



KADIR HAS UNIVERSITY
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**THE REACTION OF CONSUMER PRICES TO
EXCHANGE RATE MOVEMENTS: A CASE STUDY**

KARDELEN ÇİÇEK

MASTER'S THESIS

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MASTER'S THESIS

Submitted to the School of Graduate Studies of Kadir Has University in partial fulfillment of the requirements for the degree of Master's in the Program of Economics.

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THE REACTION OF THE CONSUMER PRICES TO EXCHANGE RATE MOVEMENTS: A CASE STUDY

ABSTRACT

The purpose of this study is to identify and analyze exchange rate pass through coefficients for the last 13 years of the Turkish economy. For this purpose, I use latest data of inflation levels and exchange rate for the period of January 2006 and March 2019. Unlike other studies focusing on implicit inflation targeting period and pre-inflation targeting periods, focusing on explicit inflation targeting regime in Turkey give real insight about how exchange rate affects inflation under the price stability objective. According to findings of this study, after the explicit inflation targeting period there is a low exchange rate pass through to inflation level. Also, good's inflation and services' inflation and core inflations are differently affected by a depreciation of Turkish lira against the U.S. Dollar. To capture this finding, I formulate three pass through equations, and test these equations by estimating a Markov Switching model.

Keywords: Inflation, Exchange Rate, Exchange Rate Pass-Through, Markov Switching Model

TÜKETİCİ FİYATLARININ DÖVİZ KURU HAREKTLERİNE TEPKİSİ: DURUM ANALİZİ

ÖZET

Bu çalışmanın amacı, Türkiye ekonomisi için son 13 yıldaki döviz kurundan enflasyona geçişkenlik katsayılarının belirlenmesi ve analiz edilmesidir. Bu amaçla, Ocak 2006 ve Mart 2019 dönemleri için en son enflasyon ve döviz kuru verilerini kullandım. Örtük enflasyon hedeflemesi dönemi ve enflasyon hedeflemesi öncesi dönemler üzerine odaklanan diğer çalışmaların aksine, Türkiye’deki açık enflasyon hedeflemesi dönemine odaklanarak, fiyat istikrarı hedeflemesinin temel olarak döviz kurundan enflasyona geçişe olan etkisinin büyüklüğü gözlenmiştir. Açık enflasyon hedeflemesi döneminden sonra enflasyon seviyesine düşük bir kur geçişi olduğu bu çalışmada gösterilmiştir. Ayrıca, mal grupları enflasyonunun, hizmet grupları enflasyonunun ve çekirdek enflasyonunun, Türk Lirası’nın ABD Dolarına karşı değer kaybından farklı etkilendiği bulunmuştur. Bu bulguyu yakalamak için üç geçiş denklemi formüle edildi ve ayrıca Markov Rejim değişikliği modeli tahmin edilerek bu denklemler test edildi.

Anahtar Sözcükler: Enflasyon, Döviz Kuru, Döviz Kuru Geçişkenliği, Markov Rejim Modeli

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LIST OF ABBREVIATIONS

CRBT: Central Bank of the Republic of Turkey

EMDE: Emerging Markets and Developing Economies

ERPT: Exchange Rate Pass Through

AR: AutoRegression

ADF: Augmented Dickey Fuller Test

Exc: Exchange Rate

SVAR: Structural Vector Auto Regression

c: constant term

Inf: Inflation

s: State

CHAPTER 1

INTRODUCTION

The concept of exchange rate pass through describes the effects of the changes in the price of a currency on another macroeconomic variable. Pass through is a transmission mechanism in macroeconomics and international economics literature and it can be measured among different variables. Most discussed type of pass through are exchange rate pass through to inflation and exchange rate pass through to import prices. Exchange rate pass through to inflation is defined as the effect of exchange rate changes on changes in the inflation rate.

There are many factors that determine the prices of final goods. On the cost side, changes in the prices of inputs are reflected in the final good prices. In an open economy, part of the inputs is imported. Hence, input prices are partially determined by the exchange rates. In an open economy, depreciation of the currency may lead to an increase in prices, whereas an appreciation of that currency might cause a reduction in prices. The changes in the exchange rate might have a one-to-one impact on the price level which is called complete pass through (full pass through) or a one percent change in the exchange rates might lead to a less than one percent change in prices which is called incomplete pass through (partial pass through).

In today's economies price stability has increasingly become the main target of monetary authorities. In economies with price stability targets, one can talk of two kinds of inflation targeting regimes: implicit inflation targeting regime and explicit inflation targeting regime (or sometimes referred to as conventional inflation targeting). Implicit inflation targeting can be defined as a period during which inflation targets are announced to the public but not the details of the inflation targeting program. In an explicit inflation targeting regime, all information about inflation expectations is announced to the public and the long run goal of central banks is defined as price stability, presuming that a high inflation rate is harmful to economic activity.

According to the Phillips curve approach, there is a tradeoff between the rate of inflation and the rate of unemployment. Kalecki interprets this relationship as inflation being an outcome of the struggle between labor and employers.

If workers can obtain higher wages, employers adjust their price as the cost of production goes up and therefore the general price level increases. However, according to the classical monetary theory, the money supply is the main reason of inflation. In the classical monetary theory, a stable inflation rate is important to control fluctuations in the economic activity and the inflation rate is effected by only monetary policy in the long run (Bernanke et al, 2001, p.10).

In addition to these factors, there are many contributing factors of inflation and the exchange rate is one of them. Therefore, taking exchange rate fluctuations into consideration is important for central banks to control monetary stability (Mishkin 2008; Forbes 2016; Fischer 2015). Exchange rate fluctuations in emerging markets and developing economies (EMDE), especially high volatility in exchange rate markets, can lead to a deterioration of macroeconomic variables as well. Therefore, assessing the exchange rate pass through is important for monetary policy authorities and transmission from exchange rate to inflation should be properly evaluated in EMDEs where exchange rate movements are common and frequent. Doing this may enable central banks to implement necessary precautionary policies to minimize the magnitude of pass through to price level (Calvo and Reinhart, 2002).

1.1 TURKEY'S INFLATION HISTORY

High inflation rates and highly volatile exchange rates appear as common problems for a number of EMDEs after the 1980s. When we look at Turkey, we see high inflation along with unsuccessful disinflation programs beginning in the 1980s. Despite many policy attempts to reduce the inflation rate, 1980s and 1990s are high inflation periods for the Turkish economy. In these periods, actual inflation rates were always above the targeted inflation levels. The average annual inflation rate was 35-40 percent at the beginning of 1980s and it reached 60-65 percent at the end of 1980s. Although at times the rate of inflation passed 80 percent, the situation never evolved into hyperinflation.

One of the announced targets of the January 24, 1980 decisions was reducing the inflation rate. It was thought that the high inflation rate in 1970s was the outcome of excess demand arising from monetary expansion and therefore to reduce the inflation rate, contractionary demand policies were planned.

However, the price of goods produced by the public sector and oil prices were also increasing. Effects of high oil prices and high public sector borrowing were higher than the remedial policy set. Also, Turkish Lira depreciated parallel to oil price changes. At the same time because of devaluation, the cost of the manufacturing sector which was using imported intermediate goods increased at the same time when the oil shock hit the economy. All these lead to the high inflation rate which is 101 percent annually in 1980, despite the January 24 policy set.

In 1981 crawling peg foreign exchange rate regime was implemented, meaning that foreign exchange rates were published on a daily basis. Following 2 years after the announcement of the January 24 policy set, the inflation rate had started to decline. January 24 program implemented by pursuing export-led growth. In 1984 foreign exchange market was liberalized with the help of IMF stand-by agreements to open economy fully to global markets and until 1989 capital movements are fully liberalized.

Central Bank of Republic of Turkey (CRBT) involved foreign exchange market to manage monetary expansion and foreign exchange deposit development. At the beginning of 1987, CBRT announced daily exchange rates and the domestic currency was depreciated under a floating exchange rate regime (Berument and Pasaogullari, 2003). In 1989, international capital movements and foreign exchange operations were entirely liberalized. During 1980s high public sector borrowing requirement was seen as one of the reasons of ineffective disinflation efforts.

Between 1989 and 1993, a flexible exchange rate regime was in place. From 1988 to 1995, Turkish Lira had started to appreciate and at the same time inflation rate was high therefore increasing inflation in this period was not the outcome of exchange rate behavior (TCMB, 1991, TCMB, 1992, TCMB, 1993, TCMB, 1994, TCMB, 1995). At the beginning of 1994, Central Bank of the Republic of Turkey switched to a fixed exchange rate regime.

In April 1994, the Turkish economy experienced a crisis and the inflation rate jumped from 65 percent to 80 percent. In 1995, the inflation rate was 105 percent annually. From 1994 to 2000, crawling band exchange rate regime was implemented. Nominal anchor was the currency peg regime. At the end of the 1990s Asian countries experienced financial crises and it spill over to the rest of the world. Turkish economy was also effected by Asian financial crises.

Both the stressful macroeconomic environment in domestic markets and the crises environment in foreign market intensified the high inflation outlook in these years. At the end of 1999, deterioration in public finance balance and increasing real interest rate led to climbing inflation rate and economic contraction. Because of unfortunate foreign environment and effect of crises on Turkish economy, real success of currency peg regime could not be realized in this period (TCMB 1994, TCMB, 1995).

At the end of the 1999 an IMF-directed policy set was implemented to reduce the inflation rate. According to this program, increasing value of exchange rate bundle was determined by the CRBT in each month. In other words, this program aimed to decrease the inflation rate by taking the exchange rate under control. However, this program led to a liquidity problem and eventually an increase in the interest rate. In November 2000, a crises hit the economy. Despite the November 2000 crises, exchange rate level sustained in determined level but aimed inflation level is not sustained. There was increased fluctuations in the markets. In February 2001, the crawling peg regime collapsed and Turkish Lira depreciated significantly while inflation rate reached a high level. IMF program end up with February 2001 crisis (Orhangazi, 2002). Existence of crawling peg regime was signal of a crisis. In February 2001, floating exchange rate regime has started to implement.

Turkey had inflation rates of annually 29.7 percent in 2002, annually 18.4 percent in 2003, annually 9.3 percent in 2004, and annually 7.7 percent in 2005; and starting from 2005, though still high, it achieved a proper level for the initial stage is achieved as well as low inflation rate criteria. In 2001 Stability program, Central Bank monetary base was determined as a nominal anchor and Central Bank of the Republic of Turkey was fully liberalized by law.

