |
| <b>15%</b>              | 1.0552         |
| <b>20%</b>              | 1.0000         |
| <b>25%</b>              | 0.9420         |
| <b>30%</b>              | 0.9019         |
| <b>35%</b>              | 0.8608         |

<sup>21</sup> Notice that the level of welfare at the rate 20% is 1.0000. It is due to the fact that the welfare levels are indexed and since the payroll tax rate of Turkey is 20%, at that rate welfare is indexed to 1.0000.

As expected, as tax rate increases welfare of the society declines. This is due to the obvious reasons such that higher tax rates means lower disposable income. Lower disposable income leads to lower consumption, saving, bequest of which all the criteria lowers the total utility of the society.

The examination of the impacts of the different sizes of informality on the society welfare is given below:

Table 5-5: Welfare Analysis under Different Size of Informality

| <b>Proportion of Informal Sector</b> | <b>Welfare</b> |
|--------------------------------------|----------------|
| <b>10%</b>                           | 1.0173         |
| <b>20%</b>                           | 1.0088         |
| <b>30%</b>                           | 1.0000         |
| <b>40%</b>                           | 0.9905         |
| <b>50%</b>                           | 0.9803         |

As can be seen from the Table 5.5, the higher ratio of informality results in the lower society welfare.

#### **5.4 Resulting Comments**

When we consider the findings of the simulation which take place in the section 5.3.2.1, 5.3.2.2 and 5.3.3, it can be concluded that increasing the tax rates with the purpose of boosting the revenues makes the situation worse. We have shown that in the section 5.3.2.1, as payroll tax rate increases, some important macroeconomic indicators, such as GDP, capital stock and wages decrease substantially. Moreover, the simulation at the section 5.3.2.2 show that as informal sector grows, same macroeconomic indicators are declining. Besides, in the section 5.3.3 the welfare

analysis of the two simulations indicate that both increasing payroll tax rates and growing informal sector results in a decline in social welfare.

Under the given circumstances, the optimal policy for the government may be to look for solutions to mitigate the size of informality. If the government achieve this goal, the results will be substantially better, such as higher GDP, lower tax rates and more importantly higher social welfare.

## **CHAPTER 6**

### **CONCLUSION**

Informality is a very serious problem for especially developing countries. Through the declining tax revenues of the government, this problem affects the economy in a negative way through many channels. Therefore, many developing countries struggle to decrease the size of the informal sector to manageable levels. In case of Turkey, with approximately 30 % informal sector size (to the official GDP), decreasing the size of informality should be one the most urgent agenda of Turkish government.

In this study, we attempt to analyze the impacts of increasing payroll tax rates in the existence of the shadow economy. For this purpose, basic 55 period OLG model of Auerbach and Kotlikoff (1987) has been enriched to demonstrate the basic characteristics of Turkish households, firms and the government. In the model, the presence of the informal sector alters the behavior of both firms and households. In the shadow economy, firms take wage levels as given (through the Equation 4.39) and households evade payroll taxes, but, in return, receive no retirement benefit.

The simulation results showed that the damage of informality is vast. As, the table 5.3 shows that almost all important macroeconomic variables take serious harm. For instance, greater size of informal sector means, lower consumption, capital stock, labor supply, wages of formal and informal sector and GDP substantial amounts. Moreover, as informal sector grows, the total revenue of the PAYG system decreases substantially.

The expected reaction of the Turkish government for decreasing PAYG revenues might be to increase the payroll tax rates. However, simulation results also show that increasing the tax rates might not be the best policy to apply. As payroll tax rate increases, many important macroeconomic indicators, such as GDP, capital stock and wage levels of both sectors decrease. In the long run, the situation might get worse, since eventually, PAYG revenues will fall as a result of these decrements in the GDP, capital stock and wage levels.

Moreover, welfare analysis is conducted to measure the two phenomenon: increasing payroll tax rates and growing of informal sector. Not surprisingly, the simulation results indicate both increasing payroll tax rates and growing informal sector results in declining society welfare.

Thus, what the government has to do is, strive with informality and looking for solutions to mitigate the size of the underground economy. If the government carries out structural reforms and become successful, then this decrease in the magnitude of the shadow economy, will return as higher GDP, higher PAYG revenues even with lower tax rates and more importantly higher society welfare.

This study can be improved in many ways by sophisticating informality modeling. First of all, size of the informal sector could be endogenous in order to observe the impacts of tax policies. By this way, we could have the chance to observe the transitions from formal to informal sector or vice versa.

Moreover, in this study we compare only the steady state equilibriums, we do not have the chance to observe the immediate effects of the policies. In order to carry out short run analysis, transition path of the economy has to be simulated.

Also, in our model agents are homogenous, however agents can be differentiated in accordance with their education level, skill level etc. Moreover, in our model, firms are strictly divided into two subcategories as formal and informal. But more complicated models, which include the partial tax evasion of formal sector, can be constructed. Illegal activities, too, can be included in the model, as they are the bigger portion of the informal sector.



Furthermore, as mentioned in the informality chapter, informal sector employs money in transactions. The other medium of transactions is almost negligible. Thus, in an environment like informal sector where money is the only transaction method, the model could include money.

As a final remark, pension reforms (i.e. privatizing the social security system) or some tax reforms are left for future studies, as this thesis is the first step of more sophisticated models.

