EXCHANGE RATE PASS-THROUGH IN TURKEY: AN EMPIRICAL INVESTIGATION

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ABSTRACT

EXCHANGE RATE PASS-THROUGH IN TURKEY:
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This study investigates the degree of exchange rate pass-through to prices in different sectors for Turkish economy using Johansen Cointegration procedure. The study is based on quarterly data from 1994:1 to 2003:4. In this study it is concluded that the long-run exchange rate pass-through to overall wholesale prices for Turkey is very high and nearly complete. High pass-through degrees are also valid for different sub-sectors wholesale prices like private, public, manufacturing industry and energy. Moreover, it is detected that the prices set by public sector have higher exchange rate pass-through but longer adjustment period as compared to private sector prices.

Key Words: Exchange Rate Pass-Through, Exchange Rates, Inflation, Cointegration, Turkey.

ÖZ

TÜRKİYE'DE DÖVİZ KURUNUN FİYATLARA GEÇİŞKENLİĞİ ÜZERİNE AMPİRİK BİR ÇALIŞMA

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Bu çalışmada döviz kurunun fiyatlara geçiş derecesi, Türkiye ekonomisindeki farklı sektörler kapsamında Johansen eşbütünleşim analizi kullanılarak incelenmiştir. Çalışmada 1994:1'den 2003:4'ü kapsayan üç aylık veri seti kullanılmış. Analiz sonuçlarına göre Türkiye için uzun dönem döviz kurunun toptan eşya fiyatlarına geçişkenliği oldukça yüksek ve tama yakın bulunmuştur. Yüksek geçişkenlik derecesi özel, kamu, imalat sanayii ve enerji gibi sektör fiyatları içinde geçerli olduğu sonucuna varılmaktadır. Ayrıca, kurun kamu tarafından belirlenen fiyatlara geçiş derecesinin, özel sektör tarafından belirlenen fiyatlara geçiş derecesine kıyasla daha yüksek ancak geçiş sürecinin daha uzun olduğu tespit edilmiştir.

Anahtar Kelimeler: Kurun Fiyatlara Geçişkenliği, Döviz Kurları, Enflasyon, Eşbütünleşim Analizi, Türkiye.

To My Parents

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CHAPTER 1

INTRODUCTION

The determinants of price level and inflation have been at the heart of the economics theory and policy literature. There are various factors that may influence the price level of a country but main rising factor among them is changes in exchange rates. The impact of exchange rates on domestic prices is often referred to "exchange rate pass-through" in the literature. Exchange rate pass through is an important empirical issue as the degree of it has crucial policy implications. A high degree of pass through, for example, is often seen as an obstacle to a successful inflation targeting (Mishkin, 2004) and a cause for fear of floating (Calvo and Mishkin, 2003). The aim of this thesis is thus to investigate the magnitude of exchange rate pass through in Turkey considering not only the aggregate price level but also its main components. Turkey, as a country with an experience of sustained high inflation and substantial exchange rate fluctuations for more than three decades appears to be an excellent candidate to investigate this important empirical issue.

Conventionally, exchange rate pass-through is defined as the percentage change in the domestic currency price of imported goods resulting from a one per cent change in the nominal exchange rate between exporting and importing countries. The change in import prices due to changing of nominal exchange rate is likely to translate into a change both in the producer and the consumer price indices. The pass-through definition can be modified to other types of prices for instance producer

prices. If the change of exchange rate is translated to prices fully, it is said that the exchange rate pass-through is full or completed. Otherwise partial reflection is called partial or incomplete exchange rate pass-through.

Exchange rate pass-through to producer prices consists of many transmission mechanisms. The main rising questions in literature are not only in which channels the change of exchange rate into prices translates but also how much the degree of exchange rate pass-through to prices is. *Ceteris paribus*, import prices should move identically with the exchange rate due to the Law of One Price (LOP). However, prices are often set in different stages. The affect of exchange rate shocks can be transmitted from one stage to another and much of the absorption of exchange rate shocks can take place somewhere along the stages. Therefore, it is important to know how transmission channels of exchange rate shock on domestic prices works. It is useful to assess the degree of pass-through in different sectors of the economy, in particular to prices set early in the distribution chain, such as those summarized in the Wholesale Price Index (WPI).

Most developed countries had experience of rising inflation after the demise of the Bretton-Woods system and consequently potential effects of exchange rate on domestic prices became main concern of the economy. Many studies covering this period showed that there was a strong link between exchange rate and prices. In the recent years, however, low and stable inflationary environment contributed to reduction of influence of exchange rate movements on prices in the industrialized countries. This experience has led to decline the pass-through to domestic prices in the industrialized countries. On the other hand, changes in exchange rates are found to be strong and contemporaneously correlated with inflation in the

countries with high and persistent inflation like emerging market countries. Exchange rate movements have considerable role in these economies due to the influence on expectation and impact on fundamental macroeconomic parameters. Exchange rate affects inflation through many transmission channels that is not explained explicitly such as the impact of exchange rate changes on inflation expectation. There are some signals of positive improvement on the degree of exchange rate pass-through in the emerging countries. Stable macroeconomic conditions, monetary policy credibility and structural reforms have contributed to fall in the degree of exchange rate pass-through in the emerging countries since mid-1990s. It is thus important to expose the properties of price movements regarding exchange rate changes for emerging countries in order to design sound, sustainable and credible policies.

Turkey adopted a policy regime change towards integration with the rest of the world after abandoning an import substitution development policy from the beginning the 1980s. With the capital liberalization in 1989 and convertibility of the Turkish Lira in 1990, Turkey completed the main steps towards integration with the world economy. After these dates, the economy of Turkey has become more sensitive to external developments. Turkish economy has been affected by unstable and substantially fluctuating exchange rates. Henceforth, different exchange rate regimes have been implemented in different periods.

There has been a strong correlation between exchange rate movements and domestic prices in Turkey due to continuing depreciation of domestic currency and high inflationary environment during the last three decades. Estimating the degree of exchange rate pass-through to

wholesale price indices is thus crucially important for understanding the roots of inflation. In this thesis, we investigate the degree of changes in wholesale price index and its disaggregated main components caused by exchange rate changes and attempt to estimate the degree of exchange rate pass-through in Turkey.

The rest of the paper is organized in three main parts. First, we summarize the exchange rate pass-through literature in the Chapter 2. Secondly, Chapter 3 presents the data used in the analysis and discusses the main characteristics of them. Chapter 3 contains also the estimation results to assess the degree of the exchange rate pass-through to aggregate wholesale prices in Turkey and long run equations for disaggregated wholesale prices. Finally, Chapter 4 concludes.

CHAPTER 2

EXCHANGE-RATE PASS THROUGH: A BRIEF REVIEW OF THE LITERATURE

An exchange rate is the current market price of a country currency in terms of another country currency. There is now a broad and growing literature attempting to explain the relationship between exchange rate and domestic prices. The conventional literature considering exchange rate pass-through to import and domestic prices has generally interested in the microeconomic side of the debate, which is stressed the importance of microeconomic factors like the market power, industrial structure and international pricing strategies. Our focus in this thesis, on the other hand, the macroeconomic side of the debate. Consequently, we aim to analyze the determinants and degree of exchange rate pass-through to import prices of the importing country and to investigate how domestic prices are directly affected by import prices changes. This transmission and pass-through to domestic prices are key factors for macroeconomic balances.

A useful starting point of the transmission of exchange rates to domestic prices may be the Law of One Price (LOP) and the Purchasing Power Parity (PPP) hypotheses. According to the Law of One Price, the same item or closely equivalent items must sell for the same price or related prices in the marketplace when trade is open and costless. The Purchasing Power Parity postulates that the exchange rate between two countries' currencies equals to the ratio of the countries prices levels (Krugman and Obstfeld, 1997). PPP suggests that, in the long run, currency exchange rates

will adjust so that the cost of similar goods and services will tend to be the same in all markets and in all currencies. According to the PPP hypothesis, exchange rates adjust to price differentials in open economies to restore international commodity market equilibrium. The PPP hypothesis indeed stems from LOP which states that, measured in a common currency, freely traded identical commodities should have the same price everywhere in the absence of transaction and transportation costs. That is:

$$p_t = e_t + p_t^* \quad (1)$$

Where e is the log of the nominal exchange rate (domestic currency per unit of foreign currency), p and p* are the logs of the domestic and foreign prices, respectively. Rearranging (1) gives the PPP hypothesis (the strong or absolute form):

$$e_t = p_t - p_t^* \quad (2)$$

The lack of absolute price level data constructed for an internationally standardized basket of goods to test the absolute PPP often enforces researchers to retreat to the testing of relative PPP (Rogoff, 1996). The relative (or weak) version of the PPP often defines the evolution of exchange rates in a growth rate form:

$$\Delta e_t = \Delta p_t - \Delta p_t^* \quad (3)$$

Where Δ is the first difference operator. Rearranging (3) gives:

$$\Delta p_t = \Delta e_t + \Delta p_t^* \quad (4)$$

The cointegration of variables in the systems defining the parities with unitary coefficients can be interpreted as evidence supporting the PPP hypothesis. However, a cointegration between the variables can be consistent with alternative conditioning restrictions for the parameters of the long-run relationship. As noted by Özmen and Gökcan (2004, p. 780)

> although going from Equation 1 to 2 maintains the endogeneity of exchange rate, the theory may not be inconsistent with the joint endogeneity of the system variables (except the case that one of the countries is small enough to effect price level of the other).