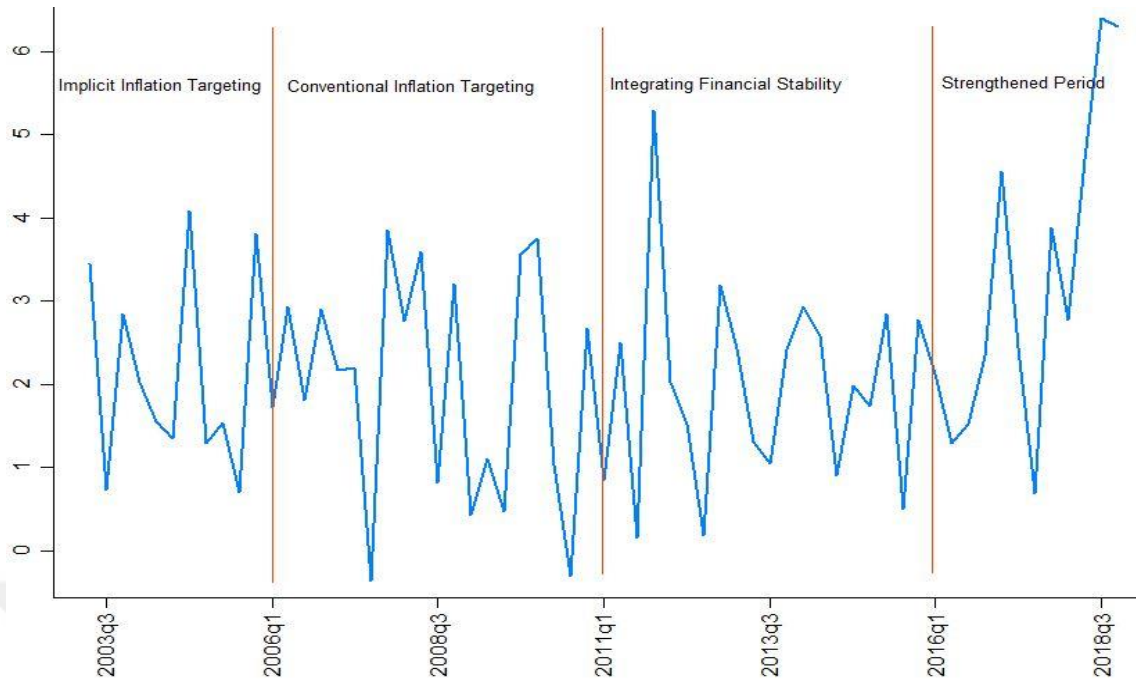


Figure 1.1 Quarterly inflation rate during different inflation targeting periods

Also, in 2001 implicit inflation targeting regime implemented. At the same time floating exchange rate regime was adopted. Decreasing the inflation rate regime which was started in 2002, was 9.3 percent percentage in December 2004 which was lower than inflation targeting level for 2004. Composition of new inflation regime and exchange rate regime was relatively successful in early years of these new system.

In April-May 2004, there was an increasing USD/TL exchange rate but its' effect on inflation rate was quite limited, there was not any increasing pressure on inflation rate. Due to the floating exchange rate regime, fluctuations in exchange rate weakened, which undermined the mechanism in which exchange rate movements are indexed to prices. Also, positive expectations about inflation contributed to the decreasing inflation rate. The success of the new inflation targeting regime in early years of the policy cemented the credibility of regime and positively affected expectations.

Monetary and fiscal discipline, falling inflation rate which have been continuing from 2002, have contributed to the weakening of the effect of exchange rate transition to inflation by affecting the general price level. In 2006, formal inflation targeting was started to be implemented.

During 2006 and 2007, the inflation rate in Turkey started to increase despite the decreasing domestic demand and monetary contraction in the country. In this period, monetary policy had limited effects on the increasing inflation rate and most of the fluctuation was the outcome of external factors. Also, during 2006-2007 period increasing price of energy, non-durable and durable consumption goods were reasons of inflation rate which is higher than expected inflation level. In other words, increasing goods and energy prices were the primary reason behind increasing inflation rate (TCMB, 2007, p. 29).

In 2008, global financial crises deepened. Because of decreasing demand and decreasing economic activity, inflation rate was at a low level at the global level. After the 2001 economic crisis in Turkey, restructured fiscal and monetary policy and structural reforms provided high economic growth rate and a single digit inflation rate; economic confidence improved for both domestic investors and foreign investors. Hence, expenses and investments of private sector was funded by foreign capital inflow so in 2006 because of fluctuations in global markets, risk premium of Turkey increased. Therefore, interest rate was increased to avoid increasing inflation. Inflation expectation was revised and inflation was around 10 percent at the end of 2008. In 2010, effects of global financial crises had started to decrease in Turkey and Turkish economic performance improved. Capital inflows has started to increase.

CRBT started to decrease liquidity supports for the market, required reserve ratio increased, interest rate payments for Turkish lira required reserve ended. Monetary expansion gradually shifted to monetary tightening regime. In the last quarter of 2010, inflation targeting was combined with additional financial stability orientation to take control of capital inflow and direct them to long-run investments. During 2010, there was an increasing trend for non-durable food prices therefore it leads to increasing pressure on general price level. Inflation rate in 2010 was lower than inflation rate of 2008-2009.

A credit expansion started to speed up and Turkish Lira appreciated. In August 2010, risk preferences of global markets has switched and Turkish lira has started to depreciate. At the same time, prices of non-durable food increased. Inflation rate reached to 10.4 percent annually. During 2010, effect of depreciation of TL, led to increasing prices for goods.

Increasing price of food was primary reason of increasing consumer price in 2011. At the end of April 2011, CRBT started additional monetary tightening to eliminate secondary sources of increasing inflation level. During 2012, additional monetary tightening was implemented five times¹. Hence quantitative easing period which had implemented to avoid from effects of global financial crises ended.

Since 2014, the annual inflation rate of Turkey has started to increase gradually. At the end of the 2014, primary reason of increasing inflation rate is the depreciation of the currency. Beside the exchange rate pass-through to inflation, increasing trend in food prices are other reason of increasing inflation rate in 2014. The increasing trend in inflation in Turkey after 2009 is explained by increasing trend in food prices and depreciation of Turkish Lira. November 24, 2015 crises between Russia and Turkey and July 15, 2016 Military Coup Attack were negative shocks for Turkey. Conflict between Russia which is one of the trade partners and source of most of the tourism income was negative for Turkish economy especially for tourism sector which is one of income generating sector especially in summer seasons.

All these developments in 2015-2016 period implied that supply conditions were effective sources for inflation developments. Also, price and tax regulations in tobacco products and increase of special consumption tax were driving sources of consumer inflation. Hence, effect of increasing price of tobacco products was 1.1 point which is highest historical contribution to consumer price index. Also, impact of changes in exchange rate on inflation level was calculated to be 1.1 point at the end of the 2016. Oil prices, alcoholic beverages, tobacco products, food prices were important drivers of consumer price index because core inflation level was stable in the same period (Kara et al, 2016, CRBT Inflation Report 2016: 4).

At the first quarter of 2017, depreciation of Turkish Lira and hence changes in import prices affected the inflation level. Both exchange rate, oil prices and energy prices have risen and led to increasing pressure on inflation despite a tax reduction in certain goods. Food prices increased sharply because of both harsh weather conditions and depreciation in the currency.

¹ March 23-29 2012, April 11-17 2012, May 4-11 2012, May 21-25 2012, May 31-June 4 2012, additional monetary tightening by decreasing one week repo rate (CRBT Annual Report, 2012).

Annual core inflation rate was 10.46 percent in the first quarter of 2016 (CRBT, 2017: II). Increasing food prices and adjustments in good prices were important reasons of inflation. In the second quarter of 2017 consumer inflation was 10.90 percent and in third quarter 11.20 percent and in the last quarter 11.92 percent. There was an upward trend for consumer inflation during 2017 (CRBT 2017: IV, 2018: I).

In the second quarter of 2018 inflation rate was 15.39 percent and Turkish lira depreciated by around 16 percent against the currency basket (CRBT, 2018: III). In August 2018, Turkish Lira depreciated sharply and in the mid of August 2018, TL/USD come to the climax of the year² and from beginning of the year Turkish lira depreciated 82 percent. In the third quarter of the 2018, Turkish lira depreciated by around 37 percent and consumer inflation hiked to 24.52 percent from the previous quarter (CRBT 2018: IV). At the same period, currency crisis accompanied with debt crisis (Orhangazi, 2019). In September 2018, "New Economic Program" for 2019-2021, was announced by the government. Contractionary monetary and fiscal policies were main features of the new program. One of the main aim of the program was decreasing inflation level; keeping inflation one digit level in 2020 and 6 percent inflation rate annually at the end of the 2021.

Precautionary policies designed to reduce inflation rate to moderate level and Turkish Ministry of Finance and Treasury has started to tackle with inflation campaign³. In the last quarter of the 2018, Turkish Lira appreciated against the currency basket, international commodity prices declined, tax cuts on certain products contributed to declining inflation level which is 20.30 percent. In the first quarter of 2019, consumer inflation decreased to 19.7 percent. Weaker demand conditions since the last quarter of 2018 and tax cuts for in certain goods and effects of appreciating exchange rate contributed disinflationary process.

On the contrary, increasing in special consumption tax for tobacco products and progressing high prices on certain goods contributed to core goods pulled inflation (CRBT 2019:I, II). From last quarter of 2018, inflation and exchange rate have same pattern and there is a simultaneous increasing trend.

² In August 14 2018 1 TL= 6.88 USD

³ New Economic Program announced in 20th of September 2018 in Official Gazette (No: 30541).

1.2 EXCHANGE RATE PASS THROUGH MODELS

There are many theoretical and empirical studies about exchange rate pass through to inflation which are important to understand how impacts of devaluation of the currency spill to the domestic economy by changing the expenditure behavior of economic agents. Change in nominal exchange rate might not be reason of substitution between domestically produced goods and internationally produced goods because the relative prices of these final goods do not change for consumers (Devereux, Engel, 2004). Also, Friedman argued in the same manner by including price rigidities in the case of producer's currency. However, these arguments would not be satisfied by looking at the countries which are using intensive imported goods in their final good production process.

Most of the models in this literature are built by assuming the conditions of developed countries. Nevertheless there are really narrow literature about EMDEs. In the most of the open-economy macroeconomic models as mentioned in Obstfeld and Rogoff (1995) and Goldberg and Knetter (1997) based on local currency pricing framework. Another new perspective for explaining exchange rate transmission mechanism is invoice practice. Invoice practice is logical approach for explaining pass through dynamics of EMDE's. Hence, in most of the emerging markets and developing economies, trade activities invoiced in U.S. Dollar and governments have dollar debts.

As a small open economy, Turkish economy is more sensitive to changes in the nominal exchange rate. Also, production process in Turkey is highly depends on imported intermediate goods for producing final goods. In most of the sectors, there is no room for substitution between domestic intermediate goods and internationally produced intermediate goods so there is direct cost channel for exchange rate pass through to consumer prices. Also changes in commodity prices and energy are indirectly effect pass through to consumer prices and producer prices.

Additionally, Calvo (1983) modeled price adjustments using state-contingent pricing and menu costs or with imperfect information and rational inattentions under Calvo pricing the existence of nominal rigidities can be understood. Therefore, having knowledge about pass through mechanism give insight about existence of nominal rigidities in a country. In further studies nominal rigidities can be analyzed by looking ERPT dynamics.

1.3 CONTRIBUTIONS AND OUTLINE OF THIS STUDY

This thesis contribute to recent branch of the literature which emphasizes the importance of transmission of exchange rate movements to inflation. Study is latest in the literature of exchange rate pass through into prices in Turkish economy case since I use latest data which covers between 2006 and 2019, to understand the current situation of exchange rate pass through into inflation in Turkey. In this study I identify and analyze ERPT with Markov regime switching process. Also, this study reports the developments in exchange rate and its effect on different price levels at the last quarter of 2018. I identify different pass through coefficients for goods and services which is one of the hypothesis of the study. Findings of the study show that there are different pass through coefficients and dynamics for goods and services. In last 13 year, exchange rate pass through to goods' inflation is highest pass through coefficient. However, exchange rate pass through to services' inflation is lowest pass through coefficient. This difference would be explained with labor market dynamics and changes in price of labor.