## REFERENCES

- Altig, D., Auerbach, A. J., Kotlikoff, L. J., Smetters, K. A., & Walliser, J. (2001). Simulating fundamental tax reform in the United States. *American Economic Review*, 574-595.
- Auerbach, A. J., & Kotlikoff, L. J. (1987). *Dynamic fiscal policy (Vol. 11)*. Cambridge: Cambridge University Press.
- Blinder, A. S. (1973). A model of inherited wealth. *The Quarterly Journal of Economics*, 608-626.
- Cagan, P. (1958). The demand for currency relative to total money supply. *NBER*, 1-37.
- Cuff, K., Marceau, N., Mongrain, S., & Roberts, J. (2011). Optimal policies with an informal sector. *Journal of Public Economics*, 95(11), 1280-1291.
- Değer, Ç. (2011). An overlapping generations analysis of social security reform in Turkey. *Unpublished Phd thesis, Middle East Technical University, Graduate School of Social Sciences*.
- Diamond, P. A. (1965). National debt in a neoclassical growth model. *The American Economic Review*, 1126-1150.
- Elgin, C., & Öztunalı, O. (2012). Shadow economies around the world: model based estimates. *Bogazici University Department of Economics Working Papers*, 5.
- Ferreira, P. C., & Do Nascimento, L. G. (2005). *Welfare and growth effects of alternative fiscal rules for infrastructure investment in Brazil*. Fundação Getulio Vargas.
- Frey, B. S., & Weck, H. (1983). *Estimating the Shadow Economy: A 'Naive' Approach*. Oxford Economic Papers.

- Fuster, L., İmrohorođlu, A., & İmrohorođlu, S. (2003). A welfare analysis of social security in a dynastic framework. *International Economic Review*, 44(4), 1247-1274.
- Fuster, L., İmrohorođlu, A., & İmrohorođlu, S. (2007). Elimination of social security in a dynastic framework. *The Review of Economic Studies*, 74(1), 113-145.
- Giles, D. E. (1999). Measuring the hidden economy: Implications for econometric modelling. *The Economic Journal*, 109(456), 370-380.
- Hart, K. (2008). *Informal Economy*. The New Palgrave Dictionary of Economics. Eds. Steven N. Durlauf and Lawrence E. Blume.
- Ihrig, J., & Moe, K. S. (2004). Lurking in the shadows: the informal sector and government policy. *Journal of Development Economics*, 73(2), 541-557.
- İleri, A., & Derin-Güre, P. (2014). Simulating the Turkish Tax System. *Topics in Middle Eastern and African Economies*, 16(2).
- İmrohorođlu, A., Imrohoroglu, S., & Joines, D. H. (1995). A life cycle analysis of social security. *Economic theory*, 6(1), 83-114.
- Kasnakođlu, Z. (1993). Monetary approach to the measurement of unrecorded economy in Turkey. *METU Studies in Development*, 20(1-2), 87-111.
- Kaufmann, D., & Kaliberda, A. (1996). Integrating the unofficial economy into the dynamics of post-socialist economies. *Economic transition in Russia and the new states of Eurasia*, 8, 81-120.
- Kök, R., & Şapçı, O. (2006). Kayıt Dışı Ekonomi ve Türkiye Ekonomisi'ndeki Büyüklüğünün Tahmin Edilmesi. *Turkish Economic Association International Conference on Economics*.
- Laitner, J. (1990). Tax changes and phase diagrams for an overlapping generations model. *Journal of Political Economy*, 193-220.
- Laitner, J. (1992). Random earnings differences, lifetime liquidity constraints, and altruistic intergenerational transfers. *Journal of Economic Theory*, 58(2), 135-170.
- Loayza, N. V. (1996). The economics of the informal sector: a simple model and some empirical evidence from Latin America. *Carnegie-Rochester Conference Series on Public Policy*. Vol. 45, 129-162.

- Öğünç, F., & Yılmaz, G. (2000). Estimating the underground economy in Turkey. *CBRT Research Department Discussion Paper, 15*.
- Samuelson, P. A. (1958). An exact consumption-loan model of interest with or without the social contrivance of money. *The journal of political economy*, 467-482.
- Saracoğlu, D. Ş. (2008). The informal sector and tax on employment: A dynamic general equilibrium investigation. *Journal of Economic Dynamics and Control*, 32(2), 529-549.
- Schmidt-Hebbel, K. (1997). *Pension reform, informal markets and long-term income and welfare (No. 4)*. Banco Central de Chile.
- Schneider, F. (1986). Estimating the size of the Danish shadow economy using the currency demand approach: An attempt. *The Scandinavian Journal of Economics*, 643-668.
- Schneider, F. (2013). Size and Progression of the Shadow Economies of Turkey and Other OECD Countries from 2003 to 2013; Some New Facts. *Ekonomi-tek-International Economics Journal*, 2(2), , 83-116.
- Schneider, F., & Buehn, A. (2013). Shadow Economies in highly developed OECD countries: What are the driving forces? (No. 1317). *Working Paper, Department of Economics, Johannes Kepler University of Linz*.
- Schneider, F., & Savasan, F. (2007). Dymimic estimates of the size of shadow economies of Turkey and of her neighbouring countries. *International Research Journal of Finance and Economics*, 9, 126-143.
- Soto, H. d. (1989). *The Other Path: The Invisible Revolution in the Third World* . New York.
- Tanzi, V. (1983). The Underground Economy in the United States: Annual Estimates, 1930-80. *Staff Papers-International Monetary Fund*, 283-305.
- Voyvoda, E., & Yeldan, E. (2005). Managing Turkish debt: An OLG investigation of the IMF's fiscal programming model for Turkey. *Journal of Policy Modeling*, 27(6), , 743-765.

# APPENDIX A

## TURKISH SUMMARY

Kayıtdışı ekonomi, gelişmiş ve gelişmekte olan ülkeler için en ciddi problemlerden biridir. Kayıtdışı ekonominin varlığı, gelir dağılımını dengesizleştirmekte, toplum refahını azaltmakta ve ayrıca devletin vergi gelirlerini azalttığından dolayı vergi sisteminin işlerliğine de önemli ölçülerde zararlar vermektedir. De Soto (1989) kayıtdışı ekonomiyi, devletin koyduğu düzenlemelere ve vergilere tabi olmayan ekonomik aktiviteler grubu olarak tanımlamaktadır.