As Taylor (1996, p. 8) notes, 'There is no a priori reason to have exchange rates on the left-hand side and prices on the right'.

Both the strong and weak versions of PPP maintain that the exchange rate pass-through is perfect with a unitary coefficient. The validity of this crucially depends on the validity of the PPP hypothesis. However, the PPP hypothesis is seldom supported by empirical evidence. There are ample alternative explanations for the conflicting results for the validity of the PPP hypothesis. The explanations for the failure of PPP include, imperfect competition, non-tradable goods, non-homogeneous goods, pricing to market, the choice of price indices and base country, information costs, transport costs and trade barriers. Non-linear dynamics, the low power of the conventional unit root tests over short time spans of data, and temporal aggregation are among the empirical modeling issues suggested as the reasons for the mixed result (Taylor and Taylor, 2004).

The exchange rate pass-through literature does not necessarily maintain that the PPP hypothesis is valid. The exchange rate movement is closely related to many other variables and the structure of the country.

According to the exchange rate pass-through literature, this set of variables contains output gap, productivity differentials, openness, countries' import share, initial rate of inflation and external factors…etc.

Many studies in the literature demonstrate that exchange rate pass-through is not complete due to factors regarding different properties of individual economies such as imperfect competition. Dornbusch (1987) and Krugman (1986) explain a less than one-to-one transmission by imperfect competition or pricing to market. According to this theory, foreign producers adjust their mark-up to maintain a stable market share in the domestic economy, which can drive the rate of pass-through to zero in principle.

Menon (1995) provides an early comprehensive study on the exchange rate pass-through. Menon (1995) focuses on the effect of the aggregate price measures and presents an overview of 43 empirical studies on industrialized economies. It is concluded that the exchange rate pass-through is incomplete and the degree of pass-through vary significantly across different countries. The main factors behind the different degree of pass-through are the size and the openness of the economies. In the same vein, Goldberg and Knetter (1997) survey the literature on pass-through to import prices and stress the empirical fact that price levels adjust less than fully to movements in the exchange rate.

Goldfajn and Werlang (2000) investigate the relationship between exchange rate depreciation and inflation using a sample of 71 countries in the period of 1980-1998 employing a panel data estimation procedure. The cyclical component of output, the extent of initial overvaluation of the real

exchange rate, the initial rate of inflation and the degree of openness of the economy are taken as main determinations of the pass-through from exchange rate depreciation to inflation. Goldfajn and Werlang (2000) conclude that the pass-through coefficient increases when the horizon analyzed is longer and the coefficient has the maximum value at a 12-month horizon. The determinations of the pass-through have different coefficient in different regions. Real exchange rate overvaluation is practically important for the pass-through coefficient in the American region rather than other regions' pass-through coefficients. On the other hand, initial inflation is important determination for European countries and openness has significant effect on the pass-through coefficient for African and Oceania countries. Goldfajn and Werlang (2000) also state that real exchange rate overvaluation must be taken into account to get a better prediction on inflation for emerging countries and initial inflation is fundamental determination to forecast inflation for European countries. Briefly, Goldfajn and Werlang (2000) found that the degree of pass-through is substantially higher in emerging market economies than in developing economies.

Kim (1998) examines exchange rate pass-through in the United States using a multivariate cointegration VAR framework. He investigates the relationship between exchange rate, money supply, aggregate income and interest rate. He finds a long-run pass-through coefficient of 0.24, but does not address short-run adjustment issue. As a consequence, the study shows that there is significant contribution of exchange rate changes to determine the producer prices.

Hüfner and Schröder (2000) investigate exchange rate pass-through to consumer prices in the large five industrialised countries (Germany, France, Italy, the Netherlands and Spain) in the Euro area. In the estimation, seven variables are used for each country. These variables are import prices, producer prices, consumer prices, output gap, short-term interest rate, oil prices and the effective nominal exchange rate, covering January 1982 until January 2001. In the study, oil price serves as a proxy for supply shocks and the output gap proxies the demand shocks. Short-term rates are used to incorporate central bank policy in the system. A vector error correction (VEC) model is established for each of the five countries and impulse-response analyses to estimate the pass-through effects of changes in the effective exchange rate to the prices at the import, producers and consumer level. Pass-through coefficients for consumer price range from 7 (France) to 12 percent (Italy) after one year and coefficients range 8 (Spain) to 18 percent (Italy). Aggregating the national results using the weights of each country's inflation rate Hüfner and Schröder (2000) find that on average 10 percent depreciation of the effective euro exchange rate leads to an increase of 0.4 percentage points in the inflation rate after one year. The total effect converges to 0.8 percentage points after about three years. Briefly, they point out that the exchange rate has an influence on consumer prices and suggest it should be taken into account for price stability.

Borensztein and Gregorio (1999) investigate the effect of large devaluations on inflation. The study covers 41 episodes of currency crises, which are characterized by a deteriorating currency account balance and a real exchange rate below the long-term average. They construct a sample of currency crises that ended with a large depreciation of the domestic currency in the 1970-1996 period. This sample includes the Mexican crisis of

1994, the last European currency realignments, the CFA Franc devaluation and the other episodes in Asia and Latin America. They have group countries in Europe, CFA-zone, Latin America, in which Israel and Turkey were include since they have shown some similarity in their macroeconomic behavior, and Asia. In the study, initial conditions of the economy, such as the inflation rate, the position in the business cycle, the misalignment of the real exchange rate, degree of openness, and current account deficit, are analyzed econometrically. They conclude that the main determinants of the extent of inflationary pass-through of the devaluations and inflation are the position of the output relative trend, the degree of exchange rate misalignment and the initial rate of inflation.

Burstein, Eichenbaum and Rebelo (2003) investigate four large depreciation episodes (Mexico-1994, Korea-1997, Brazil-1999, Argentina-2001) in order to detect main factor behind movements of real exchange rate after large depreciations. They argue that the low pass-through is mainly due to slow adjustment in the price of non-tradable goods and services. They study on an open economy general equilibrium model. It is shown that no failure of relative PPP for goods that are actually traded.

One of the main leading studies in the literature is Taylor's (2000) study. Taylor (2000) discusses the microeconomics of the exchange rate pass-through which is basically related to pricing strategies of firms. The model constructed by Taylor (2000) shows that changes in pricing power partly depends on changes in the expectations of the persistence of price and cost movements. It is claimed that decline in the degree of pass-through is brought by reduction in pricing power of firms in a low inflation environment. There is evidence that if low inflation environment is

corrupted, the low pass-through and pricing power of firms will be reversed.

Steel and King (2004) are interested in the degree of exchange rate pass-through of the exchange rate regime in operation and the degree of pass-through under inflationary environment. They test that Taylor (2000) hypothesis which claims that the pass-through under a floating regime will be lower. They consider the New Zealand data covering the period of persistently high rates of inflation through the 1970s and 1980s and the period of sustaining price stability since the end of the1980s. The analysis is done by constructing a mark-up model of import prices and applying it to three time periods, fixed exchange rate, a floating exchange rate and a low inflation environment. They found that there was dramatically reduction in exchange rate pass-through degree in New Zealand as the change from a fixed to floating exchange rate regime in 1985. However, there exists no noticeable change in the degree of pass-through after achieving a sustainable low inflationary environment.

Choudhri and Hakura (2001) explore the relationship between the pass-through and inflation rate. They study on a large database including the periods of 1979-2000 for 71 countries and the framework is based on new open economy macroeconomics models. Countries are grouped into three categories, such as low, moderate and high inflation. All industrial countries are included in low inflation group and developing countries are taken in three type groups. Authors show that the lowest average pass-through coefficients appear in the low inflation groups and the highest pass-through emerges in the high inflation groups. Most of the countries in the database are countries which have experienced a single inflation regime

and these countries provide strong evidence of relation between inflation and pass-through. A small number of countries experienced a dramatic shifts in inflation regime also support that pass-through changes depends on inflation rate changes. Thereby, this study provides the evidence of a low inflationary environment leads to a low exchange rate pass-through to domestic prices. Choudhri and Hakura (2001) also note that emerging countries have higher pass-through as compared to developed countries.

McCarthy (2000) examines the pass-through of exchange rate and import price fluctuations to domestic producer and consumer inflation for nine developed countries (the United States, Japan, Germany, France, the United Kingdom, Belgium, the Netherlands, Sweden, and Switzerland). McCarthy (2000) assumes that inflation is comprised of several components, including expected inflation, supply and demand shocks on inflation and exchange rate of shocks on inflation. The first important feature of study is that the model allows import inflation shocks to affect domestic consumer inflation both directly and indirectly through their effects on producer inflation. The second characteristic of the study is that there is no contemporaneous feedback in the model. This implies that changes of import and producer prices affect consumer price inflation but consumer inflation shocks affects import and produces inflation by means of their effect on expected inflation in future periods.