High depreciation of TL in last quarter of 2018, has strongest effect on exchange rate pass through to inflation pattern of Turkish economy last 13 years. However, this currency shock is not enough strong to switching inflation regime to another regime. Also, effects of 2008-2009 global financial crisis, effects of 2016 Military coup attack are really limited for exchange rate pass through in Turkey.

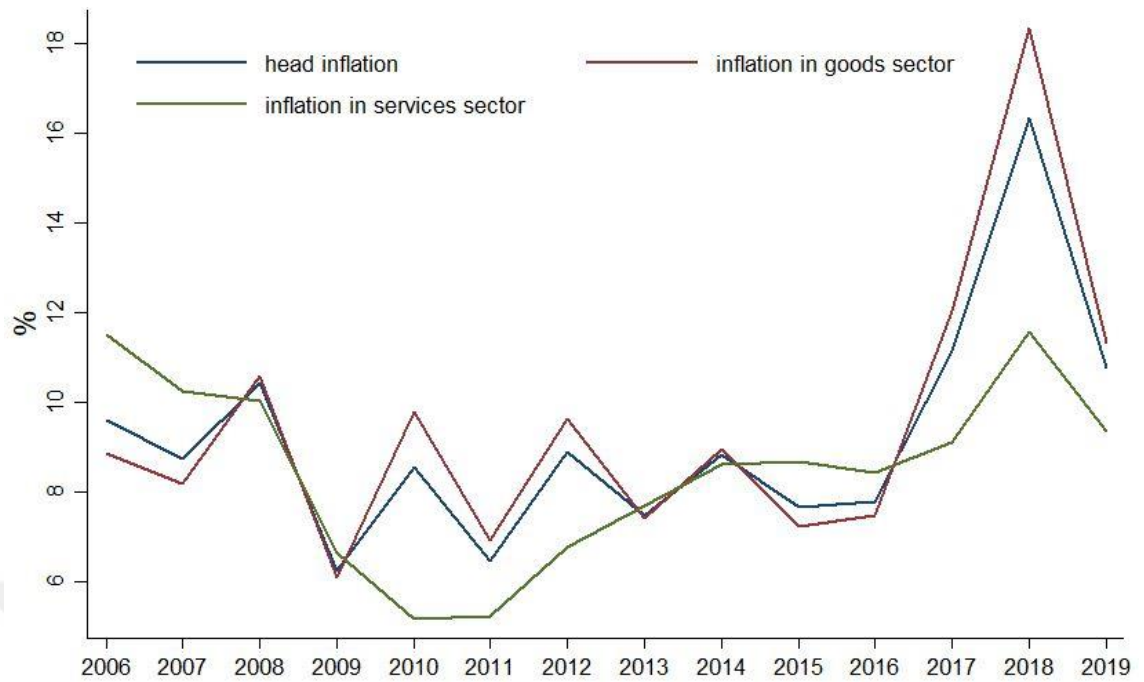


Figure 1.2. Annual head inflation, inflation in goods and services sector

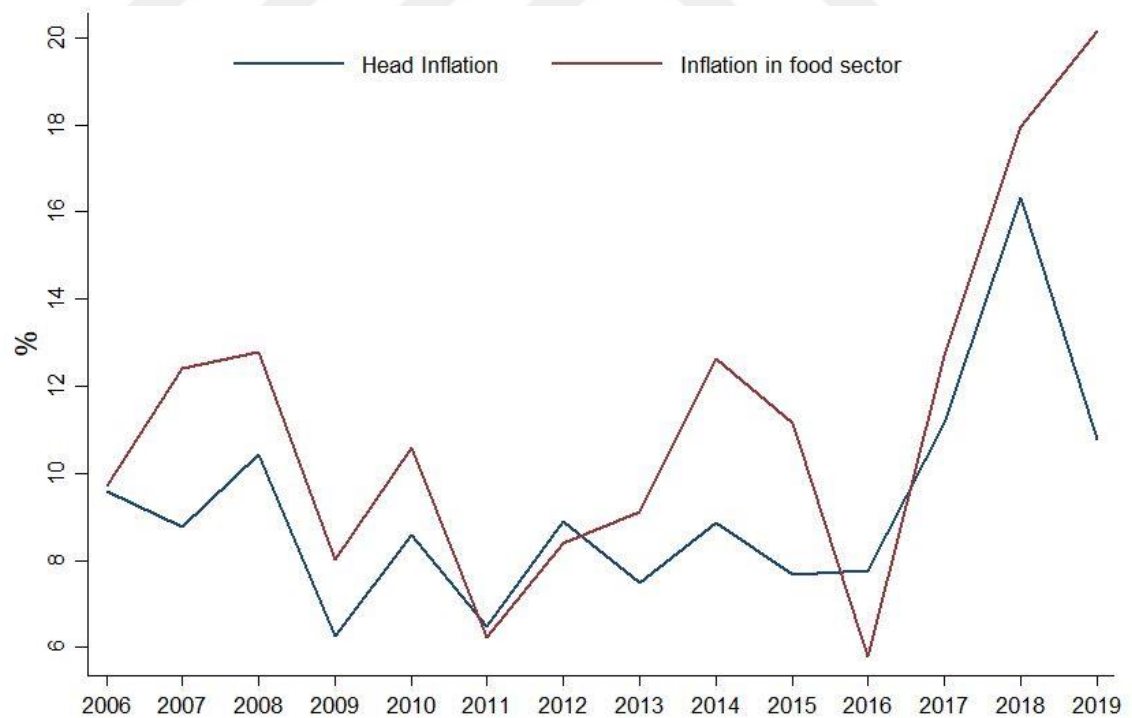


Figure 1.3. Annual head inflation and inflation in food sector

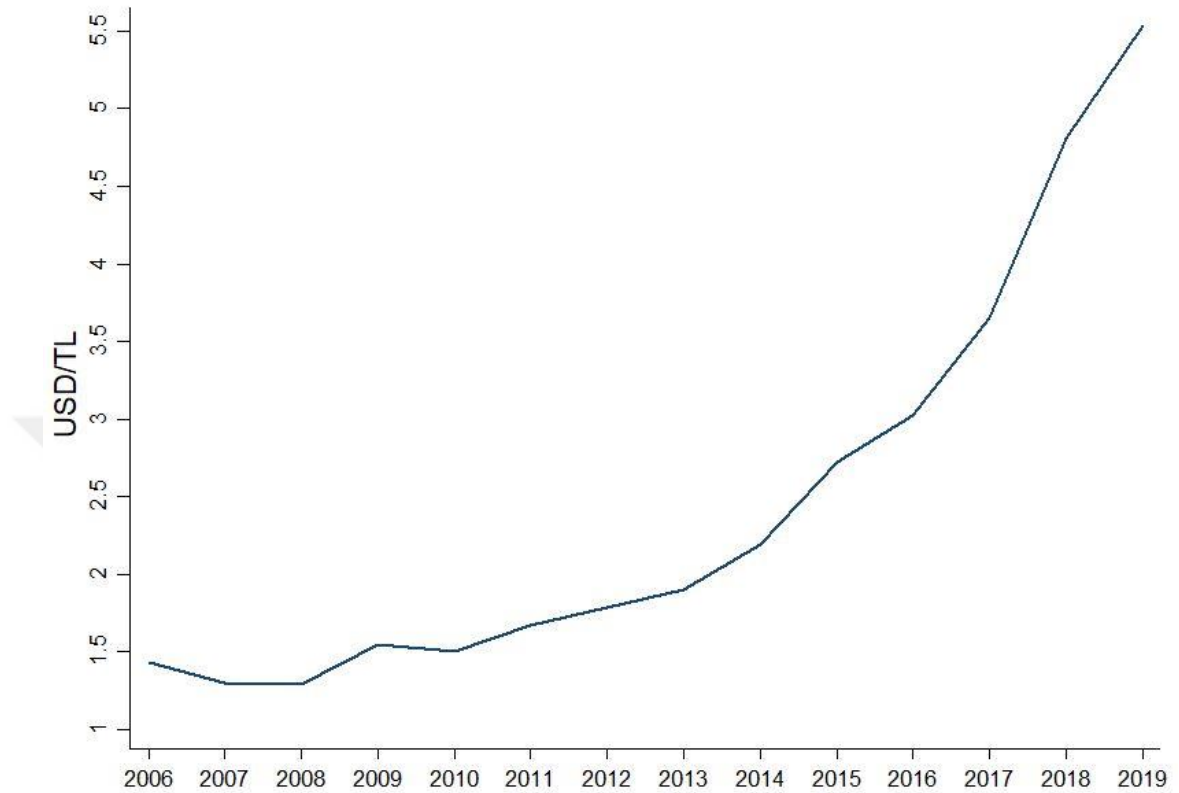


Figure 1.4. USD/TL annual exchange rate

Also, this study is unique in exchange rate pass through to inflation in Turkey literature by building a Markov Switching Regression model. This model allows us to observe regime changes and transitions from one regime to another one. Therefore we can understand how immediate shocks to economy would create a new regime and change in existence pattern of the economy.

This study may give some insights to central banks during the formulation of the monetary policy and to capture latest developments in exchange rate pass through coefficients.

In the first part of this study, I summarize both theoretical and empirical literature about exchange rate pass through. In the second part of the study, I build a model and test it with Turkish data. In the last part of the study, findings are summarized.

CHAPTER 2

LITERATURE REVIEW

2.1. THEORIES OF EXCHANGE RATE PASS THROUGH

This section discusses the literature on exchange rate pass through (ERPT). The relation between prices and exchange rate is a widely discussed topic in macroeconomics. Exchange rate pass through is a concept that defines the magnitude of the response of prices to exchange rate changes. The degree to which domestic prices adjust to exchange rate movements is called exchange rate pass through into prices.

There are three main reasons for studying exchange rate pass through. First, it is important to understand inflation dynamics to guide monetary policy. In inflation targeting countries, price stability is the primary goal of central banks. In Turkey, inflation targeting under floating exchange rate regime is nominal anchor. In most of the EMDE's central banks have a propensity to respond to exchange rate shocks by using different methods. Therefore monetary policy credibility is important for exchange rate pass through process (Mishkin and Savastano, 2001). Second, expenditure patterns of economies and purchasing power directly depends on prices. Increasing inflation rates may distort composition of welfare creating changes in consumer surplus and producer surplus. Therefore measuring the extent of exchange rate pass through to inflation depicts changes in welfare. Third, in an open economy, firms have a tendency to respond to cost shocks caused by exchange rate shocks. Understanding how firms respond to cost shocks can enable us to understand the degree of rigidities in domestic markets when exchange rates are highly volatile.

There are different hypotheses concerning the relation between prices and exchange rates. In the following parts, these models will be reviewed by following Campa and Goldberg's (2005) distinction between two strands of the theoretical ERPT literature.