Bu çalışmada, kayıtdışılığı araştırmak ve analiz etmek için dinamik bir yaşam döngüsü modeli oluşturulmuştur. Literatüre katkı olarak bu model, elli beş zaman dilimli ardışık nesiller modeli (overlapping generations model) temelinde, içsel emek arzı, nüfus büyümesi, sosyal güvenlik sistemi, miras güdüsü ve kayıtdışı ekonominin varlığı gibi Türkiye şartları için gerçekçi eklentiler içeren ilk modeldir.

Bununla birlikte, literatürde önemli bir yer teşkil etmesine rağmen, kayıtdışı ekonomi terimi bile henüz tam anlamıyla oturmamıştır. Kayıtdışılığı ifade edebilmek için gölge ekonomi, yeraltı ekonomisi, saklı ekonomi veya görünmez ekonomi gibi terimler birçok araştırmacı tarafından birbiri yerine kullanılmaktadır.

Tüm yasadışı aktiviteler (uyuşturucu ticareti, kaçakçılık, kumar vb.) kayıtdışı ekonomi çatısı altına alınabilir. Bu aktiviteler kayıtdışı ekonominin büyük bir yüzdesini oluşturmakla beraber kayıtdışılık yasal birtakım aktiviteleri de içermektedir. Yasal bir iş yürüten ama bu işte kaçak işçi çalıştırarak sigorta primlerini ödemeyen bir işverenin bu yolla vergi kaçırmaya buna bir örnektir. Görüldüğü gibi, vergi kaçakçılığı ya da diğer tüm yasadışı faaliyetler, De Soto

(1989)'un tanımladığı gibi devletin koyduğu yasalara ve düzenlemelere karşı gelmenin bir örneğidir.

Vergi kaçakçılığı yapmak ve tüm bu yasal düzenlemelere karşı gelmek devlete zararlı olduğu gibi, kayıtdışı ekonomiyi oluşturan unsurların kendisine de zararlıdır. Örneğin, kayıtdışı çalışan bir firma ya da bir işçi, her zaman için devlet tarafından yakalanma ve gerekli cezalara çarptırılma riskiyle karşı karşıyadır. Daha da önemlisi, yasadışı statülerinden dolayı hem kayıtdışı firmalar hem de hanehalkları devletin sağladığı hiçbir yasal ayrıcalıktan yararlanma hakkına sahip değildir. Hanehalkları sosyal güvenlik sistemine tabi olmadıkları ve gereken primleri ödemedikleri için, gelecekte de herhangi bir emeklilik hakkından faydalanamazlar. Ayrıca firmalar yasal düzenlemelere dahil olmadıklarından dolayı, sermaye ve iş gücü piyasalarına tam erişim sağlayamazlar. Bu nedenle kayıtdışı çalışan firmalar, dışsal şoklara karşı savunmasızdılar ve karlarını tam anlamıyla maksimize etme yeteneğinden de yoksundurlar (Loayza, 1996).

Peki, bu şartlar altında neden firmalar ve hanehalkları tüm bu devlet güvencesinden ve haklarından vazgeçip, kayıtdışı sektörün güvensiz ortamına razı olmaktadır? Loayza (1996) ve Ihrig ve Moe (2004) kayıtdışı ekonominin, devletin sıkı düzenlemeler ve yüksek vergi oranları koymasına ve bununla birlikte bu düzenlemeleri yürütme gücünden yoksun olması sonucu ortaya çıktığını ifade etmektedir. Bununla birlikte, cevap bu kadar basit olmayabilir. Çünkü kayıtdışı ekonominin büyüklüğü ve devletin sıkı düzenlemelerle birlikte yüksek vergi oranları uygulaması arasındaki ilişki çift yönlü olabilir. Yani, devletin yüksek vergi oranları uygulaması kayıtdışı ekonominin büyümesine yol açabileceği gibi, aynı şekilde kayıtdışı ekonominin varlığı da devletin yüksek vergi oranları uygulamasına neden olabilir. Ihrig ve Moe (2004) düzenlemeleri gevşetmenin veya vergi oranlarını düşürmenin tek başına yeterli olmayacağını, asıl çözümün devletin bu politikaları yürütme gücünü artırmaktan geçtiğini savunmaktadırlar.

Beklenildiği gibi kayıtdışı ekonomi konusunda en kritik pozisyonda devlet bulunmaktadır. Devletin bu bağlamda üç önemli görevi vardır. Birinci görevi, devletin tüm gerekli yasaları çıkarması, vergi oranlarını belirlemesi gibi düzenleme odaklı görevlerden oluşurken, ikinci görev uygulanan bu vergilerin toplanması ve sonuncu görev ise tüm bu düzenlemelerin denetlenmesinden oluşmaktadır.

Dolayısıyla mali sistemden sorumlu devlet memurları sistemin en önemli parçalarıdır ve bu memurlar bir şekilde yolsuzluğa bulaştıysa ve bu durumdan kendilerine çıkar sağlıyorsa, kayıtdışılığın çekiciliği de gitgide artmaktadır.

Kayıtdışılığın belirsiz şartlarını incelerken akla gelen bir başka soru ise ücret seviyelerinin belirlenmesidir. İki ayrı sektör (kayıtlı ve kayıtdışı) olduğu ve bir tanesinin yasal düzenlemelere tabi olmadığı gerçeği göz önüne alındığında Schmidt-Hebbel (1997) ve Cuff vd. (2011) hem kayıtlı hem de kayıtdışı sektörde ücretlerin uzun vadede birbirlerine eşit olması gerektiğini ifade etmektedirler.