Otani, Shiratsuka and Shirota (2003) investigate the exchange rate pass-through to Japan's import prices. They figure out the factors behind declines in exchange rate pass-through in all products categories. In this study, it is employed the rolling regression method to detect changes in exchange rate pass-through over time across industries. The periods of the

study is from January 1978 to October 2002 for overall import prices and disaggregate import prices. The results demonstrate that the decline is mainly attributable to decline in exchange rate pass-through in each product, rather than change in import share of them. Another result obtained from study is that the overall pass-through declines especially occurred from the late 1980s to the early 1990s. Factors behind the decline in exchange rate pass-through investigate in two main titles. The first one is the Yen's sharp appreciation and the change in the Japanese trade structure. Increasing competitive pressure, captured by an increase in the import penetration, has an important role on declining exchange rate pass-through. The second factor is worldwide low-inflation environment. The exchange rate pass-through to import prices is likely to be low in an environment, which is worldwide low inflation with less persistent exchange rate changes. They also conclude that the change in Japan's trade structure is main reducing factor of exchange rate pass-through.

Mihajek and Klau (2000) study on the pass-through of exchange rate and import prices changes into domestic inflation for 13 emerging market economies. One of the main findings of study is that relation between the exchange rate changes and inflation is much stronger than the relationship between import price changes and inflation. Also, they stress that volatile inflation -not persistence- cause large pass-through coefficient. Both indexation of wages and debt and currency substitution, which shapes the behavior of agency according to external influences to domestic prices and affects the expectation about future inflation, make exchange rate volatility be more correlated with inflation volatility. Finally, they remarks that stable macroeconomic conditions and structural reforms implementations help

decline the pass-through from exchange rate changes and import changes into inflation.

Peru is the one example country of small and open economy. The study regarding exchange rate pass-through analysis for Peru is provided by Lira (2003) . The main purpose of this document is to estimate the pass-through coefficient in Peru for the period 1995-2002 and to analyze its main transmission channels. Moreover, the main sources of exchange rate shocks were investigated in the study. A vector autoregressive model (VAR), which allows to develop a model of pricing along a distributional channel, is used to reach the proposed objective. The results are consistent with exchange rate pass-through literature. The pass-through coefficient is smaller as exchange rate shock moves down in the distribution of chain. The exchange rate pass-through to wholesale prices is twice the exchange rate pass-through to consumer prices, so this shows that by changing profit margins producer are assimilated the shock of exchange rate. They conclude that nominal exchange rate is an important transmission channel of nominal shocks to relative prices in Peru.

In the study of Devereux, Engel and Storgaard (2003), both pass-through and exchange rate are determined simultaneously in a model featuring the basic tenets of the new open economy macroeconomic literature. It is assumed that exchange rate itself is endogenously determined in the model. It is concluded from the results of study that there will be a dramatic change between structural parameters and exchange rate volatility when the pass-through is endogenized. In other words, they show that the relationship between exchange rate volatility and economic structure are substantially affected by the presence of endogenous pass-

through. Devereux, Engel and Storgaard (2003) also show that relative stability of monetary policy is the key factor of pass-through. Countries with relatively low volatility of money growth will have relatively low rates of exchange rate pass-through and vice-a-versa.

Belaisch (2003) analyzes the degree of exchange rate pass-through of currency depreciation to domestic prices in Brazil. Due to the domestic and external shocks, there exists significant trend depreciation in Brazil during the period of 2001-2002 but there was no large increase in inflation in this period. Limited rise in inflation is due to a consistently low exchange rate pass-through. Belaisch (2003) argues that the exchange rate pass-through has fallen in Brazil and why the pass-through coefficient is smaller than expected. It is concluded that a combination factor matters the degree of pass-through, such as the depressed level of economic activity, the availability of domestically-produced goods as substitutes for imports for import-users, the slow adjustment of non-tradable prices and wages and the sentiment that the depreciation was temporary.

Croatia, which is heavily dollarized economy, has a monetary policy which is characterized by a very low tolerance of exchange rate movements and a market activism of the central bank in foreign currency markets. The policy has successful in reducing inflation and stabilizing the economy. An exchange rate pass-through analysis is presented by Billmeier and Bonato (2004) with following recursive ordering procedure of McCarthy (2000). It is interpreted that the pass-through coefficient should increase with price liberalization process and so exchange rate movements become more remarkable for policy maker. Ross (2000) and Kuijs (2002), on the other hand, suggest that there exists no significant evidence of low pass-through

in transition economies. This result may be due to the lack of credibility of the monetary authorities and to structural elements, e.g., the price-taking nature of domestic firms on international markets.

The Turkish case is considered recently by Leigh and Rossi (2003). Leigh and Rossi (2003) investigate the impact of exchange rate movements on different prices in Turkey, particularly since the floating of the Turkish lira in February 2001. The data sample covers the period from January 1994 to April 2002. The pass-through of the exchange rate to domestic prices is evaluated using a five variable recursive VAR approach. Variables in this study are oil prices, real output, nominal exchange rate relative to the US dollar, wholesale prices and consumer prices. Supply shocks are identified by oil prices and demand factors are identified by industrial production index. The VAR analysis in this paper confirms the importance of the exchange rate movements in explaining domestic price inflation. Three findings are worth emphasizing. First, the impact of the exchange rate on the exchange rate on prices is over after about a year, but is mostly felt in the four months. Second, the pass-through to wholesale prices is more pronounced compared to the pass-through to consumer prices. After a year, about 60 percent of an initial exchange rate shock has pass-through to wholesale prices and about 45 percent of the shock has pass-through passed through to consumer prices. Third, the estimated pass-through in Turkey is both quicker and larger than estimated in other key emerging market countries. The pass-through to wholesale prices seems more pronounced compared to the pass-through to consumer prices, with as much as 60 percent of the exchange rate change being eventually reflected in domestic prices. By the end of the first month after the shock, the WPI and CPI have risen by 17 and 12 percent of the exchange rate shock, respectively. The

pass-through coefficients increase until the eleventh month, by which time 60 and 45 percent of the depreciation shock seems to have passed through to wholesale and consumer prices, respectively.

According to Leigh and Rossi (2003), the impact of the exchange rate on CPI fluctuation is less than it is for the WPI, which is not surprising given the larger share of tradable goods in the WPI. The WPI contains a larger share of tradable goods (about 70 percent) than the CPI (about 45 percent). The estimated pass-through in Turkey by Leigh and Rossi (2003) is both shorter and larger than those estimated in other key emerging market countries.

CHAPTER 3

EMPIRICAL ANALYSIS

In this section, we present and discuss our empirical results on the exchange rate pass-through to wholesale price index and its main components. It is beneficial to assess the degree of pass-through in different sectors of the economy. Prices are set in different stages and producer prices or wholesale prices are set in an earlier stage than consumer prices in an economy. Determining the degree of exchange rate pass-through to wholesale price indices is, thus, important for understanding the root of changes in consumer prices when exchange rate changes.

The chapter is structured to tackle these issues. In the following section a brief review of the empirical methodology employed in this study is presented. Section 2 is devoted to some descriptive statistics about the data used in the analysis. Investigating for the degree of the exchange rate pass-through to aggregate wholesale prices in Turkey is the main subject of section 3. Long run equations for disaggregated wholesale prices are illustrated in section 4.

3.1. Methodology

The relationship between variables which integrated of order one (I(1)) or more may be spurious due to the common nonstationarity component. There is said to be a long-run equilibrium relationship between a set of I(1) variables if they are cointegrated. Therefore, it is now widely accepted that testing for the lack of cointegration between I(1) variables is a necessary step for an empirical investigation of a relationship between time series variables. We prefer to employ the cointegration procedure developed by Johansen (1988, 1995) and Johansen and Juselius (1990) as the methods based on single equation estimation such as Engle and Granger (1987) or Pesaran Pesaran, Shin and Smith (2001) may be misleading in the case of an invalid inference. A starting point for a cointegration analysis is determining the orders of integration of the series. To this end, we employ Augmented Dickey-Fuller tests developed by Dickey and Fuller (1981). The following subsections briefly present the ADF unit root tests and Johansen cointegration procedure.

3.1.1. Unit Root Test

To determine the integration order of the series we consider the Augmented Dickey-Fuller (ADF) tests developed by Dickey and Fuller (1981). The ADF test for a generic variable x is based on the following regression equation:

$$\Delta x_t = a_0 + a_1 x_{t-1} + \Sigma_{i=1}^{p} \Delta x_{t-i} + \varepsilon_t$$

The rejection of the unit-root null hypothesis ($a_1=0$) suggests the stationarity of the series. MacKinnon (1991) provides the appropriate critical values to test the unit root null against the stationarity alternative.