2.1.1. Partial Equilibrium Models for Firms Interaction Models

Literature about exchange rate pass through to inflation was built on leading studies of Krugman (1987) and Dornbusch (1987). Studies of Krugman (1987) and Dornbusch (1987) focus on developed countries and the effects of the appreciation of U.S. The initial studies of Dornbusch (1987) and Krugman (1987) consider the pricing to market model. Pricing to market is a specific pricing method for each country, adjusting export prices in response to exchange rate changes so as to limit changes in the prices paid by importers. This explains the differences in the pass-through effects across locations and industries and deviations from PPP.

Therefore building a model on the pricing to the market phenomenon addresses the determinants of relative price changes of different groups of goods and identify the sectors where an exchange rate change should lead to large relative price changes in basic models. It could be considered as an imperfect competition model which takes into consideration industry features. The model of pass-through is built with supply and demand analysis of import goods by adding monopolistic price discrimination Dixit-Stiglitz model to capture market dynamics with combination of law of one price.

Cournot type of competition exists for both domestic and foreign firms. Law of one price posits that the same good sells for the same price in foreign and domestic markets when selling and buying prices are converted to same currency. If the law of one price is consistent, changes in the value of a currency should directly affect the prices of the goods so there should be one to one pass-through. The direct effect of a change in exchange rate prices which is a direct channel between prices and the exchange rate is explained by the law of one price. According to the law of one price changes in exchange rate reflects domestic good's prices via imported good prices (Krugman, 1987; Dornbusch 1987).

Purchasing power parity condition supposes that the exchange rate is determined so as to eliminate price differences across countries so that the real exchange rate of each country is equal. Purchasing power parity condition is consistent for tradable goods so pass through can be complete. However, the presence of non-tradable goods leads to a persistent departure from purchasing power parity. Also studies of Goldberg and Knetter (1996) claims that pass-through is incomplete.

According to the study of Dornbusch (1987) pass-through depends on product substitutability, market structure and the number of foreign and local firms. Studies of Krugman (1987) and Dornbusch (1987) suggest that complete pass-through is possible under imperfect competition framework.

In the models of Krugman (1987) and Dornbusch (1987) elasticity of demand and supply is constant. Other models explain the degree of pass-through to export prices with convexity of demand curve (Marston, 1990; Feenstra, 1989).

Froot and Kremperer (1989) use a dynamic model which takes into account future profits, therefore prices are not adjusted because of change in value of currency. Firms may choose a decreasing profit margin and lower profits instead of reflecting the changes in the exchange rate.

Another concern of the pass through studies is the extent of pass through. Many studies in this literature investigate why changes in the exchange rate are partially transmitted to prices. Also, the responsiveness of the exchange rates and the consumer prices are discussed in this context by considering relative prices. Responsiveness level of exchange rates could effect relative price levels through expenditure switching. If the exchange rate changes has little effect on the behavior of final purchasers of goods, then it may take large changes in exchange rates to achieve equilibrium (Engel and Devereux, 2002). If a shock reduces the supply of foreign goods, very large home depreciation is required in order to raise the relative price of foreign goods enough to reduce demand sufficiently. Therefore high exchange rate volatility and low exchange rate pass through might occur together at equilibrium (Krugman 1989, Betts and Devereux 1996, Engel and Devereux 2002). However, open-economy macroeconomics models with sticky prices state that exchange rate volatility is difficult to generate when there is even low pass through. Obstfeld and Rogoff (1995) assume complete pass through of exchange rates to prices because nominal prices are set in the currency of the producer.

Engel (1993), Parsley and Wei (2001) extend the assumption of Obstfeld and Rogoff (1995) by building models with local currency pricing case. Engel and Devereux (2002) investigate the relation between exchange rate volatility and local currency pricing; local currency pricing eliminates the pass through from changes in exchange rates to consumer prices. In Engel and Devereux (2002) exchange rate pass through is discussed under the

exchange rate disconnect puzzle, that is the exchange rate volatility does not matter for real variables. Findings of this study show that local currency pricing cannot eliminate exchange rate pass through. For eliminating exchange rate pass through local currency pricing, incomplete international financial markets, absence of international pricing and product distribution and stochastic deviations from uncovered interest parity should be satisfied together.

New Open Economy Macroeconomic models examine the effects of differentiated pricing strategies for exchange rates and monetary policy. The local currency pricing or the producer currency pricing models are completely different, justifications of models use different evidences. Each pricing case, present a different degree of pass-through. Betts and Devereux (1996) consider consumer currency pricing and result of it limited pass-through to consumer prices arising from the relationship between nominal and real exchange rate.

2.1.2. General Equilibrium Models for Firms Interaction Models

In partial equilibrium models, exchange rate shocks and wages are considered as exogenous. In general equilibrium model of Gopinath and Burstein (2014), exchange rate shocks and wages are endogenous. Gopinath and Burstein (2014) build a general equilibrium model by introducing local currency pricing phenomenon and show deterioration in trade balance and exchange rate depreciation. Under local currency pricing there is limited expenditure switching effect in the short run. The model of Gopinath and Burstein (2004) is consistent for developed countries. However, emerging market economies and developing countries have different characteristics.

Garcia-Solanes and Torrejon-Flores (2015) build a general equilibrium model for small and open emerging market economies. In the model there are many market imperfections and external shocks on nominal exchange rate exist. There are five different agents: entrepreneurs, households, firms, governments, and the monetary authority. The monetary authority has the following objectives: price stability, output growth and stable nominal exchange rates. There is Calvo pricing: prices adjust slowly.

Increasing nominal exchange rate leads to increasing price level and nominal value of expenditures increase, which is the expansionary effect of the expenditure channel.

Depreciation of domestic currency increases net exports since exported goods become cheaper in foreign markets and imported goods become expensive in domestic market, hence the expenditure switching effect of pass-through. Also, different from other studies Garcia-Solanes and Torrejon-Flores (2015) include balance-sheet parameters.

Barhoumi (2006) builds another general equilibrium model. Aggregate demand conditions, money demand, interest parity, import price setting and real exchange rate are analyzed.

Barhoumi (2006) identifies that different shocks generate different exchange rate pass through coefficients. In an inflationary environment ERPT is higher than low inflationary environment.

2.1.3. Models for Macroeconomic Factors

Another element in explaining the pass through channel is the macroeconomic factors. Betts and Devereux (1996) present insensitivity of aggregate price levels to nominal exchange rate disturbances by building a model on an earlier model of Obstfeld and Rogoff (1995). Betts and Devereux's (1996) general equilibrium model investigates how exchange rates respond to monetary shocks when sticky prices and local currency pricing are together. Under the pricing to market model when prices are assumed sticky, exchange rates respond sharply to monetary policy shocks. Models which are built on pricing to market, consider tradable and non-tradable goods (law of one price suggested for tradable goods). Pass through for tradable and non-tradable goods have different coefficients in the existence of monetary policy shocks. However, discrimination of prices for different countries alleviate effects of depreciation in nominal currency and monetary shocks do not change present pass through pattern.

The inflationary regime and its effect on exchange rate pass through firstly introduced by Taylor (2000). Taylor (2000) argues that the credibility of monetary policy affects the declining pass through.

Lower pricing power of firms leads to lower inflation and therefore there is pressure on demand so that pass through is not exogenous in the low pass through environment. Also, expectations become important in this phase because they shape an inflationary environment in monopolistically competitive model⁴. Taylor (2000) concludes that lower inflation is the outcome of lower continuity of inflation and low pass through in US. Expectations on pass through has a significant effect on pass through and credible low inflation regime results in lower pass through.

Devereux and Engel (2002) suppose that local currency pricing removes the effects of the volatility of exchange rates. Exchange rate pass through to consumer prices is eliminated because of local currency pricing.

2.2. EMPIRICAL LITERATURE ON EXCHANGE RATE PASS THROUGH

Empirical studies of ERPT can be classified as linear and non-linear models. These studies address reasons of pass through and estimate pass through coefficients. Changes in exchange rates are transmitted to the real economy via direct and indirect channels. Changes in commodity and energy prices are reflected in domestic prices, which is the direct channel. Changes in profit markups and wage formation are reflected in domestic prices, which is the indirect channel. Extent of transmission can be partial or complete.

Yang (1997) builds a linear exchange rate pass through model for the U.S. manufacturing industry between 1980 and 1991. In this linear model, marginal cost varies and pass through arises from product differentiation. A two stage equation system is presented to understand the effect of product differentiation on pass through. Knetter (1993) analyzes the relation between price discrimination and pass through for manufacturing industries in the United States, Japan, the United Kingdom and Germany by building a linear model. Pass through concept is analyzed for export prices in the study of Knetter (1993). Each industry is examined by taking into consideration their own characteristics. Findings show that the extent of pricing to market differs across countries and industries by assuming changes in marginal cost are same for each country.

⁴ The effect of general inflationary environment on the pricing behavior of firms is explained with the theory of price setting with imperfect competition models (Arrow, 1959).

Linear models of Kim (1998) and McCarthy (1999) focus on the exchange rates and import price pass through to the domestic price inflation. McCarthy (1999) studies various channels of pass through to different price levels and analyzes the impact of exchange rate changes and import prices on producer prices and consumer prices by using data from nine industrialized countries (Japan, United States, Switzerland, United Kingdom, Netherlands, Germany, Sweden, France, Belgium) with a recursive vector autoregressive model during 1996-1998 period. Changes in exchange rates, oil price inflation, the output gap, consumer price index inflation, import price inflation, producer price index inflation, short-term interest rate, and money growth variables are included in the model. Vector Auto Regression model enables the tracking of pass through from exchange rate fluctuations to each stage of the distribution chain in a simple framework. Cholesky decomposition method is used to identify structural shocks.

In McCarthy (1999) exchange rate fluctuations have moderate effects on consumer prices and pass through correlated with the degree of openness of the economy. Hence higher import price effect on pass through shows openness to trade. Several studies consider the relationship between estimated exchange rate pass through and country characteristics. Generally, openness to trade, financial transactions, the credibility of central banks, volatility level of inflation and exchange rate and level of market competition are investigated in these cases.

Calvo and Reinhart (2002) investigate the relation between exchange rate arrangements and their impact on inflationary environment. Calvo and Reinhart (2002) show that in emerging market economies exchange rate pass through tends to be larger when compared to developed economies. The relationship is tested by using monthly data of 39 countries during January 1970 and November 1999 and 155 exchange rate arrangements are analyzed. Findings depict that when inflation rate is high in emerging market economies, pass through coefficients have a tendency to increase.

Goldfjan and Werlang (2000) study the relationship between inflation and exchange rate depreciation by building a linear model for 71 countries during 1980 and 1998. In their model, pass-through coefficients are linear functions of other variables, which are deviation from gross domestic product, initial inflation rate, initial overvaluation of exchange rate and openness to trade.

Goldfjan and Werlang (2000) find that when measured time horizon which is monthly data increase pass-through coefficients go up. 12 months after depreciation, pass-through coefficients become the highest and correlated with business activity, size of initial real exchange rate, initial rate of price level and initial openness of economy. However, variables of business activity and openness of economy react to changing time interval. Pass through coefficients of developing countries and emerging market economies are larger than the coefficients of developed countries. While in emerging market economies and developing countries depreciation of exchange rate is the most important determinant of inflation, in developed countries initial inflation variable is the most important determinant of pass through dynamics.

Gagnon and Ihrig (2004) study the relation between monetary policy and exchange rate pass-through by building a linear model. Model is tested with data of 20 developed countries between 1971 and 2003.

In the study effects of monetary policy are captured by dividing the time interval into two parts as before and after the adoption of formal inflation targeting. Findings of the study show that central banks' credible monetary policy aiming price stability may lead to a low exchange rate pass-through regime. After adoption of inflation targeting regime, pass-through coefficients decline in related countries.

Another linear model investigating the effects of monetary policy on pass through dynamics is built by Bailliu and Fujii (2004). They find that because of low inflation environment which is inclined from monetary policy, exchange rate pass through to consumer prices declined from 1977 to 2001 in 11 developed countries (Belgium, Spain, Denmark, Australia, Canada, Finland, France, United Kingdom, Italy, Netherlands and United States). They estimate three equations for three different price indices; which are consumer price index, producer price index and import price index. Changes in inflation regimes and shocks to exchange rate captured by dummy variables and changes in foreign producer cost and output gap are included as control variables. Related equations are estimated with a generalized method of moments. Pass through to import prices, consumer prices and producer prices decline after implementation of stabilizing monetary policies.

Also, nonlinear and asymmetric models address pass-through dynamics by considering regime changes and policy changes. These models address how shocks affect the pattern of pass through and appreciations; how pass through coefficients vary with appreciation and depreciation; and how complete and incomplete pass through dynamics can be detected in different regimes.

Pollard and Coughlin (2004) investigate exchange rate pass through to import prices in the U.S. for 30 industries from 1978 to 2000. In the study, a linear model is specified as other linear models to determine sources of pass through. Import prices, depreciation of exchange rate, domestic demand conditions, foreign and domestic marginal costs and quarterly dummy variables included into model. They show that even in different sectors pass through coefficients vary and most of the industries react asymmetrically to appreciations and depreciations. Also, the study suggests that the size of pass through coefficient depends on the magnitude of the exchange rate shock.

Yang (2007) investigates exchange rate pass through to import prices at disaggregated level for U.S. Findings of Yang (2007) are similar to the findings of Pollard and Coughlin (2004). Bachetta and van Wincoop (2003) investigate the differentiation between pass through to import prices and pass through to consumer prices and explain the differences of each pass through mechanism by considering indirect channels. Findings of the study conclude that the extent of the pass through to consumer prices is lower than extent of pass through to import prices. There are two explanations of the differences in the degree of the pass through. First one is existence of local inputs in distribution sector. Second one is imported goods used for production of final goods by combining domestically produced good in local market so pricing decision of both intermediate input producer and final good producer are important. Bachetta and van Wincoop (2003) build a model on the second explanation.

Gopinath and Burstein (2003) examine the theoretical models built on studies of Krugman (1987) and Dornbusch (1987) by using data from eight developed countries between 1975 and 2001. Different price indices, consumer prices, producer prices, border prices, are used to understand local currency pricing. Using different price indices is useful for detecting changes in the composition of non-tradable goods and tradable goods and effect of distribution cost.

Devereux and Yetman (2003) look at the effects of price adjustment in explaining exchange rate pass-through by inducing menu costs. Effects of price adjustments on pass-through is analyzed by data from 122 countries. Findings estimated exchange rate pass-through tends to vary systematically with the mean inflation rate. For small open economies, exchange rate pass through should be taken into account when designing monetary policy.

Campa and Goldberg (2005) and Campa and Goldberg (2010) investigate trade openness and composition of imported goods. Campa and Goldberg (2005) analyze extensive disaggregated micro data for 23 OECD Countries for cross-country comparisons and conclude that border prices of goods are sensitive to exchange rate fluctuations and countries with higher exchange rate volatility have higher pass-through elasticities. Also Campa and Goldberg (2005) suggest that pass through coefficients vary across regimes.

Vector Auto Regression models are useful to detect underlying shocks and enable observing the sources of shocks, their direction and the extent of pass through coefficients. Many studies in the literature build different VAR models. Ito and Sato (2008) find that import prices constitute a channel for exchange rate pass-through to inflation level. They examine exchange rate pass-through for East Asian countries, Indonesia, South Korea, Thailand, Malaysia, Philippines, by building a VAR model during Asian Financial Crises. Changes in output gap, nominal effective exchange rate, money supply, oil prices and price indicator for domestic price level are included in the VAR model. Like most of the other studies which examine pass through to import prices and pass through to consumer prices, Ito and Sato (2008) conclude that exchange rate pass through to consumer prices are lower than exchange rate pass through to import prices. Changes in monetary policy have significant effect on pass through dynamic.

Shambaugh (2008) investigate exchange rate pass through by estimating a VAR model for 16 countries (Colombia, Denmark, Finland, Germany, Greece, Hungary, Korea, Japan, Poland, Singapore, Switzerland, the United Kingdom, the United States, Austria and Australia) from first quarter of 1973 to last quarter of 1999. Shambaugh (2008) focuses on major shocks to the economy and test their effects on exchange rate depreciations, import prices and consumer prices instead of direct relation between exchange rate and inflation.

Shambaugh (2008) builds a simple open economy model to capture short run pattern of pass through dynamics by limiting long run behavior of variables. By this way, immediate effects of shocks to real economy can be realized. Industrial production index for output level, real exchange rate, depreciation in nominal exchange rate, import price index and quarterly dummy variables for detecting seasonal changes are included in the VAR analysis. Findings of Shambaugh (2008) suggest that there are convincing differences across pass through coefficients of each country.

Choudri and Hakura (2006) test the hypothesis of Taylor (2000) by building a new open economy macroeconomics model with a large data set which covers 1979-2000 for 71 countries including both developing and industrialized countries. They consider regime changes and the effect of macroeconomic variables on these regimes. In the study inflation regimes are determined according to mean of rate of inflation in each country. Countries which have high inflation rates have a tendency to have changes in their inflation patterns and also inflation stabilization policies effect their inflation regimes.

In the study for each inflation regime a log linear regression equation estimated. Consumer price index and nominal trade weighted exchange rates regressed and for cross country comparison relative price index included. Findings show that the relation between pass-through and average inflation is positive in each regime. In high inflation environment, the effect of monetary shocks are more persistent and are reflected to exchange rate changes to larger degree and therefore pass through coefficients are higher. There is a significant relation between mean of inflation rate and exchange rate pass through coefficients.

Amiti et al. (2014) investigate exchange rate pass through at firm level and how export share and import share of firms affect the magnitude of exchange rate pass through in the firm level by using Belgian firm data which covers 2000 and 2008 period. This study contributes to the indirect channel of pass through and markup literature. Firms which have high import intensity reflect changes in exchange rate to price level via two channels. First channel (direct channel) is the offsetting changes in cost. Second channel is increasing markup. Findings conclude that import share of firms in production process affect pass through coefficients.

Frankel et al. (2005) explained decreasing in exchange rate pass through coefficients in developing countries using data of 76 developing countries. Findings show that stabilizing monetary policy leads to decreasing exchange rate pass through coefficients. Carriere-Swallow et al. (2016) studied relation between monetary policy and exchange rate pass through to consumer prices in emerging market and developing economies and developed economies. In the study data of 31 developed countries and 31 developing countries examined from January 2000 to December 2015. Findings of the study conclude that credible monetary policy and inflation stabilization policies have important for reducing pass through coefficients. Reyes (2007) conclude that low exchange rate pass through to inflation in emerging market economies is a result of inflation targeting regime. Rabanal and Schwartz (2001) analyze inflation dynamic in Brazil after the floating of the Brazilian currency and find that 20 months after floating initial shock has worked itself through the system.

The type of the macroeconomic shock that leads to exchange rate movements play a role in determining the extent of the associated pass through.

Comunale and Kunovac (2017) investigate the pass-through to consumer prices in the Euro Area. Also, effects of European Central Bank policy rate which is zero lower bound is analyzed in this study. Findings conclude that the exchange rate pass through in the euro area declines along the pricing chain. Another finding is that exchange rate pass-through in the euro area is not constant along time and it related with composition of economic shocks. Forbes et al. (2016) analyzed sample of 26 advanced and emerging market economies by estimating SVAR to understand exchange rate pass through across countries and over time and argue that shocks to exchange rates explain variations in pass-through over time. In the study different shocks which include aggregate shock, euro area aggregate demand shock, global supply shock, global demand shock, exchange rate shock, monetary shock are identified by a Bayesian VAR model.

2.3. LITERATURE SURVEY FROM TURKEY

According to literature in most of the emerging market economies, there is a strong correlation between exchange rate movements and inflation level. The depreciation of the exchange rate is one of the factors which triggers inflation. Turkish lira is very volatile and vulnerable against to U.S. dollar, therefore having information in this issue is very important in the policy making process. There are few studies about exchange rate pass through to inflation in Turkey.

Leigh and Rossi (2002) estimate a recursive vector autoregressive model to address the effects of exchange rate movements as Turkey moves to an inflation targeting regime using data from January 1994 until April 2002. Endogenous variables of the model are oil prices in Turkish lira to capture supply shock, real output, the nominal exchange rate relative to U.S. dollar, wholesale prices and consumer prices. VAR model allows to decompose effects of shocks and examine the importance of shocks in explaining wholesale prices and consumer price inflation fluctuations. Impulse response functions are used to assess the impact of exchange rate movements on prices. VAR analysis results suggest that the pass-through from exchange rate to prices in Turkey is over about a year, but mostly in the first four months.

Arbatlı (2003) analyze the exchange rate pass through in Turkey using threshold vector autoregression (TVAR) model that is introduced by McCarthy (1999) by using monthly data from January 1994 and May 2004.

Data period covers two crises and significant events in Turkey including the Gulf crisis. Oil prices in terms of US dollars, industrial production index, nominal exchange rate, consumer price index, wholesale price index, and short term interest rate are treated as endogenous variables. Dummy variables for each crisis are used as the exogenous variable. Threshold Autoregression (TAR) models used in the study of Arbatlı (2003) can be classified along with Smooth Transition Autoregression (STAR) and Markov Switching (MS) models. These models introduce non-linearity in the conditional expectation of a series behaving differently under different regimes. In TAR models which correspond to TVAR, regime switch is instant where if random variable exceeds a certain threshold s regime shift takes place.

Findings of the study underline that asymmetries in the exchange rate should be considered in ERPT in Turkey. Study of Arbatlı (2003) has similarities to Mccarthy (1999) as it builds on it and differs from Leigh and Rossi (2002) as it uses data from after the flotation of the Turkish Lira and also considers the asymmetries in the behavior of exchange rate and also threshold VAR model used.

Yücel et al. (2005) examine different exchange rate pass-through effects in different regimes by using with seemingly unrelated regressions (SUR). Kara et al. (2005) conclude that pass-through of the exchange rate to domestic prices decrease after the adaptation of inflation targeting because of the decline in indexation behavior when compared with pre-inflation targeting period. Kara and Ogunc (2005) estimate pass-through for Turkey from February 1995 to September 2004, covering both managed floating regime and floating exchange rate regime period. The difference of Kara and Ogunc (2005) from Kara et al. (2005) is the use of multivariate modeling strategy and impulse responses. While the Leigh and Rossi (2002) utilize a similar method with Kara and Ogunc (2005), Kara and Ogunc's (2005) analysis differs because of separation of currency regimes.

Yunculer (2011) analyzes pass-through similar to Kara and Ogunc (2005) and Yücel et al. (2005) by estimating VAR and considers inflation targeting periods and pre-inflation targeting and finds the same results with them after adaptation of inflation targeting regime, exchange rate pass through decrease compared with pre-inflation targeting period. Analysis of Yunculer (2011) covers the period between January 1997 and September 2010.

Also, Civeir and Akcaglayan (2009) examine how monetary policy react to the exchange rate under inflation targeting period and how exchange rate shocks affect inflation. They split the data into two different period- January 1987 and December 2001, January 2002 and May 2009- according to the regime.

Benialper and Comert (2013) investigate pass through between 2002 and 2008 by building a VAR model and find that supply-side factors such as the variation in exchange rate and international commodity prices determine inflation. They suggest that Turkish Lira significantly appreciated in this period and the Central Bank of Republic of Turkey (CBRT) benefitted from its to manage inflation and appreciation of currency related with

policy stance of CBRT. They state that the policy stance of CBRT is “*implicit asymmetric exchange rate peg*” because when Turkish lira appreciated Central Bank tolerated it but aggressively responded to the depreciation of the currency.

While Benlialper and Comert (2013) depict that supply-side factors are more significant than demand factors to explain variations in inflation, Dogan (2013) suppose that aggregate demand conditions have important effects on pass through. Different from other studies Dogan (2013) adopts the methodology of Hansen (2000), which focuses on threshold type nonlinearities and also considers short-term elasticity to show the impact of exchange rate depreciations on the general price level on a monthly frequency. Unlike other studies, manufacturing industry producer price index is utilized and mining, energy and agricultural prices excluded. Kal et al. (2015) investigate pass through between 1986 and 2014 and show that coefficients of pass-through depend on which method chosen. They conduct both the VAR method and Markov Switching Regression.

CHAPTER 3

EMPIRICAL MODEL, DATA AND ESTIMATION RESULTS

3.1. MARKOV SWITCHING MODEL

Markov switching model of Hamilton (1989) is a non-linear time series model. This model involves equation systems that can identify the time series patterns in different structures. By allowing switching among these regimes, this model is able to capture more complexity of the patterns. An explicit benefit and feature of the Markov switching model is that the switching mechanism is controlled by an unobservable state variable which depends on a probability parameter of the initial period which monitors a first-order Markov chain. Especially, the Markovian feature adjust that the present value of the state variable depends on its instant past value (Kuan, 2002).

Consider a first order autoregression:

$$y_t = c_{st} + \Phi_{st}y_{t-1} + \varepsilon_t, \quad (3.1)$$

Where $\varepsilon_t \sim \text{i.i.d}$ and $N(0, \sigma^2)$. First subscript, s , represents the number of regime and second subscript, t , represents time. The proposal is to model the regime s_t as the outcome of an unobserved N -state Markov chain with s_t independent of ε_t for all t and T . The advantage of Markov chain over deterministic specifications is that it takes into account the possibility of a switch from one regime to another and calculates the duration of the regimes.

In an autoregressive model, T state Markov-switching mean and variance are written as:

$$\Phi(L)(y_t - \mu s_t) = e_t, \quad e_t \sim N(0, \sigma_{s_t}^2), \quad (3.2)$$

$$\Pr[s_t = j / s_{t-1} = i] = p_{ij} \quad i, j=1, 2, \dots, T \quad (3.3)$$

$$\sum_{j=1}^T p_{ij} = 1 \quad (3.4)$$

$$\mu_{s_t} = \mu_1 S_{1t} + \mu_2 S_{2t} + \dots + \mu_T S_{Tt}, \quad (3.5)$$

$$\sigma_{s_t}^2 = \sigma_1^2 S_{1t} + \sigma_2^2 S_{2t} + \dots + \sigma_T^2 S_{Tt}, \quad (3.6)$$

Where

$$S_{mt} = 1, \text{ if } S_t = m \text{ and } S_{mt} = 0 \text{ otherwise.}$$

For the AR(1) case,

$$(y_t - \mu_{s_t}) = \Phi_1 (y_{t-1} - \mu_{s_{t-1}}) + e_t \quad e_t \sim i.i.d N(0, \sigma_{s_t}^2) \quad (3.7)$$

$$f(y_t / \varphi_{t-1}, s_t, s_{t-1}) = \frac{1}{\sqrt{2\pi\sigma_{s_t}^2}} \exp\left(-\frac{[(y_t - \mu_{s_t}) - \Phi_1(y_{t-1} - \mu_{s_{t-1}})]^2}{2\sigma_{s_t}^2}\right) \quad (3.8)$$

$$\ln L = \sum_{t=1}^T \ln(f(y_t / \varphi_{t-1}, s_t, s_{t-1})) \quad (3.9)$$

To deal with unobserved S_t, S_{t-1} . To solve the problem consider a joint density of y_t, S_t, S_{t-1} . Derive the joint density of y_t, S_t, S_{t-1} , conditional on past information φ_{t-1} :

$$f(y_t, s_t, s_{t-1} / \varphi_{t-1}) = f(y_t / S_t, S_{t-1}, \varphi_{t-1}) \Pr[S_t, S_{t-1} / \varphi_{t-1}] \quad (3.10)$$

Where $(y_t / S_t, S_{t-1}, \varphi_{t-1})$ is given in

To get $f(y_t / \varphi_{t-1})$ integrate S_t and S_{t-1} out of the joint density by summing the joint over all possible values of S_t and S_{t-1}

$$f\left(\frac{y_t}{\varphi_{t-1}}\right) = \sum_{S_t=1}^M \sum_{S_{t-1}=1}^M f(y_t / S_t, S_{t-1} / \varphi_{t-1}) \quad (3.11)$$

$$= \sum_{S_t}^M \sum_{S_{t-1}}^M f(y_t / S_t, S_{t-1}, \varphi_{t-1}) Pr[S_t, S_{t-1} / \varphi_{t-1}] \quad (3.12)$$

where the marginal density $[S_{t-1} = i / \varphi_{t-1}]$, $i = 1, \dots, M, j = 1, 2, \dots, M$

Then the log likelihood function is given by:

$$\ln L = \sum_{t=1}^T \ln\left(\sum_{S_t=1}^M \sum_{S_{t-1}=1}^M f(y_t / S_t, S_{t-1}, \varphi_{t-1}) Pr[S_t, S_{t-1} / \varphi_{t-1}]\right) \quad (3.13)$$

After iterations and if the Markov chain is presumed to have ergodic unconditional probabilities:

$$\pi_1 = \Pr\left[S_0 = \frac{1}{\varphi_0}\right] = \frac{1-p_{22}}{2-p_{22}-p_{11}} \quad (3.14)$$

$$\pi_2 = \Pr\left[S_0 = \frac{2}{\varphi_0}\right] = \frac{1-p_{11}}{2-p_{22}-p_{11}} \quad (3.15)$$

In this study $s_t = 1, 2$ is realization of a two-state Markov chain with:

$$\Pr(s_t = j / s_{t-1} = i, s_{t-2} = k, \dots, y_{t-1}, y_{t-2}, \dots) = \Pr(s_t = j / s_{t-1} = i) = p_{ij} \quad (3.16)$$

In the two regimes case, S_t is described by two state Markov chain. Two state Markov chain with transition matrix which consist of transition probability switching from regime 1 to regime 2. In this setting the regimes refer to the different states of the economy, high exchange rate pass through to price level and low exchange rate pass through to price level.

$$P = \begin{bmatrix} p_{11} & p_{21} \\ p_{12} & p_{22} \end{bmatrix} \quad (3.17)$$

The diagonal elements of the matrix of the transition probabilities contain information about expected duration of regime. If D is duration of regime j .

$$D=1, \text{ if } S_t=j \text{ and } S_{t+1} \neq j; \Pr[D = 1] = (1 - p_{ij}) \quad (3.18)$$

$$D=2, \text{ if } S_t=S_{t+1}=j \text{ and } S_{t+2} \neq j; \Pr[D = 2] = p_{ij}(1 - p_{ij}) \quad (3.19)$$

$$D=3, \text{ if } S_t=S_{t+1}=S_{t+2}=j \text{ and } S_{t+3} \neq j; \Pr[D = 3] = p_{ij}^2(1 - p_{ij}) \quad (3.20)$$

Then the expected duration of regime j derived as:

$$E(D) = \sum_{j=1}^{\infty} j \Pr[D = j] \quad (3.21)$$

$$= 1 \times \Pr[S_{t+1} \neq j/S_t = j] \quad (3.22)$$

$$+ 2 \times \Pr[S_{t+1} = j, S_{t+2} \neq j/S_t = j] \quad (3.23)$$

$$+ 3 \times \Pr[S_{t+1} = j, S_{t+2} = j, S_{t+3} \neq j/S_t = j] \quad (3.24)$$

...

$$= 1 \times (1 - p_{jj}) + 2 \times p_{jj}(1 - p_{jj}) + 3 \times p_{jj}^2(1 - p_{jj}) + \dots \quad (3.25)$$

$$= \frac{1}{1 - p_{jj}} \quad (3.26)$$

Regime variables are not observed directly but are only inferred from dependent variable of each equation, the parameters necessary to fully describe the probability law governing y_t are the variance of the Gaussian innovation σ^2 , the autoregressive coefficient Φ , two intercept for two equation.

3.2. DATA

All the data I use in the estimations are taken from the Central Bank of the Republic of Turkey Electronic Data Delivery System. All the series are in monthly frequencies and the general period for estimation is from January 2006 to March 2019.

Base year of the consumer price indexes are 2003. Explained variables in the exchange rate pass through equations are monthly percentage changes in the core prices and consumer price index for goods, consumer price index for services.

Core prices are estimated by CRBT by excluding prices of foods, beverages, alcohol and tobacco products from general price level. The main explanatory variable is the monthly percentage changes of nominal United States Dollar per Turkish Lira. All series are seasonally adjusted by using X12 method of U.S. Census.

3.3. ESTIMATIONS

As baseline model, inflation regression model used (Kara, et al, 2005) and reduced form of the standard model only with the relevant variables will be employed in the estimations:

$$\pi_t = \alpha_{0,t} + \alpha_{1,t}\pi_{t-1} + \beta_{0,t}q_t + \beta_{1,t}q_{t-1} + \varepsilon_t \quad (3.27)$$

Where π_t is the monthly inflation rate showing the percentage change in consumer price index (2003= 100) and q_t is the percentage change in the nominal USD/TL rate. Markov regime switching model is a non-linear specification and is different from linear specification. In this non-linear model the lag of exchange rate is not-included because states are determined depending on the current value of the state variable.

Before analyzing the relationship between exchange rate and inflation, the time series properties of all series are checked with the Augmented Dickey Fuller test (ADF). Percentage changes of all variables are stationary. Other unit root tests give the same result with the ADF test. Lag lengths are selected according to the Schwarz Information Criteria. The test results cannot reject the hypothesis that all percentage change variables are stationary at the level. In a regime switching regression context, equation 3.18 is converted to the following two equations for two states. Therefore there are two equations for each state. Number of regimes are detected by looking at the log likelihood test results. First equation represents regime 1 and second regime represents regime 2.

$$\pi_{1t} = \alpha_{10} + \alpha_{11}\pi_{t-1} + \beta_{12}q_t + \beta_{13}q_{t-1} + \varepsilon_{1t} \quad (3.28)$$

$$\pi_{2t} = \alpha_{20} + \alpha_{21}\pi_{t-1} + \beta_{22}q_t + \beta_{23}q_{t-1} + \varepsilon_{2t} \quad (3.29)$$

Baseline model is analyzed for three different inflation regressions for the Turkish economy between January 2006 and March 2019. Once the baseline model is determined, a two state Markov regime switching model is implemented to decompose, identify and quantify non-linearity in consumer price pass through. Pass through coefficients are different in each state therefore the alternative hypothesis of nonlinearity which is coefficients are different from each in each state is not rejected.

Three types of passthrough are measured for different price categories, which are good prices, services prices and core consumer prices. Core consumer price index shows all consumer goods except energy, food, alcoholic and non-alcoholic beverages, tobacco and gold prices. Energy prices are the primary source of general inflation and it effects directly and indirectly the prices of many goods. Changes in food prices may be volatile and the food price index has an increasing time trend during the period of this study. Also, alcoholic beverages and tobacco products are highly taxed goods. Core consumer price index is useful to observe the effects of changes in exchange rate for goods whose prices are not easily adjustable.

Table 3.1: Least squares regression coefficients for goods' inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>c</i>	0	0	6.02	0
<i>inflation</i> _{<i>t</i>-1}	0.30	0.06	4.45	0
<i>Exc</i> _{<i>t</i>}	0.04	0.01	3.97	0
<i>Exc</i> _{<i>t</i>-1}	0.05	0.01	4.57	0
R-squared	0.40	Adjusted R-squared	0.39	
Log likelihood	606.27	F-statistics	21.74	

Table 3.1 presents the results for the least squares regression for goods' inflation. According to the baseline model for goods, the lagged value of inflation, exchange rate and the lagged value of exchange rate are statistically significant explanatory variables for inflation. *Exc* denotes the percentage change in Turkish Lira per US Dollar, so an increase of the exchange rate indicates depreciation of the TL and a decrease of the exchange rate indicates an appreciation of the TL. Findings of the Least Squares estimation shows that depreciation in exchange rate leads to an increase in prices for goods and lagged effect of depreciation has effect on increasing price level as well as lagged value of good price inflation.

Another research interest of this study is detecting the impact of the sharp depreciation in Turkish Lira since August 2018. Table 3.2 shows effect analysis of currency crises in last quarter of the 2018.

Table 3.2: Least squares regression with dummy variables for good's inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>c</i>	0	0	7.01	0
<i>inflation</i> _{<i>t</i>-1}	0.17	0.07	2.15	0.03
<i>Exc</i> _{<i>t</i>}	0.06	0.01	3.75	0
<i>Exc</i> _{<i>t</i>-1}	0.01	0.01	0.66	0.5
<i>2018dummy</i>	-0.02	0.01	-2.48	0.01
<i>2018depreciation</i> _{<i>t</i>}	0.11	0.04	2.58	0.01
<i>2018depreciation</i> _{<i>t</i>-1}	0.35	0.06	5.62	0
R-squared	0.47	Adjusted R-squared	0.45	
Log likelihood	554.44	F-statistics	22.77	

In August 2018, TL depreciated massively and this depreciation sustained until the end of the same year. Dummy variables are introduced for August, September and October to control the effects of this currency shock on pass-through. Size of the effect of depreciation in specific three months of the year on inflation is 0.46 percent, when 1 percent depreciation occurred in specified dates. Also, effects of depreciation of TL in November 2018 was analyzed. However, depreciation of currency during this month does not affect pass through coefficients much. Also, depreciation in both specified three months of 2018 and depreciation of the TL during 13 years lead to increasing in price level for goods. Effect of depreciation in August, September and October 2018 is higher than the effect of depreciation during 13 years. Total effect of depreciation on inflation is 0.55 percent during the 13 year period.

Another baseline least squares estimation is conducted for services inflation. Table 3.3 gives the results of this estimation.

Table 3.3: Least squares regression coefficients for services' inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>c</i>	0	0	6.52	0
<i>inflation</i> _{<i>t</i>-1}	0.49	0.06	7.22	0.00
<i>Exc</i> _{<i>t</i>}	0.02	0	3.81	0
<i>Exc</i> _{<i>t</i>-1}	-0.01	0	-1.82	0.06
R-squared	0.30	Adjusted R-squared	0.28	
Log likelihood	701.27	F-statistics	21.74	

Findings in table 3.3 show that depreciation of the exchange rate, lagged value of the exchange rate and lagged value of inflation are statistically significant in explaining services inflation.

Table 3.4: Least squares regression coefficients for core inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>c</i>	0	0	6.02	0
<i>inflation</i> _{<i>t</i>-1}	0.30	0.06	4.45	0.00
<i>Exc</i> _{<i>t</i>}	0.04	0.01	3.97	0
<i>Exc</i> _{<i>t</i>-1}	0.05	0.01	4.57	0
R-squared	0.30	Adjusted R-squared	0.28	
Log likelihood	701.27	F-statistics	21.74	

Another pass through analysis is conducted for core inflation and reported in Table 3.4. Percentage change in exchange rate and lagged percentage change of exchange rate and lagged value of inflation are statistically significant. Depreciation of TL leads to increasing core inflation.

Table 3.5: Least squares regression with dummy variables for core inflation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>c</i>	0	0	7.01	0
<i>inflation</i> _{<i>t</i>-1}	0.35	0.06	5.14	0
<i>Exc</i> _{<i>t</i>}	0.01	0	2.06	0.04
<i>Exc</i> _{<i>t</i>-1}	0.02	0	3.19	0
<i>2018dummy</i>	-0.03	0	-5.73	0
<i>2018depreciation</i> _{<i>t</i>}	0.18	0.02	7.5	0
<i>2018depreciation</i> _{<i>t</i>-1}	0.28	0.02	9.55	0
R-squared	0.47	Adjusted R-squared	0.45	
Log likelihood	554.44	F-statistics	22.77	

To capture the effects of the currency depreciation period in 2018 on core inflation level, depreciation period variables are introduced and results are reported in Table 3.5. 2018 depreciation variables are significant and lead to increasing in core inflation rate and total effect is 0.47 percent for 1 percent more depreciation in August 2018 and October 2018 period.

When the results in table 3.2 and table 3.5 are compared, we see that the effects of currency depreciation in 2018 is pretty close for both good price inflation and core inflation.

After the baseline model estimations, equations 3.19 and 3.20 are estimated by Markov Switching Model. Table 3.6 shows nonlinear exchange rate pass through to good price inflation. There are two different regimes for goods' inflation. In regime 1, exchange rate pass through to good inflation is 34 percent. In regime 2 exchange rate pass through to good inflation is 4 percent. Regime 1 is a relatively high pass through regime and regime 2 is a low pass through regime. Also, lagged value of inflation leads to a 1.2 percent increase in current inflation.

Table 3.6: Markov switching regression model estimation coefficients for good price inflation.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
Exc_t	0.11	0.029	3.79	0.00
Exc_{t-1}	0.23	0.034	6.53	0.00
Regime 2				
Exc_t	0.04	0.02	2.20	0.02
Exc_{t-1}	-0.002	0.02	-0.15	0.87
Common				
Inf_{t-1}	0.012	0.07	0.16	0.86
LOG(SIGMA)	-4.98	0.06	-84.5	0.00
c	0.006	0.0008	8.15	0.00
Mean dependent var	0.008	S.D. dependent var		0.007
S.E. of regression	0.007	Sum squared resid		0.008
Durbin-Watson stat	1.85	Log likelihood		682.45
Akaike info criterion	-6.97	Schwarz criterion		-6.7
Hannan-Quinn criter.	-6.89			

Next, regime probabilities and duration of each regime are estimated. Probability of being in high pass through regime is 98 percent. Probability of being in low pass through regime is 99 percent. Probability of switching from high pass through regime to low pass through regime is 1.7 percent. Duration of regimes are calculated by using equation (3.17). Duration of high pass through regime is 50 months. Duration of low pass through regime is 100 months. According to figure 3.1 probabilities of both high pass through regime and low pass through regime are high. Therefore, there is no dominant regime. In mid of August 2018, during the currency shock, a switch to another regime is observed.

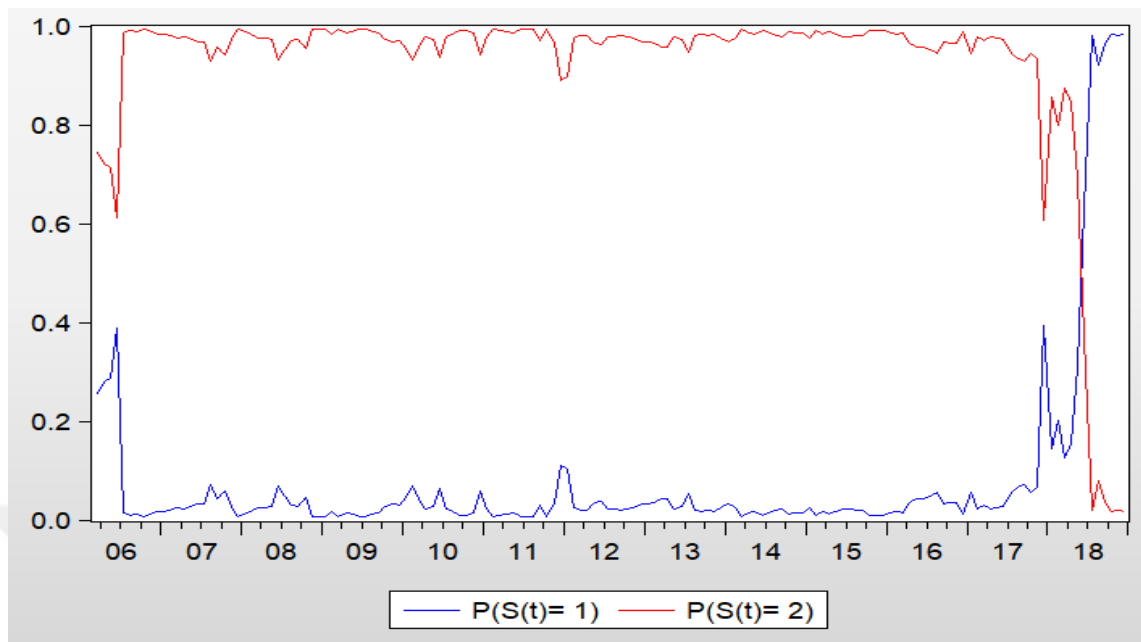


Figure 3.1. Markov switching transition probabilities to another regime for good's sector

Table 3.7 presents the two regimes for exchange rate pass through to inflation in services. According to the table, exchange rate variable and lagged value of services' inflation explain services inflation. In regime 1, exchange rate pass through to services inflation is 0.6 percent. In regime 2, exchange rate pass through to services inflation is 16 percent. Regime 2 is a relatively high pass through regime and regime 1 is a low pass through regime. Lagged value of inflation leads to increasing 44 percent in current inflation.

Next, regime probabilities and the duration of each regime are estimated and presented in Figure 3.2. Probability of being in low pass through regime is 94 percent and probability of being in high pass through regime is 16 percent. The duration of the low pass through regime is 16 months and the duration of the high pass through regime is just 1 month. Both the duration of low pass through regime and the probability of being in this regime are higher than the high pass through regime. Hence, low pass through regime is persistent during 13 years. Figure 3.2 shows that until mid-2018 the low pass through regime is persistent. However, there is a switch to another regime in mid of 2018.

Table 3.7. Markov switching regression model estimation coefficients for service price inflation

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
Exc_t	0.006	0.004	1.64	0.09
$\log(\sigma_t)$	-6.29	0.07	89.29	0.00
Regime 2				
Exc_t	-0.16	0.040	3.87	0.00
$\log(\sigma_t)$	-5.40	0.26	-20.385	0.00
Common				
Inf_{t-1}	0.44	0.05	8.30	0.00
c	0.003	0.0004	9.01	0.00
Mean dependent var	0.006	S.D. dependent var	0.003	
S.E. of regression	0.002	Sum squared resid	0.001	
Durbin-Watson stat	2.13	Log likelihood	738.31	
Akaike info criterion	-9.30	Schwarz criterion	-9.14	
Hannan-Quinn criter.	-9.24			

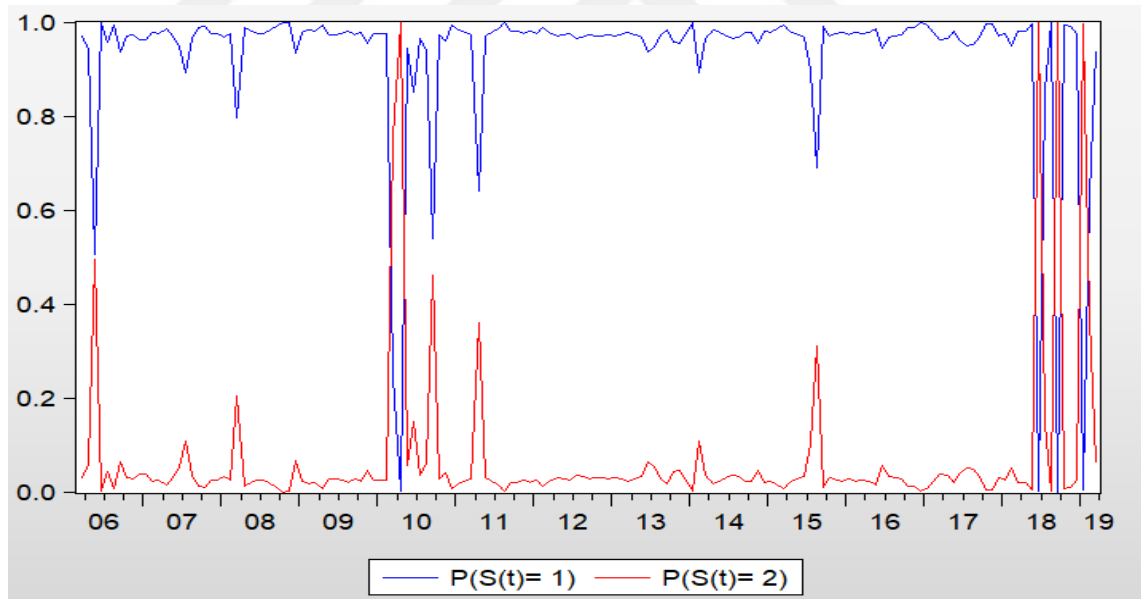


Figure 3.2. Markov switching transition probabilities to another regime for service's sector

Finally, exchange rate pass through coefficients are estimated for core inflation to capture the changes in the prices of goods that do not respond to the currency shocks immediately. Results are reported in Table 3.8. There are two regimes for exchange rate pass through to core inflation. In regime 1, exchange rate pass through to core inflation is 19 percent. In regime 2, exchange rate pass through to core inflation is 1 percent. Regime 1 is a relatively high pass through regime and regime 2 is a low pass through regime. The lagged value of core inflation leads to 61 percent increasing in current core inflation.

Regime probabilities and duration of each regime are estimated for pass through to core inflation in Figure 3.3. Probability of being in high pass through regime is 84 percent. Probability of being in low pass through regime is 99 percent. Probability of switching from the high pass through regime to the low pass through regime is 15 percent and the probability of switching from low pass through regime to the high pass through regime is 75 percent. The duration of the high pass through regime is 6 months and the duration of low pass through regime is 1 month. Low pass through regime is persistent and it is the dominant regime during 13 years. According to Figure 3.2 low pass through regime switch another regime in 2018.

Table 3.8: Markov switching regression model estimation coefficients for core inflation

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
<i>Exc_t</i>	0.19	0.06	3.08	0.00
<i>log(sigma)</i>	-4.14	0.25	-16.10	0.00
Regime 2				
<i>Exc_t</i>	0.01	0.006	1.65	0.09
<i>log(sigma)</i>	-5.99	0.06	-87.04	0.00
Common				
<i>Inf_{t-1}</i>	0.61	0.06	9.68	0.00
<i>c</i>	0.002	0.0004	5.26	0.00
Mean dependent var	0.006	S.D. dependent var		0.006
S.E. of regression	0.004	Sum squared resid		0.003
Durbin-Watson stat	2.66	Log likelihood		693.33
Akaike info criterion	-8.73	Schwarz criterion		-8.57
Hannan-Quinn criter.	-8.66			

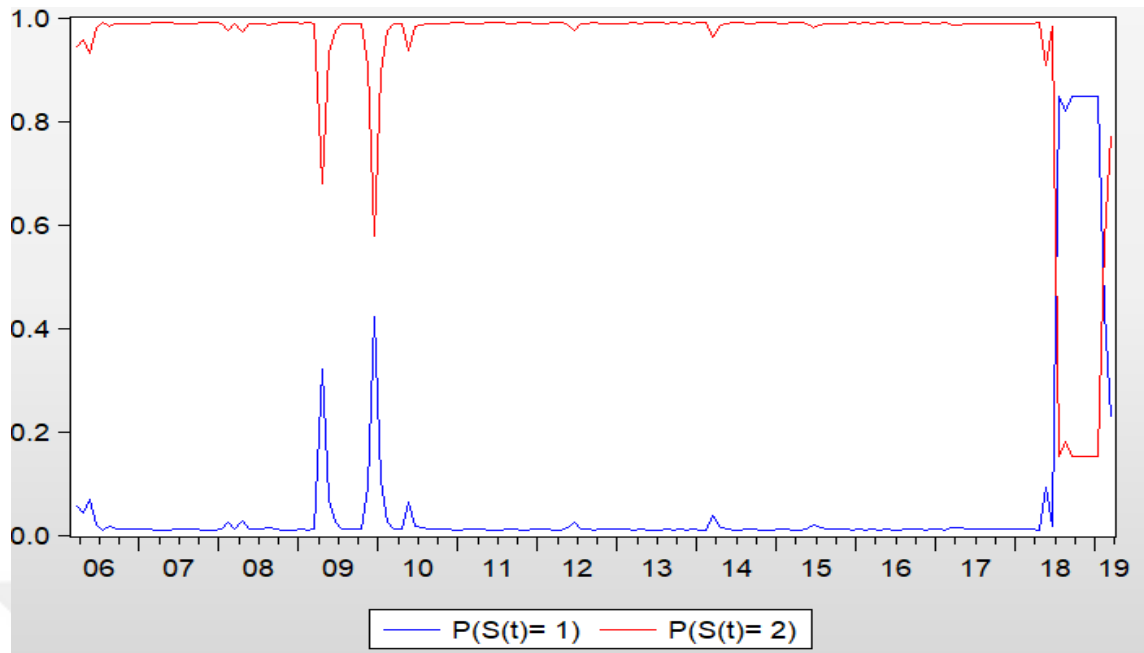


Figure 3.3. Markov switching transition probabilities to another regime for core inflation

All in all, the empirical results presented in this chapter show that after the implementation of explicit inflation targeting, the low pass through regime is persistent until 2018. For all three inflation rates there is a switch to another regime in mid-2018. Exchange rate pass through to goods inflation is highest among other pass through coefficients. These findings show that because of the high import dependency of the production of final goods, changes in currency prices are directly transmitted to costs and final prices of goods. Exchange rate pass through to inflation in the services sector is lower than the pass through to inflation in goods sector. As the services industries may be less import-dependent and since wages are the primary cost in this sector, it is possible that the changes in the currency prices are not reflected to prices immediately.

CHAPTER 4

CONCLUSION

In this study, exchange rate pass through to different inflation levels in Turkey was analyzed. Pass through coefficients identified by using monthly data of Turkey between January 2006 and March 2019. Three different inflation dynamics are examined by building a State Switching model. Pass through to inflation in goods sector, services sector, and pass through to core inflation are estimated. First, pass through coefficients for good's inflation are estimated. Findings show that a state Markov switching model is appropriate for detecting pass through to goods' inflation in the last 13 years in Turkey. Adding one more stage into model blurs the equation system. Number of regimes were determined by looking at the log likelihood test results. In this two state model, one of the states is called as high pass through regime and the other regime is called as low pass through regime because of their coefficients. For the goods sector, probabilities of both the low pass through regime and the high pass through regime are high. There is switch to another regime in mid-2018.

Second, pass through coefficients for services' inflation are estimated. Similar to the goods' inflation regime, two state Markov Switching model is appropriate for observing the pattern of services' inflation. There are two pass through regime for services sector: high pass through regime and low pass through regime. The duration and the duration probabilities of the dominant state, which is the low pass through regime, are quite high..

Third, pass through coefficients for core inflation are estimated. There are two regimes for pass through to core inflation as well. During the high pass through regime, exchange rate pass through to core inflation is 19 percent and in the low pass through regime it is 1 percent. Regime probabilities show that the low pass through regime is persistent and the dominant regime lasts 13 years. However, this low pass through regime turns into a high pass through regime in mid of 2018.

When we compare these three estimations, we see that during the last 13 years, changes in exchange rates are mostly reflected in good prices. Exchange rate pass through coefficient is the highest for goods.

The findings show that there is switch to another regime in mid-2018. Depreciation in nominal exchange rate in August 2018 and quite high increases in the inflation rate at the same period are consistent with the finding of this study.

There could be two reasons for the switch to another regime in 2018. First one is the pricing behavior of exporting and importing firms. In some periods, firms have a tendency to reflect changes in their cost which is outcome of currency volatilities to prices and it leads to upward pressure on prices. In some periods firms might be more reluctant to reflect the changes in their costs to price level. Second, the low pass through regime can be understood in conjunction with the macroeconomic policies implemented after the 2001 crisis. These policies and the favorable international environment led to a decline in the inflation rate and increased capital inflows created exchange rate appreciation. After 2004, improvements in the relations with the European Union contributed to increased confidence levels. The quantitative easing policies after the 2008 Global Financial Crisis led to further increases in capital inflows leading to real appreciation of the TL. However, this has led to increased use of imported intermediate products, which in turn prepared the ground for higher pass through effects in 2018.

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