Bununla birlikte, bu çalışmada kayıtdışılığı modelleyebilmek için Samuelson (1958) ve Diamond (1965)'in temelini attığı ardışık nesiller modeli kullanılmıştır. Modelde, tüm bireyler iki zaman dilimlik yaşam uzunluğuna sahiptir ve  $t$  anında doğan bir birey,  $t$  anında genç ve  $t+1$  anında ise yaşlı nesli oluşturur.  $t+1$  anında doğan ise, o zaman diliminde genç nesli oluşturur ve  $t+1$  diliminde yaşlı olan nesille birlikte yaşar. Dolayısıyla, ardışık nesiller modeli, adından da anlaşılacağı üzere ardışık iki neslin aynı zaman diliminde yaşaması fikri üzerine kurulmuştur.

Ardışık nesiller modeline en büyük katkı Auerbach ve Kotlikoff (1987) ile yapılmıştır. Bu çalışmada, ardışık olarak sadece iki nesil değil, elli beş nesil yaşamaktadır. Bizim çalışmamızdaki model de Auerbach ve Kotlikoff (1987)'ye dayanmaktadır.

Bununla birlikte Türkiye için gerçekçi bir model kurulabilmesi için dahil edilmesi gereken en önemli eklentilerden biri de miras güdüsüdür. Çünkü Türkiye'de miras güdüsü oldukça yüksektir ve modele dahil edilmediği takdirde hesaplanan sermaye stoku değerinin beklenenden daha düşük çıkmasına, tüketimin ise beklenenden daha yüksek çıkmasına neden olmaktadır. Miras güdüsü, ebeveynlerin sadece kendi refahlarına değil aynı zamanda çocuklarının refahına da önem vermesi olarak açıklanabilir. Bu çalışmada miras güdüsü Blinder (1973) temel alınarak modellenmiştir. Herhangi bir birey, aynen tüketim ve boş zamandan aldığı gibi miras bırakmaktan da fayda sağlamaktadır. Bununla birlikte, modelde miras bırakma tek yönlü olarak kabul edilmiştir, ama çift taraflı olarak da modellenebilir. Örneğin, Laitner (1992) çalışmasında ebeveynler ve çocuklar tüm gelirlerini bir havuzda toplayıp, ailedeki önem derecelerine uygun olarak paylaşmaktadır. Türkiye özelinde,

son yirmi-otuz yılda aile sistemi kökten değişim geçirmiş ve bunun sonucunda çekirdek aileler Türk toplum yapısına hakim olmuştur. Dolayısıyla modelimizde tek yönlü miras sistemini kabul etmek, Türkiye şartlarına daha uygun olmaktadır.

Literatürde kayıtdışı ekonomiyi araştıran çalışmalar, kayıtdışılığı iki farklı yolla modellemektedirler. Kayıtdışı ekonominin, gayri safi yurtiçi hasılaya (GSYH) oranı, ya modele dışsal olarak empoze edilir ya da model içinde içsel olarak hesaplanır. Bununla birlikte, birinci yöntemde değerlendirme metodlarından elde edilen sonuçlar kullanılmalıdır.

Türkiye’de, kayıtdışı ekonomi oranını tahmin edebilmek için birçok çalışma yürütülmüştür. Kasnakoğlu (1993) kayıtdışı ekonominin oranını tahmin eden ilk çalışmadır. Nakit Oranı ve Nakit Talebi metodları kullanarak yaptığı değerlemelerde kayıtdışılık oranı sırasıyla 5.9% ve 7.5% olarak tahmin edilmiştir. Bununla birlikte, Kök ve Şapçı (2006) Vergi Denetim Metodunu kullanarak, kayıtdışı ekonomi oranını 43.9% olarak tahmin etmiştir. Schneider (2013) ise 29.2% olarak yaptığı tahminde Çoklu Gösterge Çoklu Neden (MIMIC) yaklaşımını kullanmıştır.

Bu tahminlerin dışında, modelimizde kayıtdışı oranı empoze edilirken, Elgin ve Öztunalı (2012) çalışmasının sonuçları kullanılmıştır. Araştırmacılar, yukarıdaki bahsedilen metodların dışında yeni bir genel denge yaklaşımı oluşturup, buna göre tahminler yapmaktadırlar. Bu metod, Türkiye’deki kayıtdışılığın oranını 27.7% olarak tahmin etmiştir.

Türkiye’de kayıtdışılık sadece ekonometrik değil, aynı zamanda genel denge modeli kullanan çalışmalara da konu olmuştur. Saracoğlu (2008) kayıtlı, kayıtdışı ve tarım sektörü olmak üzere üç sektörlü bir model oluşturmuş ve bu modeli kullanarak sermaye biriktikçe kayıtdışı ekonomi oranının azaldığını ortaya koymuştur. Bununla birlikte araştırmacı, vergilerin azaltılmasının da kayıtdışı ekonominin küçülmesinde etkili olacağını göstermiştir.

Kayıtdışı ekonomiyi konu almasalar da ardışık nesiller modeli Türkiye’de bazı çalışmalarda kullanılmıştır. Voyvoda ve Yeldan (2005) otuz dönemli, açık sermaye piyasaya eklentili ardışık nesiller modeli oluşturarak, büyüme şokları altında IMF programının hassasiyetini incelemiştir. Değer (2011) ise otuz dönemli ardışık nesiller modeli kullanarak yeni sosyal güvenlik reformunun Türk ekonomisi



üzerindeki etkilerini incelemiştir. İleri ve Derin-Güre (2014) ise elli beş dönemli ardışık nesiller modeli kullanarak, Türkiye Vergi Sistemi bağlamında vergi reformlarının olası etkilerini incelemiştir.