An important point in the implementation of the ADF tests is the choice of the appropriate lag length (p) as an incorrect augmentation (under or over parametrization) may lead to misleading results. In the general-to-specific data based procedure, a maximum lag length p_{max} is first chosen and then the lag length is reduced one period (p_{max-1}) if the last lag is not significant. The process is continued to obtain a parsimonious specification where the last lag is insignificant and there is no evidence for residual serial correlation. Alternatively, information criteria such as the Akaike Information Criteria (AIC) and Schwartz Information Criteria (SIC) can be used to chose the optimum lag length.

3.1.2. Johansen Cointegration Test

The Johansen cointegration procedure developed by Johansen (1988, 1995) and Johansen and Juselius (1990) for an I(1) variable space z_t containing k variables can be presented in the context of the following reparametrized VAR(p) process:

$$\Delta z_t = \Pi z_{t-1} + \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-p+1} + \mu + D_t + \varepsilon_t$$

where μ is a vector of constants, D is a matrix of deterministic variables such as trend, centered seasonal dummies etc. and ε_t is a multivariate disturbance term. In our model z_t is comprised of import prices (LPM),

wholesale price indexes (LWPI), the nominal exchange rate (LER), and output (LGDP). Given that z_t is an I(1) system, the equation represents a vector equilibrium correction mechanism (VECM) if the rank of Π, denoted by r, is such that $0 < r < k$. For $0 < r < 5$, $\Pi = \alpha\beta'$, where α and β are k x r matrices of full column rank. If the rank of Π is zero, there is no combination of Z_t series that is stationary so the variables are not cointegrated. The parameters (Γ_1, $\Gamma_{1,\ldots}$ $\Gamma_{1)}$ are p x p total impact matrix defining the short-run adjustment to changes of the process while $\Pi = \alpha\beta'$ defines the short-run adjustment, α, to the long-run equilibrium relations, β. If there is a cointegration relationship between the variables, then the reparametrized VAR system can be interpreted as representing a vector error correction mechanism (VECM) for long-run endogenous variables:

$$\Delta z_t = \alpha\beta' z_{t-1} + \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \mu + \delta D_t + \varepsilon_t$$

Significance of no error correction term (α=0) in the Δz_t equation is a necessary condition for long-run weak exogeneity of a variable in the system. Johansen and Juselius (1988, 1995) and Johansen and Juselius (1990) provide a maximum likelihood procedure for cointegration analysis of an I(1) system.

Johansen and Juselius (1992) and Johansen (1988, 1995) provide also testing for several hypotheses about the adjustment coefficients α and cointegration vectors β along with some multivariate tests such as stationarity and long run exclusion tests.

An important advantage of the Johansen procedure is that it does not impose any a priori conditioning restriction on the variables in the system

so that the endogeneity/exogeneity status of the variables are determined by the data. Thus, Johansen procedure may be preferable to the single equation methods such as Engle and Granger (1987) or Pesaran Pesaran, Shin and Smith (2001). Conventional impulse response analyses, such as the one employed by Leigh and Rossi (2003) to investigate the exchange rate pass-through in Turkey, on the other hand maintain a sequence of non-tested endogeneity-exogeneity restrictions on variables in the system. Furthermore, such analyses assume $\Pi = 0$ and fails to incorporate both the long-run equilibrium relationships and adjustment/equilibrium correction mechanisms to deviations from the equilibrium.

3.2. Data and Descriptive Statistics

This section briefly presents the data used in the analyses. We consider a variable space containing Wholesale Price Index (WPI) and disaggregate wholesale prices indices, Exchange Rate, GDP, and Foreign Trade Import Prices postulated to explain exchange rate pass-through in Turkey.

Exchange rate pass-through depends positively on economic activity. We have used real GDP in the thesis to proxy the effect of economic activity on the pass-through. The situation of the economy whether is in recession or recovery influences the pricing strategies of firms. Producers do not tend to increase their prices as output fall so inflationary pressure declines. Garcia and Restrepo (2001) investigate the degree of exchange rate pass-through in Chile by using price equation based on imperfect competition. They show that a pass-through decreases when economy is in recession

since reducing margins yield to compensate the inflationary effect of depreciation. As economy recovers the pass-through rises.

Exchange rate and import prices are among the main determinations of domestic price level when exchange rate changes. An increase in exchange rates cause increase in input goods and the prices of imported goods in domestic currency. Especially, producer prices affected mainly from the prices of imported raw materials and capital goods. Magnitude of increasing the cost due to depreciation of currency depends on the share of imported inputs in over all inputs costs. Larger import share cause a greater the degree of pass-through.

Turkish economy is an open economy and a highly import dependent economy. Since the output depends on imported intermediate goods in Turkey, the change of imported good prices causes a substantial price change of products. Therefore, we postulate the import prices as an important determinant of the exchange rate pass-through to wholesale prices.

The other influencing factors of exchange rate and prices are external factors, such as oil prices. Especially countries with small open economies are affected by fluctuations of external factors. Oil prices play an important role on producing cost. McCarthy (2000) defines oil prices changes as a proxy for supply shocks. In the thesis, import price (LPM) includes oil prices. So, any external shock coming from oil prices is already reflected by import price changes in the model.

We consider the quarterly data covering the period from 1994:1 to 2003:4. The data are obtained from The Central Bank of the Republic of Turkey electronic publications. Abbreviations of the variables considered in the study are as follows:

LER: Exchange Rate, US Dollar buying rate (Quarterly average)

LGDP: Gross National Product in real terms (Quarterly)

LPM: Import Price Index in dollar terms, including oil prices. (According to ISIC REV 3 classification, 1994=100, SIS, Quarterly Average)

LWPI: Wholesale Prices Index (1994=100, SIS) (Quarterly Average)

LWPI_G: Wholesale Prices Index, Public- All Items

LWPI_P: Wholesale Prices Index, Private- All Items

LWPI_MAN: Wholesale Prices Index, Manufacturing Industry

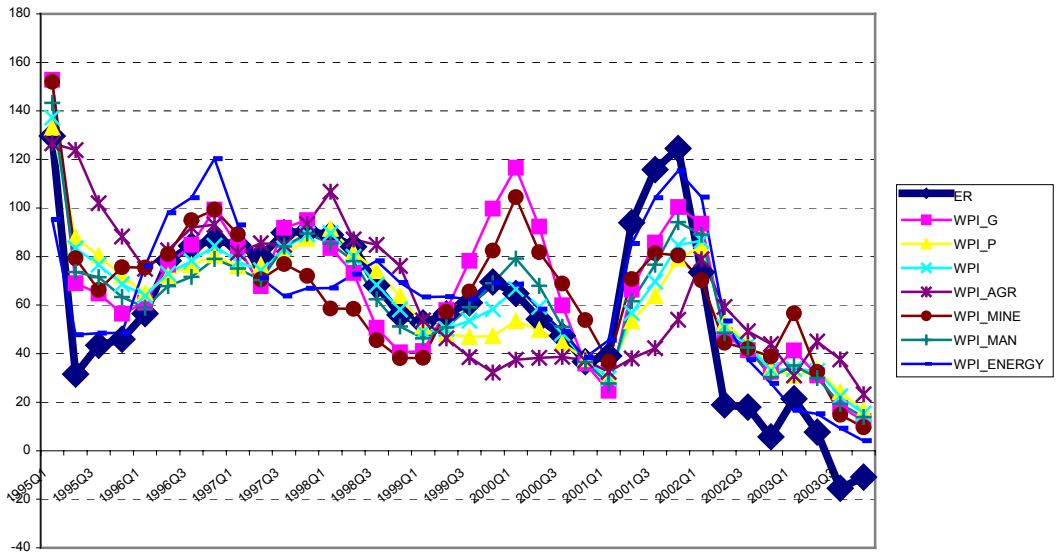
LWPI_AGR: Wholesale Prices Index, Agriculture, Hunting, Forestry and Fishing

LWPI_MINE: Wholesale Prices Index, Mining and Quarry

LWPI_ENERGY: Wholesale Prices Index, Electricity, Gas and Water

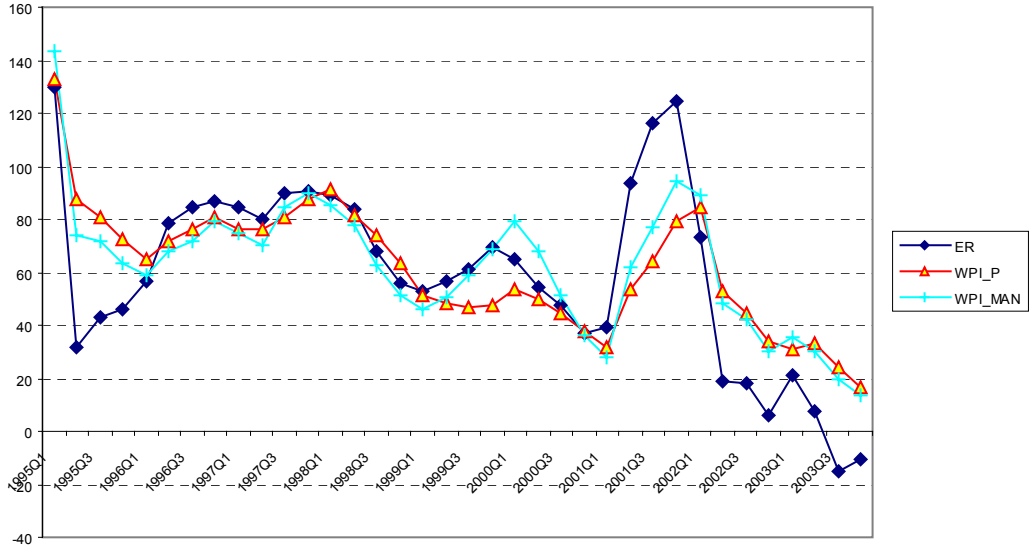
All variables are used in log form. "L" and "D" denote log and first difference of variables, respectively.

Figure 1 plots the time series of WPI inflation and its main components and nominal exchange rate change during the sample period. From the figure it may be inferred that there is a high degree of correlation between nominal exchange rate changes and WPI and disaggregated WPI inflation rates. The high degree of correlation becomes much more evident in Figures 2 and 3 where exchange rate changes and changes in the main components of the WPI are plotted.



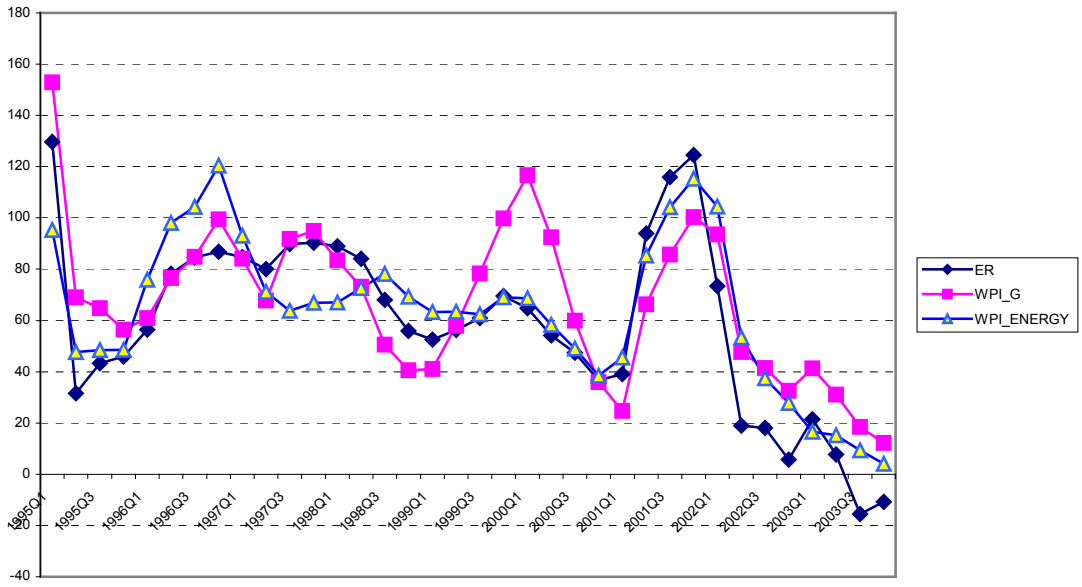
Source: Central Bank of the Republic of Turkey

Figure 1: Turkey: Inflation and Exchange Rate Change



Source: Central Bank of the Republic of Turkey

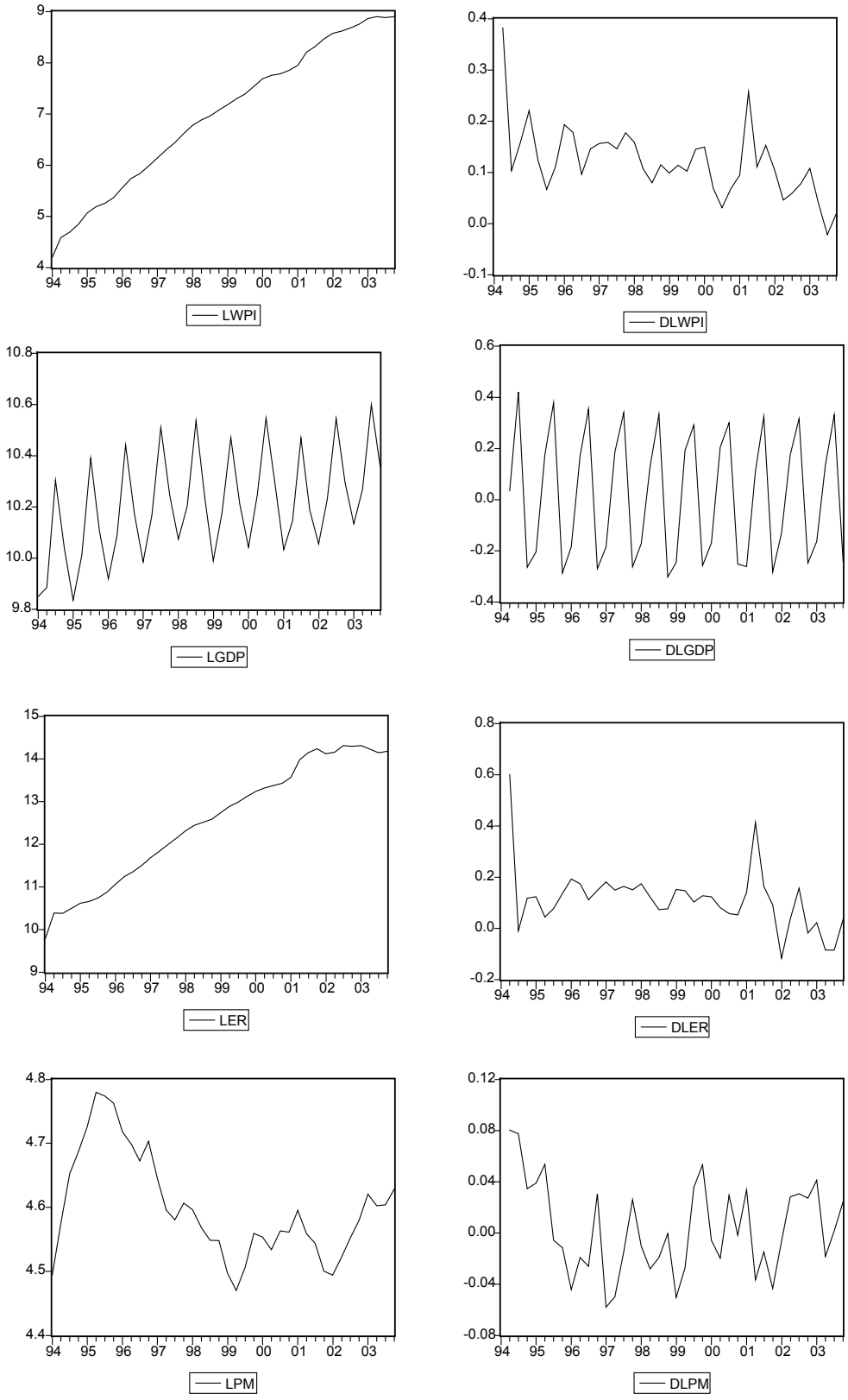
Figure 2: Turkey: Inflation and Depreciation (Selected prices- I)



Source: Central Bank of the Republic of Turkey

Figure 3: Turkey: Inflation and Depreciation (Selected prices- II)

Figures 4 plots the time series of the levels and first differences of all the variables considered in this study. The levels of all the domestic variables appear to have a strong positive trend owing to the high inflation rates sustained much of the estimation period. The real GDP appears to have a strong seasonality. The first differences of all the variables, on the other hand, can be interpreted as stationary or near stationary processes without an apparent trend and/or mean shift. However, the non-stationarity and thus the integration levels of the variables should be tested empirically to obtain valid cointegration evidence.



Source: Central Bank of the Republic of Turkey

Figure 4: Time series plots of the variables used in analysis

Table 1: ADF Statistics for Testing Unit Root

	Level without trend		Level with trend		First Difference without trend		First Difference with trend	
Variable	Lag	DF/ADF Stat.	Lag	DF/ADF Stat.	Lag	DF/ADF Stat.	Lag	DF/ADF Stat.
LER	1	-1.78	1	-0.46	0	-3.44*	0	-3.94**
LGDP	4	-2.39	1	-1.35	2	-20.64*	2	-20.95**
LPM	4	-2.39	4	-3.37	1	-15.48*	1	-15.30**
LWPI	2	-2.38	2	0.61	0	-3.62*	1	-4.32**
LWPI_P	2	-2.71	0	-0.47	0	-3.42*	1	-4.53**
LWPI_G	1	-1.54	4	0.99	0	-3.50*	2	-4.06**
LWPI_AGR	4	-1.85	4	-0.91	3	-1.58	3	-2.28
LWPI_MINE	0	-2.49	0	0.00	0	-4.12*	0	-4.73**
LWPI_MAN	4	-2.63	4	1.36	0	-3.18*	0	-3.85**
LWPI_ENERGY	1	-2.02	1	-0.44	0	-3.49*	0	-3.60**

(*) 95% critical value for the augmented Dickey-Fuller statistic = -2.9472 (MacKinnon, 1991)
(**) 95% critical value for the augmented Dickey-Fuller statistic = -3.5426 for including linear trend in regressions. (MacKinnon, 1991)

The integration properties of the variables are investigated by conducting augmented Dickey-Fuller [ADF] tests. For the ADF tests, we started with a maximum lag length 5, which is plausible for quarterly data and choose the appropriate lag length according to the Akaike Information Criteria (AIC). Table 1 records the results of the ADF tests. The results suggest that each of the variables considered, except LWPI_AGR, is integrated of order 1, I(1). The evidence for LWPI_AGR is less conclusive. From its ADF statistics LWPI_AGR might be I(1). The results of the Johansen and Juselius multivariate stationarity tests reported in the following sections also suggest the strong rejection of the stationarity null for each of the variables in levels.

3.3. Empirical Analysis for Aggregate Wholesale Prices

We first consider the exchange rate, real GDP, import prices and WPI variable space to investigate the long-run evolution of the exchange rate pass through in Turkey. The results in Table 1 suggested that all the variables in the system, LER, LGDP, LPM and LWPI, are individually I(1) suggesting the validity of a Johansen cointegration inference among them.

For Johansen cointegration analysis for the I(1) variable system of LER, LGDP, LPM and LWPI, we first started with VAR lag length 4, which is plausible for quarterly data, and choose the appropriate lag length according to the sequential likelihood ratio (LR) test of system reduction from VAR(k) to VAR(k-1). The vector autoregression (VAR) contains also three centred seasonal dummies and an unrestricted constant. The sequential likelihood ratio (LR) test of system reduction from VAR(4) to VAR(3), to VAR(2) and to VAR(1) yielded F(16,40) = 1.51 (0.15), F(32,49) = 1.45 (0.12) and F(48,52) = 1.49 (0.08), with p-values in parentheses, respectively. Thus, reductions from VAR(4) to VAR(3), and from VAR(4) to VAR(2) are data-acceptable whilst the reduction to VAR(1) is rejected at the 10 % level. The choice of VAR(2) is supported also by the Akaike Information Criterion (AIC). Table 2 records various residual diagnostics to test the empirical adequacy of the system with the VAR lag length k = 2. Each equation passes all the diagnostics except the normality test for LWPI and LER. The results for the univariate Jarque-Bera test suggest that it is basically excess kurtosis causing the rejection of normality for LER and LWPI equations. The residual non-normality may not be alarming as cointegration results appear robust to excess kurtosis (Gonzalo 1994). The model passes all the system tests suggesting the lack of serial correlation,

residual non-normality and heteroscedasticity in the VAR(2) system According to these results, the VAR(2) seems to be a valid approximation of the data generation process, and thus a congruent system for cointegration inference

Table 2: Single Equation Residual Diagnostics and System Evaluation

System: z_1 = [LWPI, LGDP, LPM, LER]

Statistic	ΔLWPI	ΔLGDP	ΔLPM	ΔLER	System
$F_{AR4}(4,20)$	2.08	0.79	1.14	1.39	
$F_{ARCH4}(4,20)$	0.07	0.16	0.55	0.36	
$\chi^2_{NORM}(2)$	5.67*	0.72	0.38	6.14*	
$F_{HET}(16, 7)$	0.32	0.77	0.48	0.47	
$F_{AR4}(48,36)$					0.83
$\chi^2_{NORM}(8)$					4.67
$F_{HET}(160, 2)$					0.03

Notes: The misspecification tests are against the alternative hypotheses: fourth-order autocorrelation (F_{AR4}), fourth-order ARCH (F_{ARCH4}), non-normality (χ^2_{NORM}) and heteroscedasticity (F_{HET}). See Doornik and Hendry (1997) for the tests. An asterisk (*) denotes rejection at the 5 % critical value.

Table 3 reports the eigenvalues (λ_i), the maximal eigenvalue (λ_{max}) and trace eigenvalue (λ_{trace}) statistics for the Johansen procedure applied to the four variable system containing LER, LGDP, LPM and LWPI. Both λ_{trace} and λ_{max} statistics can reject the null of no cointegrating vectors and cannot reject the null of 1 or at most one cointegration vectors in the system. Therefore, there appears to be single cointegration vector among the

variables according to both of the likelihood ratio (LR) statistics λ_{trace} and λ_{max}.

Table 3: Testing of the Number of Cointegration Relations r (LWPI)

	H_o	H_A		99% Critical Value	H_o	H_A		99% Critical Value
λ_i	λ_{trace} tests		λ_{trace} value		λ_{max} tests		λ_{max} value	
0.4551	r=0	r>0	44.55*	43.84	r=0	r=1	23.07*	17.15
0.2326	r≤1	r>1	21.48	26.70	r=1	r=2	10.06	13.39
0.1432	r≤2	r>2	11.42	13.31	r=2	r=3	5.87	10.60
0.1357	r≤3	r>3	5.54	2.71	r=3	r=4	5.54	2.71

After determining the number of cointegration relations, we have performed some tests about the individual variables and their role in the system. These tests are long run exclusion tests and stationarity of variables in the system. Table 4 reports the results of multivariate stationarity and long-run exclusion tests. The long run exclusion test investigates whether any one of the variables can be excluded from the cointegration space. Multivariate test for stationarity investigates whether any one of variables can be interpreted as stationary by itself. According to the long-run exclusion tests no variable is insignificant for the cointegration space at the 5 % level. The results of the stationarity test under r=1 strongly suggest the rejection of the stationarity null for each of the variables in the system.

Table 4: Multivariate Tests about the Properties of the System Variables (LWPI)

	Critical Value	LER	LWPI	LGDP	LPM
TEST FOR EXCLUSION					
LR Test CHISQ (r=1)	3.84	11.41*	11.62*	5.21*	6.81*
TEST FOR STATIONARITY					
LR Test CHISQ (r=1)	9.49	12.83*	12.13*	11.87*	13.97*

(*) indicates that the rejection of the null hypothesis at 5 % level.

Table 5: Standardised Eigenvectors β and Standardised Adjustment Coefficients α (LWPI)

Cointegration Analysis

Standardised Eigenvectors β		Standardised Adjustment Coefficients α		t-values for α
Var.	B	Eq.	α	
LER	-0.935	DLER	-0.489	-2.186
LWPI	1.000	DLWPI	-0.393	-3.786
LGDP	-1.130	DLGDP	0.135	1.809
LPM	-0.831	DLPM	0.187	2.566

Table 5 reports the significant normalised cointegration vector and the corresponding adjustment coefficients. The cointegration vector normalised by LWPI can be interpreted as wholesale price equation:

LWPI = 0.935 LER + 1.13 LGDP + 0.831LPM

Coefficients of all variables are positive in the equation as anticipated. An increase in the foreign currency price of import, currency

depreciation and an economic growth are all expected to lead to higher domestic inflation. As an increase in LER means currency depreciation, the positive sign of the LER coefficient shows the impact of currency depreciation on LWPI. When exchange rate depreciates, domestic products become relatively cheaper for foreign and domestic consumers. Domestic consumers prefer to buy domestic goods instead of imported goods and foreign consumers demand more exported goods, so demand for domestic goods increase. As a consequence of increasing demand for domestic goods, price of domestic products will rise. Real output (LGDP) has also positive coefficient as a demand expansion or positive output gap can lead to higher domestic prices. Change in the exchange rate firstly affects prices of imported goods and imported inputs. Imported inputs prices changes incline towards production cost of output and consumer price level. In a more open economy, depreciation or appreciation has a larger effect on prices in both direct and indirect way (Goldfajn and Valdes, 2000).

The long run exchange rate pass-through is the coefficient of LER in the equation. The degree of exchange rate pass-through is very close to 1 and statistically significant. In the long run, the effect of depreciation is nearly fully reflected in the whole prices in Turkey. In addition to these results, Table 5 shows the convergence coefficient of long run equation. An adjustment coefficient α for LWPI is -0.393 and statistically significant. It means that any shock causing deviation from long run equilibrium is adjusted in two and a half quarter (nearly 7.5 months) in the system. The significance of the adjustment coefficient for the ΔLER equation suggests the rejection of the weak exogeneity null hypothesis for LER. Therefore, exchange rates and wholesale prices appear to be jointly determined in the system. Consistent with the characteristics of a small open economy, foreign

prices appears to be weakly exogenous for the evolution of domestic prices in Turkey. The joint endogeneity of exchange rates and prices further suggest that the results of the much of the exchange rate pass-through literature maintaining the weak exogeneity of exchange rates for prices must be interpreted with an extreme caution as they may be subject to a simultaneity bias. The joint endogeneity of exchange rates and prices has also an important policy implication as exchange rate changes not only can cause and but also be caused by inflation. Thus, currency appreciations can be interpreted as positively helping to the success of an inflation targeting policy regime. Furthermore, a successful inflation targeting policy can be expected to help exchange rate stability.

3.4. Empirical Analysis for Disaggregate Wholesale Prices

Private sector prices

In this section, exchange rate pass-through coefficients are investigated for disaggregate wholesale price indices which are private, public, manufacturing industry, agriculture, mining and energy price indices. We employ the same procedure used for the WPI variable space in the earlier section.

We first consider the private wholesale price index LWPI_P. Private wholesale prices consist of all prices except prices set by public sector. We now consider an I(1) system containing LWPI_P, LER, LGDP and LPM. The lag length for vector autoregressions is chosen as 2 and the VAR(2) system contains an unrestricted constant and three seasonal dummies. The results

of the cointegration analysis to determine the rank r are presented in Table 6.

Table 6: Testing of The Number of Cointegration Relations r (LWPI_P)

	H_o	H_A		99% Critical Value	H_o	H_A		99% Critical Value
λ_i	λ_{trace} tests		λ_{trace} value		λ_{max} tests		λ_{max} value	
0.5053	r=0	r>0	47.54*	43.84	r=0	r=1	26.75*	17.15
0.2236	r≤1	r>1	20.80	26.70	r=1	r=2	9.62	13.39
0.1427	r≤2	r>2	11.18	13.31	r=2	r=3	5.85	10.60
0.1309	r≤3	r>3	5.33	2.71	r=3	r=4	5.33	2.71

According to Table 6, both likelihood statistics strongly supports that the cointegration rank is one at the 1 % level. Table 7 reports the multivariate statistics for the LWPI_P system. The test statistics for long run exclusion suggest that all variables are statistically significant for the system so they should be in the model. The results of the stationarity test under r=1 strongly suggest the rejection of the stationarity null for each of the variables in the system.

Table 7: Multivariate Tests about the Properties of the System Variables (LWPI_P)

	Critical Value	LER	LWPI_P	LGDP	LPM
TEST FOR EXCLUSION					
LR Test CHISQ (r=1)	3.84	13.58*	14.25*	7.60*	5.36*
TEST FOR STATIONARITY					
LR Test CHISQ (r=1)	9.49	14.62*	13.65*	15.87*	16.54*

(*) indicates that the rejection of the null hypothesis at 5 % level.

Table 8: Standardised Eigenvectors β and Standardised Adjustment Coefficients α (LWPI_P)

Cointegration Analysis				
Standardised Eigenvectors β		Standardised Adjustment Coefficients α		t-values for α
Var.	B	Eq.	α	
LER	-0.878	DLER	-0.601	-2.993
LWPI_P	1.000	DLWPI_P	-0.396	-5.401
LGDP	-1.270	DLGDP	0.130	1.831
LPM	-0.618	DLPM	0.158	2.250

The significant normalised and the corresponding standardised adjustment coefficients are reported in Table 8. The cointegration vector normalized by LWPI_P is:

LWPI _P = 0.878 LER + 1.27 LGDP + 0.618 LPM

The long run exchange rate pass-through for private prices is 0.878 and statistically significant. Adjustment coefficient α for LWPI_P is -0.396 and statistically significant supporting the interpretation of the normalised cointegration vector as a long-run private sector price equation. The coefficients of the variables appear to be theory-consistent and are approximately the same with the long-run WPI equation estimated earlier. Only the foreign prices, LPM, appear to be weakly exogenous for the parameters of the cointegration vector.

Public sector prices

The second disaggregate wholesale price index is public wholesale price index LWPI_G. Following the earlier analyse, we consider VAR(2) system for the I(1) system of LWPI_G, LER, LGDP and LPM. The VAR(2) system contains also an unrestricted constant and three seasonal dummies.

Table 9: Testing for The Number of Cointegration Relations r (LWPI_G)

	H_o	H_A		99% Critical Value	H_o	H_A		99% Critical Value
λ_i	λ_{trace} tests		λ_{trace} tests		λ_{max} tests		λ_{max} value	
0.4828	r=0	r>0	46.77*	43.84	r=0	r=1	25.06*	17.15
0.2379	r≤1	r>1	21.71	26.70	r=1	r=2	10.32	13.39
0.1543	r≤2	r>2	11.39	13.31	r=2	r=3	6.37	10.60
0.1237	r≤3	r>3	5.02	2.71	r=3	r=4	5.02	2.71

Table 10: Multivariate Tests about the Properties of the System Variables (LWPI_G)

	Critical Value	LER	LWPI_G	LGDP	LPM
TEST FOR EXCLUSION					
LR Test CHISQ (r=1)	3.84	13.06*	13.21*	8.78*	14.29*
TEST FOR STATIONARITY					
LR Test CHISQ (r=1)	9.49	18.40*	18.37*	15.38*	18.49*

(*) indicates that the rejection of the null hypothesis at 5 % level.

According to Table 9, Both λ_{trace} and λ_{max} statistics can reject the null of no cointegrating vector and cannot reject the null of 1 or at most one cointegration vector. The results strongly support that the cointegration rank is one. Besides, Table 10 reported that test statistics for long-run exclusion suggest that all variables are statistically significant for the system. The results of the stationarity test under r=1 strongly suggest the rejection of the stationarity null for each of the variables in the system.

Table 11: Standardised Eigenvectors β and Standardised Adjustment Coefficients α (LWPI_G)

Cointegration Analysis

Standardised Eigenvectors β		Standardised Adjustment Coefficients α		t-values for α
Var.	β	Eq.	α	
LER	-1.069	DLER	-0.301	-1.325
LWPI_G	1.000	DLWPI_G	-0.224	-1.810
LGDP	-1.155	DLGDP	0.212	3.078
LPM	-1.473	DLPM	0.218	3.389

Standardised significant eigenvector and the corresponding standardised adjustment coefficients are reported in Table 11. The cointegration vector normalised by LWPI_G can be interpreted as wholesale public price equation:

$$LWPI\_G = 1.069\ LER + 1.155\ LGDP + 1.473\ LPM$$

The long run exchange rate pass-through for public prices is 1.069 and statistically significant. Adjustment coefficient α for LWPI_G is -0.224

and it is also statistically significant. The coefficients of the LWPI _G equation are virtually the same with those obtained for the WPI and private sector WPI systems. Only the adjustment coefficient for the ΔLWPI _G is statistically significant suggesting the weak exogeneity of exchange rates, real output and foreign prices for the long-run evolution of the public sector prices. This result suggests that the endogeneity of exchange rates for the WPI system mainly comes from the dynamics of the private sector prices.

Sectoral Price Indices

Another disaggregate wholesale price index is agriculture wholesale price index. Nevertheless, the agriculture prices have different cyclical properties compare to the other wholesale prices. As Table 1 reported, LWPI_AGR appears not to be I(1) .as a consequence, it is not included in the exchange rate pass-through analysis.

Fourth disaggregate wholesale price index is wholesale price index for mining and quarry. Table 12 reports cointegration rank statistics for the I(1) system containing LWPI_MINE, LER, LGDP and LPM. The VAR(2) system includes also an unrestricted constant and three seasonal dummies. According to the λ_{trace} and λ_{max} tests, there appears to be single cointegration vector in the system. The results presented in Table 13 suggest strong rejection for hypothesis of long run exclusion and stationary for all variables. The adjustment coefficient for the ΔLWPI_MINE equation is statistically insignificant suggesting the weak exogeneity of LWPI_MINE. Consequently, it may be misleading to postulate the cointegration vector as a mining price equation.

Table 12: Testing for The Number of Cointegration Relations r (LWPI_MINE)

	H_o	H_A		99% Critical Value	H_o	H_A		99% Critical Value
λ_i	λ_{trace} tests		λ_{trace} tests		λ_{max} tests		λ_{max} value	
0.4219	r=0	r>0	41.02*	43.84	r=0	r=1	20.83*	17.15
0.2363	r≤1	r>1	20.19	26.70	r=1	r=2	10.24	13.39
0.1479	r≤2	r>2	9.95	13.31	r=2	r=3	6.08	10.60
0.0967	r≤3	r>3	3.87	2.71	r=3	r=4	3.87	2.71

Table 13: Multivariate Tests about the Properties of the System Variables (LWPI_MINE)

	Critical Value	LER	LWPI_MINE	LGDP	LPM
TEST FOR EXCLUSION					
LR Test CHISQ (r=1)	3.84	7.48*	7.72*	8.70*	8.30*
TEST FOR STATIONARITY					
LR Test CHISQ (r=1)	9.49	13.69*	13.69*	9.60*	13.45*

(*) indicates that the rejection of the null hypothesis at 5 % level.

Table 14: Standardised Eigenvectors β and Standardised Adjustment Coefficients α (LWPI_MINE)

Cointegration Analysis

Standardised Eigenvectors β		Standardised Adjustment Coefficients α		t-values for α
Var.	β	Eq.	α	
LER	-1.039	DLER	-0.109	-0.591
LWPI_MINE	1.000	DLWPI_MINE	0.135	1.024
LGDP	-1.837	DLGDP	0.164	2.876
LPM	-2.136	DLPM	0.171	3.248

Sixth disaggregate wholesale price index is manufacturing wholesale price index. LWPI_MAN is I(1) as reported in Table 1. The lag length for vector autoregressions is chosen as 2 and the VAR(2) system contains also an unrestricted constant and three seasonal dummies.

Table 15: Testing for The Number of Cointegration Relations r (LWPI_MAN)

	H_o	H_A		99% Critical Value	H_o	H_A		99% Critical Value
λ_i	λ_{trace} tests		λ_{trace} tests		λ_{max} tests		λ_{max} value	
0.4278	r=0	r>0	42.77*	43.84	r=0	r=1	21.21*	17.15
0.2403	r≤1	r>1	21.56	26.70	r=1	r=2	10.44	13.39
0.1448	r≤2	r>2	11.11	13.31	r=2	r=3	5.94	10.60
0.1271	r≤3	r>3	5.17	2.71	r=3	r=4	5.17	2.71

According to Table 15, both likelihood statistics strongly support that the cointegration rank is one. Table 16 reports that all variables are statistically significant for the system so they should be retained. Also, the results of the stationarity test under r=1 strongly suggest the rejection of the stationarity null for each of the variables in the system. The cointegration vector normalized by LWPI_MAN can be interpreted as wholesale price equation for manufacturing.

$$LWPI\_MAN = 0.982\ LER + 0.809\ LGDP + 1.049\ LPM$$

The long run exchange rate pass-through for manufacturing prices is 0.982 and statistically significant. Adjustment coefficient α for LWPI_MAN is -0.402 and it is also statistically significant supporting our normalisation.

Table 16: Multivariate Tests about the Properties of the System Variables (LWPI_MAN)

	Critical Value	LER	LWPI_MAN	LGDP	LPM
TEST FOR EXCLUSION					
LR Test CHISQ (r=1)	3.84	10.64*	10.64*	3.59	8.03*
TEST FOR STATIONARITY					
LR Test CHISQ (r=1)	7.81	13.69*	13.30*	11.55*	13.99*

(*) indicates that the rejection of the null hypothesis at 5 % level.

Table 17: Standardised Eigenvectors β and Standardised Adjustment Coefficients α (LWPI_MAN)

Cointegration Analysis				
Standardised Eigenvectors β		Standardised Adjustment Coefficients α		t-values for α
Var.	B	Eq.	α	
LER	-0.982	DLER	-0.397	-1.552
LWPI_MAN	1.000	DLWPI_MAN	-0.402	-2.659
LGDP	-0.809	DLGDP	0.135	1.618
LPM	-1.049	DLPM	0.234	2.989

The last disaggregate wholesale price index is energy wholesale price index. LWPI_ENERGY appears to be I(1) in Table 1. The lag length for vector autoregressions is chosen as 2 and the VAR(2) system contains an unrestricted constant and three seasonal dummies.

Table 18: Testing for The Number of Cointegration Relations r (LWPI_ENERGY)

	H_o	H_A		99% Critical Value	H_o	H_A		99% Critical Value
λ_i	λ_{trace} tests		λ_{trace} tests		λ_{max} tests		λ_{max} value	
0.4621	r=0	r>0	43.75*	43.84	r=0	r=1	23.57*	17.15
0.2319	r≤1	r>1	20.19	26.70	r=1	r=2	10.03	13.39
0.1442	r≤2	r>2	10.16	13.31	r=2	r=3	5.92	10.60
0.1056	r≤3	r>3	4.24	2.71	r=3	r=4	4.24	2.71

λ_{trace} and λ_{max} eigenvalue test results strongly rejects the hypothesis of no cointegration and there appears to be single cointegration vector for the system. Also Table 19 demonstrates that there is strongly rejection for hypothesis of long run exclusion and stationary for all variables.

Table 19: Multivariate Tests about the Properties of the System Variables (LWPI_ENERGY)

	Critical Value	LER	LWPI_ENERGY	LGDP	LPM
TEST FOR EXCLUSION					
LR Test CHISQ (r=1)	3.84	12.78*	12.96*	1.66	13.13*
TEST FOR STATIONARITY					
LR Test CHISQ (r=1)	7.81	15.22*	15.01*	13.64*	13.05*

(*) indicates that the rejection of the null hypothesis at 5 % level.

Table 20: Standardised Eigenvectors β and Standardised Adjustment Coefficients α (LWPI_ENERGY)

Cointegration Analysis				
Standardised Eigenvectors β		Standardised Adjustment Coefficients α		t-values for α
Var.	B	Eq.	α	
LER	-1.058	DLER	-0.187	-1.037
LWPI_ENERGY	1.000	DLWPI_ENERGY	-0.313	-3.222
LGDP	-0.569	DLGDP	0.084	1.386
LPM	-1.276	DLPM	0.162	3.061

The cointegration vector normalised by LWPI_ENERGY can be interpreted as energy wholesale price equation.

LWPI_ ENERGY = 1.058 LER + 0.569 LGDP + 1.276 LPM

The long run exchange rate pass-through for energy prices is 1.058 and statistically significant. An adjustment coefficient α for LWPI_ENERGY is -0.313 and statistically significant. The result is consistent with the results of the public wholesale price indexes since the energy prices are set by public sector. As the public sectors of pass-through degrees are higher than private sectors' pass-through degree, but the period of translating exchange rate changes is longer.

CHAPTER 4

CONCLUSION

Transmission mechanism of exchange rate movements passing through to domestic prices is very essential information for policy makers and economists. Especially, exchange rate movement is important for countries which have a vulnerable system to external shocks like emerging countries. Since the exchange rate is a major channel of monetary transmission, monetary authorities should pay special attention to the extent to which domestic inflation is affected by the exchange rate. High pass-through causes a serious constraint on monetary policy. In high pass-through economies, exchange rate shocks will be passed to over prices and thereby affect the price strategy decided by central bank. On the other hand, under low exchange pass-through degree, monetary authority behaves more freedom to carry through an independent policy and to facilitate the implementation of monetary policy.

It is beneficial to assess the degree of pass-through in different sectors of the economy, especially for the prices set early in the supply channel. In this study, it has been examined the degree of changes in wholesale price index and its main disaggregated components caused by exchange rate changes for Turkey.

Johansen cointegration technique is used to examine the degree of pass-through in Turkey. Johansen technique does not a priorily impose an exogeneity/endogeneity conditioning restriction on the variables in the

system. This study thus differs from the bulk of the exchange rate pass through literature which often employ VAR/Impulse response analyses based on a priori conditioning and ignored the long-run equilibrium relationships. Moreover, quarterly data for the period from 1994:1 to 2003:4 were used to investigate the exchange rate pass-through to producer prices of both aggregate and by sectors of activity.

As a consequence of analysis, it is found that the long-run degree of exchange rate pass-through are statistically significant and nearly complete for overall wholesale prices, private wholesale prices, public wholesale prices as well as manufacturing prices and energy prices.

In the long run, the effect of depreciation is nearly full reflected in the wholesale prices in Turkey. The pass-through degree to overall wholesale prices (WPI) is 0.935 and the adjustment value is 0.393. Any shock of exchange rate is reflected to wholesale prices in two and a half quarter. Moreover, it is discovered that exchange rate and wholesale prices appear to be jointly determined in the system. It is consistent with the characteristics of Turkish economy, which is a small open economy.

The pass-through degrees for disaggregate wholesale prices display variation from public sector prices to private sector prices. While the pass-through degree of private sector prices is 0.878 and its adjustment coefficient is 0.396, the pass-through degree of public sector prices is 1.069 and its adjustment coefficient is 0.224. In the public prices, the pass-through coefficient increases, as the adjustment period is longer. Completed pass-through for public prices is observed in almost 14 months after changing the nominal exchange rate.

The manufacturing prices pass-through coefficient is 0.982 and its adjustment coefficient is 0.402. This result is very similar to the pass-through of private sector prices since the weighted of private sector is higher than public sector in manufacturing area. In contrast, the energy prices pass-through is similar to public sector since the energy prices are set by public sector. The exchange rate pass-through of energy prices is 1.058 and adjustment coefficient is 0.313.

The most recent study regarding Turkey is the study of Leigh and Rossi (2003). It covers the period of January 1994 to April 2002 and the pass-through of the exchange rate to domestic prices is evaluated using a five variable recursive VAR approach. According to study, about 60 percent of an initial exchange rate shock has pass-through to wholesale prices and about 45 percent of the shock has pass-through passed through to consumer prices after a year. They conclude that there is an incomplete pass-through in Turkey. Nevertheless, they miss the point of reciprocal responses between prices when nominal exchange rate changes. Thus, the pass-through degree of wholesale prices analyzed in the thesis is higher than the previous studies' pass-through due to taking into account the reciprocal responses between prices.

It is noteworthy that the decline in exchange rate pass-through is associated with the decline in inflation in many countries (Taylor, 2000). The decline trend is achieved by implications of suitable monetary policy via taking into considering the characteristics of prices set by different sectors in the economy. In this study, it is concluded that exchange rate pass-through are very high in Turkey, especially of public prices.

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