Çalışmamızda, içsel iş gücü arzı, sabit büyüme oranı, miras güdüsü, sosyal güvenlik sistemi ve kayıtdışı ekonomi eklentileri dahil edilerek elli beş dönemli ardışık nesiller modeli oluşturulmuştur. Bu çalışma, bahsedilen tüm eklentilerin aynı anda dahil edildiği ve Türkiye ekonomisine ilişkin verilerin kullanıldığı ilk çalışmadır.

Oluşturulan modelde hanehalkları, firmalar, devlet ve devletin içinde bağımsız bir kurum olarak sosyal güvenlik kurumu bulunmaktadır. Ekonomi kapalı, hanehalkları homojen, firmalar ise kayıtlı ya da kayıtdışı olmalarına göre heterojendir. Hanehalkları kayıtlı firmalarda çalışıyorlarsa sosyal güvenlik sistemine dahil olmakta ve bunun sonucunda gelir vergisi ödeyip, karşılığında emekli olduklarında emekli aylığı almaktadırlar. Bununla beraber, eğer işçi kayıtdışı bir firmada çalışıyorsa ne gelir vergisi ödemekte ne de karşılığında emekli maaşı alabilmektedir.

Hanehalkları elli beş yıl boyunca yaşamakta ve  $t$  zamanında aynı anda elli beş nesil bulunmaktadır. Bununla birlikte, birinci zaman dilimi gerçek hayatta yirmi bir yaşa denk gelmekte ve aynı şekilde elli beşinci zaman dilimi de gerçek hayattaki yetmiş beşinci yaşa denk gelmektedir. Ayrıca hanehalkları temsilidir; yani tek bir hane halkı ekonominin tamamındaki hanehalklarının davranışını temsil edebilir. Nüfus ise sabit bir oranda (1.37%) büyümektedir.

Her bir hanehalkının tercihleri tüketim, boş zaman ve miras içeren bir fayda fonksiyonuyla modellenmiştir. Bu fayda fonksiyonu sabit ikame esnekliği (constant elasticity of substitution - CES) formunda olup, bir hanehalkının yaşam boyu faydasını temsil eder. Bununla birlikte, hanehalkları homojen kabul edildiği için kayıtlı ya da kayıtdışı sektörde çalışan tüm hanehalkları aynı fayda fonksiyonuna sahiptir.

Hanehalkları tüketim sonrası gelirden artakalan miktarı tasarruf ederler ve ayrıca, ekonomi kapalı ekonomi olarak modellendiğinden, yaptıkları tasarrufu kayıtlı ya da kayıtdışı tüm firmalara sermaye olarak kiralar ve bunun sonucunda faiz oranına eşit bir gelir elde ederler.

Kayıtlı sektörde çalışan hanehalkları, çalıştıkları süre boyunca vergilerini ödeyerek sosyal güvenlik sistemine katkıda bulunurlar ve buna karşılık hayatlarının son 15 yılında (40. periyottan sonra) emekli maaşı almaktadırlar. Ayrıca modeli basit tutmak adına, emeklilik zorunlu yapılmamıştır. Yani, kayıtlı sektörde çalışan bir işçi, eğer isterse, emekli olduktan sonra da çalışmaya devam edebilir. Bu durumda hem ücret geliri hem de emeklilik maaşı elde etmektedirler.

Bununla birlikte kayıtdışı sektörde çalışan hanehalkları, herhangi bir sosyal güvenlik sistemine dahil olmadıkları için, sisteme herhangi bir katkıda bulunmazlar ve dolayısıyla sermaye stokları, tüm vaktini boş zamana ayırmaya izin verecek kadar artmadığı takdirde emekli de olamazlar.

Miras ise şöyle modellenmiştir: her bir nesil, bir önceki nesil tarafından bırakılan miktarı hayatının sadece ilk periyodunda alabilir ve bununla birlikte bir sonraki nesle bırakacağı mirası ise hayatlarının sadece son yılında bırakabilir. Yani, miras modelde sadece ilk periyot ve son periyot bütçe kısıtına dahil edilmektedir. Bununla birlikte, mirasların nesiller arası transferi hayali bir aracı kurum tarafından yapılmaktadır. Bu aracı kurum, hayatlarının son periyodundaki bireylerden mirasları toplar ve hayatlarının ilk periyodundaki nesle eşit olarak paylaşır.

Hanehalkları, ister kayıtdışı ister kayıtlı çalışsın, aynı optimizasyon sürecinden geçerler. Her ikisi de kendilerine ait fayda fonksiyonlarını, bahsedilen bütçe kısıtlarına göre maksimize edip, hayat boyu tüketimlerini, boş zamanlarını ve bırakacakları mirası seçerler.

Oluşturulan modelde iki tip firma vardır: kayıtlı ve kayıtdışı. Her sektör tek bir firma tarafından temsil edilmektedir. Yani, kayıtlı sektörde çalışan bir firmanın tüm kayıtlı sektörün davranışlarını, aynı şekilde kayıtdışı sektörde çalışan bir firmanın da tüm kayıtdışı sektörün davranışlarını yansıttığı kabul edilmiştir. Bu firmalar üretimlerini rekabetçi piyasada, sermaye ve iş gücü kullanarak yapmaktadırlar. Hem sermaye hem de iş gücü homojen kabul edilmiştir. Ayrıca, kayıtlı sektör sermaye yoğun, kayıtdışı sektör ise iş gücü yoğun olarak modellenmiştir. Her iki sektör de aynı malı ürettiği için fiyat bire normalize edilmiştir.

Ekonominin toplam çıktısı, kayıtlı ve kayıtdışı ekonominin çıktıları toplanarak hesaplanır. Üretim fonksiyonu ise sabit ikame esnekliği formunda oluşturulmuştur.

Modelde sermayenin fiyatı, hem kayıtlı hem de kayıtdışı sektöre dışsal olarak verilmektedir. Dışsal olarak alınan bu fiyat ise faiz oranına eşittir. Bununla birlikte bu faiz oranı içsel olarak (yapılan varsayımlar altında) toplam üretim fonksiyonun, sermaye miktarına (K) göre birinci dereceden türevi alınarak (yani toplam üretim sermaye miktarına göre optimize edilerek) hesaplanabilir.

İşgücü piyasaları analizi ise farklı sektörler için farklı şartlar teşkil ettiği için biraz daha farklıdır. Modelde kayıtlı sektör firmaları, hiçbir sınırlamaya maruz kalmadan, doğrudan karlarını maksimize edebilmektedir. Böylece kayıtlı sektör firması, işçilere ödeyeceği ücretin miktarını, kayıtlı sektöre ait üretim fonksiyonunun iş gücü miktarına (L) göre birinci derece türevini alarak (yani üretimini iş gücü arzına göre optimize ederek) hesaplayabilir.

Kayıtdışı sektör için durum biraz daha karmaşıktır. Kayıtdışı sektörün işgücü piyasalarına erişimi kısıtlı olduğu için, karını tam anlamıyla maksimize edememektedir. Bunun yerine Schmidt-Hebbel (1997)'in önerdiği gibi kayıtdışı firmalar, ödeyeceği ücretleri belirli şartlar altında dışsal olarak belirlemektedirler. Bu şartlar ise şunlardır: hanehalkları kayıtlı ya da kayıtdışı sektörde çalışmakta farksız oldukları için yaşam boyu bütçe kısıtlarının bugünkü değerlerinin de eşit olması gerekmektedir. Yani, kayıtlı sektörde çalışan bir işçinin yaşam boyu gelirlerinden, sosyal güvenlik sistemine ödeyeceği katkıyı çıkarıp, alacağı toplam emekli maaşını eklediğimizde, kayıtdışı sektörde çalışan işçinin yaşam boyu gelirini elde etmiş oluruz.

Hanehalkları yetenek açısından farklı olmadığından ve her iki sektörde de çalışabilme olanağına sahip olduğundan, kayıtdışı firmalar yukarıda bahsettiğimiz eşitlikten daha az bir ücret ödedikleri takdirde hiçbir hanehalkı kayıtdışı sektörde çalışmak istemeyecektir.

Modelde devlet, kendi harcamalarını vergi toplama yoluyla finanse etmektedir. Burada dikkat edilmesi gereken husus ise kayıtdışı firmalar vergi ödemedikleri için, devletin toplam vergi gelirleri olması gerekenden daha düşük çıkmaktadır. Bununla birlikte, modeli basit tutabilmek adına, devlet harcamalarının firmalar ya da hanehalkları üzerinde herhangi bir dolaylı etkisinin olmadığı varsayılmıştır. Yani,

devlet harcamaları üretken değildir ve hanehalklarına herhangi bir fayda sağlamamaktadır.

Bununla birlikte modelimiz, bağımsız bir sosyal güvenlik sistemi içermektedir. Devletin gelirlerinden ve harcamalarından bağımsız olarak sosyal güvenlik sistemi de her yıl kendi bütçesini dengelemektedir.

Vergilendirme ise hanehalkının harcanabilir gelirini düşürdüğü ve ayrıca boş zamanların ya da malların fiyatlarını değiştirdiği için hanehalklarını iki farklı kanalla etkilemektedir. Kurulan modelde, kayıtlı firmalar tüm vergilerini eksiksiz ödediği halde, kayıtdışı firmalar gelir vergisini kaçırmaktadırlar.

Ekonomide üç tip vergi olduğu varsayılmıştır: gelir vergisi, tüketim vergisi ve sermaye gelir vergisi. Kayıtdışı sektör firmaları bu üçünden sadece gelir vergisini kaçırabilmektedir. Çünkü tüketim vergisi tüketilen mal üzerinden doğrudan kesilir ve kaçırma imkansızdır, sermaye gelir vergisi ise faiz üzerinden kesildiği için kayıtdışı firma bu vergi türünü de kaçıramaz.

Bununla birlikte devlet, her bir dönemde bütçesini dengelemektedir; bir sonraki döneme bıraktığı borç ve bu dönemki vergilerin toplamı, bu dönemki devlet harcamaları ve bir önceki dönemden aktarılan borcun (faiziyle birlikte) toplamına eşit olmak zorundadır.

Bahsedildiği gibi model, kendi ayrı denk bütçesi olan bir sosyal güvenlik sistemi barındırmaktadır. Sosyal güvenlik sistemi her yıl kayıtlı işçilerden topladığı vergileri, o yılın emeklilerine dağıtmak üzere kurulan bir sistemi temel almaktadır (Pay-as-You-Go). Bu model Türkiye’de de halihazırda kullanılan sosyal güvenlik sistemidir. Bununla birlikte modelde, sosyal güvenlik sistemi tasarruf etmeyecek ya da borçlanmayacak şekilde modellenmiştir.

Yukarıda da bahsedildiği gibi sosyal güvenlik sistemine sadece kayıtlı işçiler dahil olmakta ve dolayısıyla sadece onlar emekli aylığı almaktadır. Kayıtlı sektör işçileri bu emekli aylıklarını 41. periyotta almaya başlar (gerçek hayatta 61 yaş) ve 55. periyodun (gerçek hayatta 75 yaş) sonuna kadar almaya devam eder. Bununla birlikte, emeklilik zorunlu değildir ve hanehalkları istedikleri takdirde emekli olduktan sonra da çalışabilir.

Dinamik modellerde genel denge konsepti, hanehalklarının, firmaların ve devletin sadece bugünkü değerlerle değil, aynı zamanda gelecek değerlerle de tutarlı davranışlar sergilemelerini gerektirmektedir. Dolayısıyla faiz oranı, ücretler, vergi oranları ve emeklilik bağlanma oranı (replacement rate) verildiği takdirde, hanehalkları faydalarını maksimize eden tüketim ve boş zaman patikaları ile bırakacakları miras miktarını seçerler. Firmalar ise sermayenin ve iş gücünün marjinal verimlerini faktör fiyatlarına eşitleyerek karlarını maksimize ederler. Sermaye ve iş gücü piyasalarının denge sağlayıcı koşulları sağlandığında, devlet kendi bütçesini her yıl dengeler. Son olarak, tüm bu şartlar altında sosyal güvenlik sistemi de kendi bütçesini her yıl dengelemektedir.

Bahsettiğimiz dinamik model, tüm süreç boyunca MATLAB ortamında simüle edilmiştir. Bununla birlikte, modeldeki lineer olmayan denklem setleri MATLAB kütüphanesindeki “fsolve” fonksiyonu yardımıyla çözülmüştür. Gerekli kısıtlar ve parametreler verildiğinde kararlı durum iki şekilde karakterize edilmektedir: başlangıç kararlı durumu ve son kararlı durum. Başlangıç kararlı durumu, mali politikadaki şok verilmeden önceki ekonominin uzun vade dengesidir. Son kararlı durum ise mali politika şoku uygulandıktan sonraki ekonominin uzun vade dengesidir.

Tüm hanehalklarının ve firmaların tam öngörü sahibi oldukları varsayılmıştır. Fakat mali politikadaki değişiklik, hanehalkları ve firmalar tarafından beklenen bir değişiklik değildir. Sonuç olarak tam öngörü sahibi olan hanehalkları, mali politikadaki değişiklik öncesi durumda var olan şartlara göre davranışlarına karar verirler. Ancak mali politikadaki değişiklik sonrası da yenilenen şartlara göre davranışlarını yeniden düzenlemek durumundadırlar.

Tam öngörü kavramını açacak olursak, bahsedildiği gibi tüm hanehalkları, firmalar ve devlet, zaman boyunca tutarlı davranmaktadır. Yani, hanehalkları ve firmalar her yıl yeniden seçim yapmalarına rağmen, her yıla özgü seçimler, önceki yılların ve tüm gelecek yılların seçimleriyle tutarlı olmak zorundadır. Sonuç olarak bütün tüketim, boş zaman, sermaye birikimi, emekli aylıkları ve miras miktarı aslında ilk yıldaki optimizasyonla belirlenir ve geri kalan yıllardaki tüm optimizasyonlar, ilk yıldaki optimizasyonun bir sağlamasıdır.

Denklem çözümleri Gauss-Seidel yineleme metodu kullanılarak elde edilmiştir. Algoritma, bazı değişkenler için dışsal olarak seçilen bir başlangıç tahminiyle başlar. Bu tahmin asıl çözüme yakın olmalıdır, çünkü kullandığımız “fsolve” fonksiyonu, asıl çözüme uzak tahmin verildiğinde çalışmamaktadır. Tüm sistem, bu verilen başlangıç tahminlerini alır ve bir kereliğine algoritmayı çalıştırır. Algoritma bir kere çalıştıktan sonra artık elimizde başlangıçta dışsal olarak verilen değişkenlerin, içsel olarak elde edilen güncellenmiş tahminleri bulunur. Daha sonra Gauss-Seidel yineleme metoduna göre, bu güncellenmiş tahminler sisteme yeniden verilir ve bir sonraki güncellenmiş tahminler elde edilir. Bu süreç, iki ardışık güncellenmiş tahmin birbirine çok yakın (farkın 0.00001’den daha küçük olması) çıkana kadar devam eder. Böylece sistemin verdiği son güncellenmiş tahminler, ekonominin kararlı durum değerlerini ifade eder. Bu yakınsama kriterine ulaşabilmek için tüm sistem yaklaşık 5000 defa yinelenmektedir.

Başlangıç ve son kararlı durum çözüm metotları tamamıyla aynı olmakla birlikte, sadece verilen dışsal mali politika şoku açısından farklılık göstermektedir. Bununla birlikte, sadece mali politika şokuna ait etkiyi görebilmek için, tüm parametreler ve kısıtlar hem başlangıç hem de son kararlı durum için aynı seçilmelidir. Simülasyonumuzda, sabit bir kayıtdışı ekonomi büyüklüğü altında farklı gelir vergilerinin etkileri incelenmiştir. İkincil olarak sabit bir gelir vergisi oranı altında farklı kayıtdışı ekonomi büyüklüklerinin ekonomiye etkileri gözlenmiştir. Bununla birlikte, her iki durum için de ayrı ayrı refah analizleri yapılmıştır.

Modelde kullanılan parametre değerleri seçilirken iki kritere dikkat edilmiştir: tutarlılık ve Türk ekonomisinin 2013 yılı mali değerlerine uyumluluk. Modelsel bütünlüğü koruyabilmek için, parametrelerin çoğu Schmidt-Hebbel (1997)’den alınmıştır. Bu çalışmanın kalibrasyonu belirli bir ülke için değil, herhangi bir gelişmekte olan ülkeye göre yapıldığı için, aynı değerlerin Türkiye’ye de uygulanması uygun görülmüştür. Bununla birlikte üretim parametreleri seçilirken, kayıtlı sektörün sermaye yoğun, kayıtdışı sektörün ise iş gücü yoğun olmasına dikkat edilmiştir. Birkaç fayda fonksiyonu parametresi ise modelde çıkan mali değerlerin, Türkiye’nin 2013 yılı mali değerlerine uygun olacak şekilde dışsal olarak seçilmiştir.

Bununla birlikte nüfusun büyüme oranı Türkiye İstatistik Kurumu’ndan alınmıştır; 1.37 %. Emeklilik bağlanma oranı, 64.5%, OECD’den alınmıştır (OECD, Pension at

a Glance, 2013). Devlet harcamalarının GSYH'ya oranı ise Dünya Bankası veri tabanından elde edilmiştir. Son olarak modelin zaman birimi, Auerbach ve Kotlikoff (1987) ile uyumlu olarak, bir periyot bir yıla denk gelecek şekilde kalibre edilmiştir.

Simülasyonlar boyunca şu sorulara cevap aranmıştır: Gelir vergisi ekonomiyi nasıl etkilemektedir? Kayıtdışı ekonominin büyüklüğünün ekonomiye etkileri nelerdir? Belki de en önemlisi; gelir vergilerinin ve kayıtdışılığın toplum refahı üzerinde nasıl bir etkisi vardır? Bu sorulara cevaplar, bazı önemli makroekonomik değişkenler hesaplanarak verilmiştir. Bu değişkenler faiz oranı, ücret seviyeleri, sermaye stoku, iş gücü arzı, toplam tüketim, sosyal güvenlik sisteminin geliri ve toplum refahından oluşmaktadır. Tüm modelin aynı parametrizasyonla, farklı şartlarda (farklı gelir vergileri ve farklı kayıtdışılık oranı) çözümüyle elde edilen simülasyon sonuçları, uzun vade dengelerini karşılaştırmalı olarak vermektedir.

Simülasyon sonuçları, kayıtdışılığın ekonomiye verdiği zararının çok büyük olduğunu göstermektedir. Sabit gelir vergisi altında, kayıtdışılık oranı basamak basamak artırıldığında görülmüştür ki, kayıtdışı sektör büyüdükçe neredeyse tüm önemli makroekonomik değişkenler kötüleşmektedir. Yani, daha büyük kayıtdışı ekonomi demek daha düşük tüketim, daha düşük sermaye stoku, daha düşük iş gücü arzı, daha düşük ücret seviyeleri ve daha düşük GSYH demektir. Bununla birlikte, gelir vergisi oranı sabit tutulmasına rağmen, kayıtdışılık arttıkça toplam vergi gelirleri de ciddi ölçülerde azalmaktadır.

Bununla birlikte sabit bir kayıtdışılık oranı altında, farklı gelir vergisi oranlarının ekonomiye etkileri incelendiğinde, azalan vergi gelirlerini artırmak için devletin vergi oranlarını artırmasının daha da kötü sonuçlara yol açtığını göstermektedir. Gelir vergisini %5'ten %35'e çıkardığımızda, devletin gelir vergisinden elde ettiği toplam gelirin %73 arttığı görülmüştür. Ama bu artış, GSYH'da %57'lik, sermaye stokunda ise %53'lük bir azalışa neden olmaktadır. Ayrıca, hem kayıtlı hem de kayıtdışı sektörün vergi sonrası net ücret seviyeleri de düşmektedir.

Refah analizleri ise hem kayıtdışılık büyüdüğünde hem de gelir vergisi oranları artırıldığında toplum refahının zarar gördüğünü göstermektedir. Sonuç olarak, devlet toplum refahını düşürmeden toplam vergi gelirlerini artırmak için, vergi oranlarını artırmanın çözüm olmadığını görmeli, bunun yerine kayıtdışı ekonomiyi azaltmanın

yollarını aramalıdır. Bu amaçla devlet gerekli yapısal reformları yapması ve kayıtdışı ekonomiyi küçültmeyi başarması, GSYH, sermaye stoku ve ücret düzeylerinde belirgin bir artışı beraberinde getirmektedir. Daha da önemlisi daha düşük vergi oranları ile daha yüksek vergi gelirleri elde edilecek, dolayısıyla toplum refahı da artacaktır.

Bu çalışma, kayıtdışı ekonomiyi daha karmaşık bir şekilde modelleyerek geliştirebilir. Örneğin, kayıtdışı ekonominin büyüklüğü dışsal olarak verilmek yerine model içerisinde içsel olarak hesaplanabilir ve bu sayede vergi geliri artırıldığında kayıtlı sektörden kayıtdışı sektöre geçişler gözlemlenebilir. Hanehalkları yetenek seviyesi ya da aldığı eğitim açısından farklılaştırılabilir ve hanehalklarının her iki sektörde de çalışabilme varsayımı gevşetilebilir. Bu sayede ekonomi daha gerçekçi modellenebilir. Bununla birlikte, kayıtdışı sektörde neredeyse tüm ekonomik transferler sadece para kullanarak yapıldığı için modele para da dahil edilebilir. Son olarak, bahsedilen genişletmelerle beraber bu model farklı sosyal güvenlik sistemleri ve vergi reformu gibi mali politikaların etkilerini görebilmek için rahatlıkla uygulanabilir.



## APPENDIX B

### TEZ FOTOKOPİSİ İZİN FORMU

#### ENSTİTÜ

|                                |                                     |
|--------------------------------|-------------------------------------|
| Fen Bilimleri Enstitüsü        | <input type="checkbox"/>            |
| Sosyal Bilimler Enstitüsü      | <input checked="" type="checkbox"/> |
| Uygulamalı Matematik Enstitüsü | <input type="checkbox"/>            |
| Enformatik Enstitüsü           | <input type="checkbox"/>            |
| Deniz Bilimleri Enstitüsü      | <input type="checkbox"/>            |

#### YAZARIN

Soyadı : ÖZTÜRK

Adı : ÖZGEN

Bölümü : İKTİSAT

TEZİN ADI (İngilizce) : Simulating The Turkish Economy Under  
Informality

TEZİN TÜRÜ : Yüksek Lisans  Doktora

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir.
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir.
3. Tezimden bir (1) yıl süreyle fotokopi alınmaz.

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: