AN ANALYSIS OF THE IMPACT OF THE EXCHANGE RATE PASS-THROUGH (ERPT) TO CONSTRUCTION COST INDEX AND HOUSING UNIT PRICES IN TURKEY

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ABSTRACT

AN ANALYSIS OF THE IMPACT OF THE EXCHANGE RATE PASS-THROUGH (ERPT) TO CONSTRUCTION COST INDEX AND HOUSING UNIT PRICES IN TURKEY

After the high-speed globalization attack, the interrelations between countries have increased significantly, and local economies have become vulnerable to global economic developments. Despite the successful monetary policies in the 2000s, the Turkish Lira has severely depreciated against foreign currencies in the last decade. Thus, the exchange rate pass-through (ERPT) to domestic prices and its relationship with other macroeconomic variables has become a hot topic for governments and scholars in the literature. However, this pass-through effect on the Turkish Construction Industry and the Housing Market is minimal, although they play a pivotal role in the Turkish economy. With Vector Autoregression (VAR) models analyzing the collected monthly data between 2010 and 2020, this study reveals (1) the ERPT to housing unit prices in Turkey (hup1) and Istanbul (hup2), (2) the change in this pass-through effect during economic stabilization, and fluctuation in the Turkish economy. Moreover, this thesis uncovers (3) the ERPT to Construction Cost Index (cci1) and its material component (cci2) between 2015 and 2020. As a result of Variance Decomposition (VD) and Impulse Response Function (IRF), the housing mortgage rate's (hmr) effect on hup2 is much more significant than its effect on hup1 in the first two years. However, there is no significant difference between the nominal exchange rate's (exr) effects on these prices in the same period. Besides, the effects of hmr and exr diminished during economic stabilization. Moreover, the ERPT to cci1 is greater than the ERPT to cci2 at the end of the first year.

ÖZET

DÖVİZ KURU GEÇİŞKENLİĞİNİN (DKG) TÜRKİYE'DEKİ İNŞAAT MALİYET ENDEKSİ VE KONUT BİRİM FİYATLARINA ETKİSİNİN İNCELENMESİ

Hızlı gelişen globalleşme atakları sonrasında, ülkeler arasındaki ticari ilişkilerin arttığı ve yerel ekonomilerin dünyadaki gelişmelere açık hale geldiği gözlenmiştir. 2000'li yıllardaki başarılı ekonomi politikalarına rağmen, Türk lirası son on yılda yabancı para birimleri karşısında ciddi bir şekilde değer kaybetmiştir. Bunun sonucunda, döviz kurunun yerel fiyatlara geçişkenliği ve onun diğer makroekonomik göstergelerle olan ilişkisi hem araştırmacılar hem de politika belirleyiciler için önemli bir konu haline gelmiştir. Fakat, Türkiye ekonomisinde çok önemli rol oynamalarına rağmen; döviz kurunun konut birim fiyatlarına ve inşaat yapım maliyetlerine geçişkenliğini inceleyen araştırmalar oldukça sınırlıdır. 2010 ve 2020 arasındaki aylık verileri Vektör Otoregresyon modelleri ile analiz eden bu çalışma; (1) döviz kurunun Türkiye (tkbf) ve İstanbul (ikbf) konut birim fiyatlarına geçişkenliğini, (2) bu etkilerin Türkiye'deki ekonomik istikrar ve dalgalanma dönemlerinde nasıl değiştiğini ortaya koyar. Ayrıca, bu çalışma döviz kuru geçişkenliğinin inşaat yapım maliyet endeksine ve onun materyal bileşilene olan etkisini 2015 ve 2020 yılları için araştırır. Varyans Ayrıştırma ve Etki Tepki Fonksiyonu analizlerine göre, konut kredilerinin ikbf üzerindeki iki yıl sürelik etkisi tkbf üzerindeki etkisine göre daha yüksektir. Ne var ki, nominal döviz kurunun bu iki fiyat üzerindeki etkisi arasında aynı dönem için önemli bir farklılık gözlenmez. Öte yandan hem döviz kurunun hem de konut kredilerinin bu fiyatlar üzerindeki etkisi ekonomik istikrar döneminde bir düşüş gösterir. Ayrıca, birinci yılın sonunda, döviz kurunun inşaat yapım maliyet endeksine geçişkenliği onun materyal bileşenine olan geçişkenliğine oranla daha yüksektir.

To my family

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LIST OF ABBREVIATIONS

ADF : Augmented Dickey-Fuller
AIC : Akaike information criterion
CBRT : The Central Bank of The Republic of Turkey
CCI : Construction Cost Index
CI : Construction Industry
CPI : Consumer Price Index
EMR : Employment Rate
ERPT : Exchange Rate Pass-Through
EXR : Exchange Rate
FPE : Final Prediction Error
HM : Housing Market
HQ : Hannan-Quinn information criterion
HMR : Housing Mortgage Rate
HUP : Housing Unit Prices
IMP : Import Unit Value Index
IRF : Impulse-Response Functions
LR : Sequential modified LR test statistic
PPI : Producer Price Index
SC : Schwarz information criterion
TL : Turkish Lira
VAR : Vector Autoregression
VD : Variance Decomposition
VEC : Vector Error Correction

CHAPTER 1

INTRODUCTION

"The time to buy is when there's blood in the streets."

Baron Rothschild

1.1. Introduction

Determining the size and duration of the exchange rate pass-through (ERPT) has always been a concern of academicians and policymakers to assess any economic performance and determine monetary policy accordingly. ERPT measures the percentage change in the domestic prices caused by any shock in foreign currency between two trading countries (Goldberg and Knetter 1997). However, the size and duration of this pass-through effect change according to the economic development level, and developing economies are much more vulnerable to these shocks according to the developed ones with low inflation (Taylor 2000).

The exchange rate's trend is an important indicator to assess an economy's performance, especially in developing countries (Kandil, Berument, and Dincer 2007). Turkey adopted an inflation targeting strategy to cope with severe exchange rate fluctuations and their effect on domestic prices for a long time. Thus, the literature that seeks to determine whether Turkey's monetary policies were successful in economic stabilization emerged mainly in the last two decades. In addition to searching the ERPT to domestic prices in Turkey, these studies also investigate the effects of macroeconomic variables on the Turkish economy.

After the 2008 crash in the U.S., the housing market (HM) became a hot topic again. Although the crisis originated from the HM, it extensively affected the country's economy, and the severe effects of it impacted the world and brought about a global economic crisis. Thus, identifying the linkage between the HM and macroeconomic aggregates became an important issue for politicians and scholars to avoid a similar spillover effect.

Additionally, Turkey is a country that the Construction Industry (CI) plays a vital role in its economy and the Turkish HM significantly affects the Turkish economy as a part of the CI. Three significant reasons make the HM important for the Turkish economy. To begin with, buying residential property has already become an investment tool in the country since Turkish people were searching for new investment channels for an extended period. Turkish people aim to protect their savings against high inflation and the Turkish Lira's depreciation (Akat and Yazgan 2019, Gül and Ekinci 2006). Moreover, this investment is also charming since the housing unit prices (HUP) generally increase in Turkey for a long time, and investment options are limited. Hence, residential property investment is widespread among Turkish people for a long time. Moreover, the effect of the CI and HM on the Turkish economy is enormous since the governments use these industries to boost the economy. Finally, the Turkish governments took a series of steps to encourage Turkish and foreign people to invest in the Turkish HM with their published laws in the last two decades.

1.2. Problem Statement

In addition to the HM investment, investing in foreign currency has also become very popular for people to avoid losing money because of currency depreciation in Turkey, and the demand for foreign currencies has also increased. Furthermore, the law that lets foreign people buy property in Turkey created dynamism in the Turkish HM and re-drawn attention to the exchange rate in Turkey since there is a strong relationship between these two investment tools. Although Turkey had diminished the inflationist environment until 2008 and had a relatively economic stabilization, the Central Bank of the Republic of Turkey (CBRT) experienced high bank loan flotations to cope with the intense shocks in the exchange rate last ten years. Hence, these flotations inevitably influenced the HM since purchasing a house with a bank loan is very common among Turkish people with low purchasing power. Therefore, exploring the interrelations between the exchange rate, the Turkish economy, CI and the HM is crucial for scholars and policymakers, and investors in Turkey.

In addition to ERPT to consumer prices, import and export prices pass-through have been widely discussed in the literature. However, the studies exploring exchange rate pass-through to the HUP and Construction Cost Index (CCI) and their relationships between macroeconomic variables of Turkey are very limited. This thesis tries to fill this gap.

1.3. The Objectives of the Study

Using Vector Autoregression (VAR), Vector Error Correction (VEC), Variance Decomposition (VD), and Impulse-Response Functions (IRF) models, this thesis aim to fill the following gaps in the literature:

For the period of January 2010 and December 2020,

- Is there any long-run relationship between the housing price index for Turkey and the following four macroeconomic variables: the nominal exchange rate, housing mortgage rate, import unit value index, and employment rate?
- Moreover, is there a long-run relationship between the consumer price index in Turkey and the same four macroeconomic variables?
- What is the size and duration of ERPT to the housing unit prices in Turkey, and the comparison of this effect with the housing mortgage rate?
- Are these pass-through effects different in Istanbul's case as the most crowded city in Turkey with a residential oversupply?
- How are the housing unit prices for Turkey and Istanbul affected by the nominal exchange rate and the housing mortgage rate while Turkey's economic stabilization and fluctuation period?

For the period of January 2015 and December 2020,

- Are there any differences between the ERPT to producer price index (PPI) and construction cost index in Turkey?
- Is this pass-through effect different for the construction cost index's material component?

CHAPTER 2

THE THEORY AND LITERATURE SURVEY

2.1. Theoretical Background

As a result of globalization, economic relations between countries increased, encouraging central banks to determine their monetary policies accordingly (Ergin 2015). In developed counties, exchange rate volatility and ERPT are lower, and their central banks can determine monetary policies without being affected by those. However, exchange rate volatility and ERPT are much higher in developing countries, and thus, their central banks need to consider movements of the exchange rate while determining monetary policies (Hakura and Choudhri 2001). Hence, determining the size and duration of ERPT in developing countries has become a crucial topic for central banks to take necessary precautions to minimize the adverse effects of an increase in the exchange rate, resulting in a decrease in the purchasing power by affecting consumer prices (Akdemir and Özçelik 2018).

According to the literature, the exchange rate generally affects consumer prices in an open economy in three ways (McFarlane 2002). First, any increase or decrease in the exchange rate directly reflects imported intermediate and final goods' prices to some extent, and this reflection is named direct channel of ERPT to consumer prices. Second, price fluctuations in imported goods bring about a change in the demand for these goods and their equivalents. When there is an increase in the exchange rate, the local currency depreciates. Thus, the exact product becomes cheaper for the foreign investors after this depreciation, and the demand for it increases. As a result, its price rises, which is called the indirect channel of ERPT to consumer prices (Hyder and Shah 2005). Finally, expected inflation plays a vital role in the ERPT to consumer prices. If the public considers the changes in the exchange rate is permanent, they adjust their prices accordingly, and thus the size of ERPT increases (Taylor 2000).

The literature states that the ERPT coefficient varies between 0 and 1, named as incomplete or complete pass-through according to this number. If changes in the exchange rate are fully reflected in consumer or domestic prices, ERPT is complete, and its coefficient is 1; otherwise, it is an incomplete pass-through (Gaulier, Lahrèche-Révil, and Méjean 2008). Despite those three different EPRT channels, in real life, shocks in the exchange rate do not fully reflect consumer prices because of critical factors hindering the complete pass-through (Yüncüler 2009). First, the size of the ERPT is much higher in emerging economies than in developed ones; however, it is not a complete pass-through even in these emerging economies (Korkmaz and Bayır 2015). Second, a company might choose not to entirely reflect exchange rate shocks to its prices to maintain its products' existing demand due to market segmentation (Türkcan 2005). Furthermore, the inflation level of a country also has a stimulating effect on the incomplete pass-through, as mentioned above. The other foundations of incomplete pass-through might be listed as the country's economic power, monetary policy, inflation targeting strategy, and trade openness (Aron, Macdonald, and Muellbauer 2014).

2.2. General Literature Review

Although a vast body of literature has emerged after the 90s, their results differ significantly since the examined economy, period, and parameters are different (Açcı 2016). McCarthy (1999) examines ERPT to domestic prices in nine industrialized countries with quarterly data between 1976 and 1998. Using Var models, he also analyses the relationship between increasing globalization and pass-through. He states that the reason lying behind the disinflation in these developed economies was the effective monetary policies of the central banks in the 90s.

Campa and Goldberg (2005) examine EPRT to import prices in 23 OECD countries between 1975 and 2003 to investigate whether it is similar in these countries. They find that the unweighted average ERPT to import prices is around 46% in the short run and about 64% in the long run across these OECD countries. Specifically, this number decreases to 25% in the short run and %40 in the long run in the United States, with the lowest ERPT. However, Germany experiences the highest ERPT among those with the number of %60 and %80 respectively. The authors also find that ERPT is lower in the countries with financial stability.

Towbin and Weber (2013) investigate whether flexible exchange rate regimes outperform fixed ones while external shocks threaten the economy, which is the question dominating the literature for a long time. Using Interacted Panel Vector Autoregression, they analyze around 100 countries between 1974 and 2007 to determine which features of the countries play a role while reacting to external shocks. They state that a flexible exchange rate regime performs better when a low level of foreign debt and a high import share of raw materials simultaneously.

To determine ERPT to aggregate price indexes, An and Wang (2011) employ a VAR model with sign restriction in 9 OECD countries between 1980 and 2007 and find an incomplete pass-through for import, producer, and consumer index in almost every country. The results state that ERPT to import price index is higher than ERPT to producer and consumer price indexes both in the short and long run. Another finding is that ERPT is higher if the country has a small, open, and unstable economy.

Jiang and Kim (2013) examine to what extend the exchange rate affects domestic prices in China from 1999 to 2009. Using a structural VAR model, the authors state that there is incomplete pass-through to producer and retail price indexes; however, the producer price index is affected by the fluctuations in the exchange rate more than the retail price index is. They also underline that the effective domestic monetary policy keeps the exchange rate at the same level and helps to maintain low inflation in the country.

Shioji (2015) uses a series of VAR models to determine ERPT to consumer prices in Japan between 1975 and 2012 and finds that it has increased recently in that period. He stresses that people in Japan have experienced a price increase in the products household frequently buy, originating from the rise in the ERPT. However, he says, this increasing exchange rate pass-through could help achieve targeted inflation of the country by increasing the expected inflation of the public.

Shambaugh (2008) employs a long-run VAR model to determine how price indexes and exchange rates react to different shocks in 16 countries between 1973 and 1999 and identify which shocks are more effective in price and exchange rate volatility. He emphasizes that pass-through covariance varies considerably in different countries; however, it is relatively similar in developing economies. Besides, he states that supply, demand, and nominal shocks pass through to import price and exchange rate are almost complete.

Josifidis, Allegret, and Pucar (2009) use Vector Autoregression and Vector Error Correction models to shed light on how ERPT channels perform in different monetary policies and exchange rate regimes in Poland, Czech Republic, Slovakia, and Serbia from 1990 and 2009. The authors state that Poland has performed well while switching its monetary policies and gained a successful transmission. In contrast, the Czech Republic has shown low performance compared to the other three and experienced severe depreciation.

Focusing on the period between 1990 and 2002 in the euro area, Faruqee (2006) employs VAR analysis to identify how prices respond to shocks in the exchange rate. He emphasizes that ERPT to prices in the euro area is very low in the short term; however, there is an increasing trend in the pass-through in the area. He determines that pass-through to import prices is almost complete.

Shintani, Terada-Hagiwara, and Yabu (2013) explore the ERPT to domestic prices in the U.S. by using a smooth transition autoregressive (STAR) model between 1975 and 2007. The authors find that it is considerably low when its economy experienced low inflation in the 80s and 90s.

Vo et al. (2018) use a structural vector autoregressive model to identify the relationship between ERPT and domestic prices for different periods in five Asian countries. According to the results, the ERPT covariance is less than 1, and it is reflected less to consumer price index according to producer prices, and the producer price index reacts quickly to the exchange rate fluctuations in the short term. Furthermore, they state a weak relationship between interest rates and domestic prices; however, exchange rate, oil prices, and output gaps effectively explain inflation in these five countries.

Jammazi, Lahiani, and Nguyen (2015) investigate the relationship between the U.S. dollar exchange rate and crude oil prices in 18 countries between 1990 and 2012. The authors employ a wavelet and nonlinear ARDL model to determine how crude oil prices react to changes in the exchange rate in the short and long term since they state that this model performs better in this determination process. They also state that crude oil prices are susceptible to U.S. dollar depreciation originating from U.S. dollar usage as a common currency in this trade. Although they find asymmetric pass-through to crude oil prices in both the short and long run, it is relatively higher while depreciating the exchange rate.

Brun-Aguerre, Fuertes, and Greenwood-Nimmo (2016) use a nonlinear autoregressive distributed lag model to look to ERPT to import prices in more than 30 countries between 1980 and 2010 while exchange rate fluctuations. They suggest that ERPT to import prices becomes higher in the long run while decreasing the exchange rate, and this is similar for developed and developing economies. The authors also state that the pass-through effect is more potent if the exporters are influential in the market.

Amiti, Itskhoki, and Konings (2014) shed light on the reasons for incomplete pass-through and why ERPT to import and export prices vary between firms in the Belgian market from 2000 to 2008. They find that a company has the ability to offset the shocks in the exchange rate and lower the ERPT to their prices if it imports intensively and has an essential share in the market. However, ERPT becomes almost complete if it is a relatively small exporter firm.

Khraief et al. (2021) employ a nonlinear ARDL model to investigate how the exchange rate reacts to increases or decreases in oil prices between 1990 and 2019 in China and India as two of the biggest oil importers. The authors state that there is asymmetric pass-through from oil prices to exchange rate in the long run for the Indian case, although the short-term pass-through is asymmetric for both India and China. They also find that increases and decreases in oil prices make the Chinese currency depreciate against the USD dollar.

Frankel, Parsley, and Wei (2011) seek answers to incomplete pass-through for eight products imported to 76 developing countries between 1990 and 2001 with the help of a series of error correction models. According to the results, exchange rate changes are reflected in the prices of imported goods intensively; however, the importers offset some part of this pass-through before the product entering the market. ERPT is incomplete and at a low level even in emerging economies, but it is significantly affected by inflation.

2.3. Exchange Rate Pass-Through in Turkey's Literature

Exchange rate regimes play a pivotal role in achieving successful economic developments as a part of the monetary policies of the countries. After the 1990s, many developing countries abandoned the rigid exchange rate strategy and switched to an inflation targeting strategy. Turkey also followed this trend in 2006 to control the fluctuating domestic prices and achieve price stability (Civcir and Akçağlayan 2010, Ozkan and Erden 2015). As a result of this monetary policy adoption, the country managed to diminish inflation until 2008. However, the country has been facing high inflation and severe exchange rate fluctuation for a long time as an open and developing economy. Therefore, determining the linkage between Turkey's exchange rate and the inflation rate has already become an attractive research area for scholars. However, this determination is also critical for policymakers to assess the performance of their monetary policies. Researchers tried to estimate the size and the duration of exchange rate pass-through to consumer prices in Turkey and came across different results.

Erdem and Yamak (2016) analyze the years of 2003-2014 to determine exchange rate pass-through in Turkey, using an Almon model with the distributed lag approach. They state that the size of Euro and Dollar pass-through to the consumer and producer prices in Turkey are similar. Although EPRT to general prices in Turkey is incomplete in the short run, long-run pass-through is completed in approximately 18 months.

Akdemir and Özçelik (2018) employ a structural VAR model to assess the size and duration of the pass-through in Turkey. The authors state that EPRT to consumer prices is incomplete between the years of 2003 and 2017. According to Cpi's variance decomposition, EPRT to Cpi reaches 10% at the end of the second year.

Ergin (2015) investigates EPRT to the consumer prices in Turkey between 2005 and 2014 by using VAR model. She claimed that Turkey's consumer prices are robustly affected by the exchange rate in the short run; however, this impact tapers off in the long run.

Kara and Öğünç (2012) employ numerous VAR models to analyze ERPT to core consumer prices in Turkey between 2002 and 2011. The authors declare that the exchange rate (50% Euro + 50% Dollar) pass-through to Cpi is around 15% at the end of the first year. They also state that this pass-through impact weakened in time.

Dedeoglu and Kaya (2015) employ a series of VAR models to analyze the pass-through effect in Turkey between 2003 and 2013. According to Bayesian model averaging, they estimate that ERPT to consumer prices in Turkey is around 7.5%. However, they state that EPRT to producer prices in Turkey is 26.7% according to the same method.

Yücel and Akkoç (2017) using Markov regime-switching model, analyze the period between 2002 and 2017 to determine EPRT to consumer prices in Turkey. Although Turkey's pass-through effect differs significantly in the economic stabilization period and economic instability period, it is incomplete for both periods. Even though ERPT to consumer prices is 3% in economic stabilization time, it reaches 21% in the economic instability period in Turkey.

Toraganli (2010) argues how the changes in the exchange rate affect Turkish export prices, and the profit margins of the firms vary according to this pass-through effect at the firm and broader level between 1995 and 2007. The author shows that ERPT to export prices for the manufacturing industry is about 0.6 in the short run. She also states that Turkish exporters can offset the fluctuations in the exchange rate to some extent since they are powerful enough in the market.

Bozdağlıoğlu and Yılmaz (2017) employ a VAR model to investigate how the exchange rate and inflation react to shocks in each other between 1994 and 2014 in Turkey. As a result, the increases in exchange rates reflect domestic prices in Turkey, and this pass-through effect is on the upward trend for a half year and after starts to decrease. Over 7% of the changes in the inflation rate in Turkey originate from the shocks in the exchange rate; however, the exchange rate is not affected by inflation rate changes in Turkey.

Erdoğan and Yıldırım (2008) study the relationship between exchange rate, overnight rate, producer price index, and gross national product in Turkey, using a VAR model for the period of 1995 and 2006. The authors state that the changes in the overnight rate affect the exchange rate, gross national product, and inflation in Turkey tremendously since it is an essential factor in developing economies like Turkey.

Korkmaz and Bayır (2015) investigate the relationship between exchange rate and domestic prices in Turkey from 2008 to 2014. Using Var model, the authors uncover a causal relationship from exchange rate to producer prices in Turkey and consumer prices Granger causes exchange rate in Turkey in the long term.

Sen Dogan (2013) explores whether manufacturing prices perform asymmetric behavior against shocks originating from exchange rate fluctuations in Turkey. Concentrating on the monthly data between 2001 and 2011, she aims to determine if this pass-through is affected by the amount and volatility of exchange rate change, inflation expectation, and demand. According to threshold regression models, the author shows that ERPT to inflation in Turkey is higher while the economy is growing than the time it depresses. However, she says there is no evidence of asymmetric pass-through for the other factors.

Kara et al. (2005) explore exchange rate pass-through to check whether it is asymmetric under different exchange rate regimes in Turkey and whether it changes for the sub-sectors. They state that ERPT to domestic prices in Turkey is lower after 2001 than it was earlier due to decreasing indexation. However, the prices of imported items are affected severely by exchange rate fluctuation in the long term, even under the floating exchange rate regime. Similarly, Civcir and Akçağlayan (2010) employ a VAR model to reveal the relationship between the exchange rate and monetary policies of CBRT under different exchange rate regimes for the years 1987 and 2009. They reveal that the exchange rate still affects inflation in Turkey tremendously for the examined period. The authors find that ERPT to domestic prices while depreciation and appreciation are different from each other.

Gül and Ekinci (2006) seek to demonstrate the relationship between exchange rate and inflation using causality and cointegration tests for monthly data from 1984 and 2003 in Turkey. The authors reveal that there is cointegration between these two factors in the long run. According to the Granger Causality Test, the causality appears only from the exchange rate to inflation in Turkey.

2.4. Exchange Rate, Bank Loans, and Housing Market

The housing market plays a pivotal role in many countries' economies since it is related to many other sectors and subsectors. Primarily after the 2008 real estate market crash in the U.S., the studies investigate the relationship between the HM and monetary policies of the countries has become an important topic. Bjørnland and Jacobsen (2010) employ a series of structural VAR models to determine the linkage between monetary policies and asset prices between 1983 and 2006 in three countries. The authors emphasize that house prices decline up to 5% after a one percent increase in the interest rate originating from monetary policies. Moreover, the interest rate reacts to fluctuation in house prices; however, the size and the duration of this reaction change across these three economies.

Likewise, Elbourne (2008) investigates the reaction of house prices and sales in the U.K. to interest rate shocks as a monetary policy channel from 1987 to 2003. The author uses a structural VAR model to analyze the housing market and finds that house prices in the U.K. respond to the shocks in the interest rate and these price changes create a decline in house sales up to 15%.

Baffoe-Bonnie (1998) investigate whether the monetary policy transmission mechanism operates through the housing market in the U.S. between 1973 and 1994 with a VAR model. The author states that house prices and sales are affected strongly by the macroeconomic variables at the country level; however, this reaction generally changes across the regions.

Rosanovich and Di Giovambattista (2020) explore the size and the speed of ERPT to the rental housing market in Buenos Aires between 2017 and 2019. Using a two-step panel regression model, they estimate the ERPT to rental prices is around %30. Although it is incomplete in the long run, this effect is relatively quick. However, this increase does not reflect workers' wages as rapidly as it does at rental prices.

Vansteenkiste and Hiebert (2011) use a global VAR model to determine whether there is a general trend in the house prices of seven euro-area countries between 1971 and 2009 using different variables related to the housing market. Although there is an existing small spillover effect in the examined countries, the reactions of the countries to the changes in these variables are very asymmetric. However, the pattern of these reactions is relatively similar in the long term, hitting the peak point in one year.

Del Negro and Otrok (2007) investigate whether house price increases in the U.S. originates from national monetary policies or they are local bubbles for the period between 1986 and 2005. They state that local factors are responsible for the changes in the house prices in the examined period, although local bubbles in some regions affect the house prices between 2001 and 2005. However, compared to the rises in house prices, the effect of monetary policies is relatively small.

Ambrose, Eichholtz, and Lindenthal (2012) seek to determine the behavior of housing market prices in Amsterdam, examining more than 350 years of data. As a result, house prices and rents are correlated in the long run, and there are probably some variables affecting both simultaneously.

Vizek and Posedel (2009) investigate the components behind the increase in house prices in six different European economies from 1996 to 2007, using a series of different regression models. As a result of regression and VAR models, the housing market in the examined countries is affected significantly by GDP, interest rate, and price persistence. Moreover, house price persistence plays a pivotal role in price fluctuation in most of these countries. In addition, the developing economies among these six countries are much more fragile against shocks than developed ones.

Charles (2016) investigates the relationship between monetary policies and the housing market in eight OECD economies between 2007 and 2014 with VAR models. The author claims that the housing market reactions to monetary policy shocks are similar in all examined countries, but the duration changes across them. Moreover, these shocks impact residential supply and mortgage markets in a quite similar way in eight of them.

Examining 2008 and 2014 with a VAR model, Zheng and Yan (2017) seek to demonstrate which factors resulting from monetary policies are responsible for the house price changes in China and identify the linkages between them. As a result, the fixed capital investment has the most significant impact on house prices in the Chinese real estate market. Moreover, interest rate and money supply shocks are responsible for house price fluctuations.

Lu (2019) employs a VAR model using panel data series for the years 2005 and 2015 to identify how the real estate market is affected by economic and non-economic shocks in different cities of China. The author states that the market prices considerably respond to the economic changes, although there is no significant linkage between non-economic changes and increasing house prices. In addition, increasing market prices result in a rise in the domestic prices of China for two years.

Analyzing more than 30 developed and emerging economies from 1983 to 2009 with VAR models, Cesa-Bianchi (2013) determines whether the housing market has an impact on the macroeconomy of the countries and whether housing demand shocks have a global spillover effect over examined economies. The authors stress that the U.S. economy reacts to changes in the housing demand rapidly, and these shocks also affect the other economies globally; however, the size of this pass-through effect depends on the development of the economy.

McDonald and Stokes (2013) examine the relationship between the house prices of 20 cities in the U.S. and the Federal Funds Rate for 1987 and 2010. As a result of the Granger Causality method, this rate affects house prices and creates a price bubble in the market. Moreover, the authors state that house prices decline when there is an increase in the Federal Funds Rate for the examined period.

Employing a VAR model, Lastrapes (2002) tests how house prices and sales in the U.S. react to changes in money supply to analyze the housing market between 1963 and 1999. The author states that the housing market experiences an increase in house sales and prices in the short term after a rising money supply.

Tressel and Zhang (2016) employ panel VAR and regressions models to determine the performance of macro-prudential policies in developed euro area economies from 2000 to 2010. The authors state that house prices and household loans are affected by the changes in the cost of bank capital and loan-to-value ratios via the price margin channel.

Pontines (2020) studies the macro-prudential policies of Korea between 2001 and 2016 to check whether these policies and monetary policies have similar effects on various factors like house prices. As a result of structural VAR models with sign restrictions, the real house prices of Korea react significantly to the shocks in the loan-to-value ratio and monetary policies even though the price level is not affected by the changes in the loan-to-value ratio.

Similarly, Kim and Oh (2020) seek to demonstrate the linkage between macro-prudential policies and the real estate market and domestic prices in Korea, using a structural VAR model. As a result, house prices and bank loans react significantly to changes in loan-to-value and debt-to-income in Korea, mainly when the governments apply these two policies simultaneously.

Dinh, Mullineux, and Muriu (2012) investigate whether macroeconomic factors like house prices, unemployment rates, and interest rates in the U.K. affect household loan losses, which are secured and unsecured, employing VAR models. The authors say that secured loans are affected by these factors tremendously, although they do not have an essential effect on unsecured loans in the examined period.

Goodhart and Hofmann (2008) seek to identify the interrelationship between income, inflation, interest rate, credit, and house prices in a series of industrialized economies by using a panel VAR model between 1970 and 2006. The authors stress that macroeconomic shocks originating from income, inflation, and interest rate considerably result in changes in house prices; on the contrary, house price shocks affect economic activity and domestic prices. In addition, house prices are more fragile to money, and credit changes while the increasing house prices.

Examining the years 1990 and 2009 with the Ordinary Least Square model, Rahman, Khanam, and Xu (2012) investigate housing price determinants in Hangzhou, China. As a result, people's income, urbanization of the city, and investments play a pivotal role while determining house prices in the city. However, urbanization has an enormous effect on house price changes, among others.

2.5. Housing Market in Turkey

Exchange rate pass-through to consumer prices and the relationship between inflation and a series of macroeconomic variables in Turkey have been extensively covered in recent years. In addition, how house prices respond to the exchange rate fluctuations and other macroeconomic variable changes is also a hot topic for scholars and governments since there are a series of important reasons to examine the Turkish housing market extensively.

First, buying a house has already been an investment tool in Turkey for a long time. One of the reasons that make houses an investment tool in Turkey is the country's economic environment. Since Turkey has been facing high inflation for a long time, it is an investment tool for the people who would like to protect their savings against inflation (Coskun 2016). Furthermore, investment tools in Turkey until last years were somewhat limited in the country (Tekeli 1982). So, this also made houses a charming investment because of increasing house prices. Moreover, houses are excepted as a sign of wealth; thus, it encourages people to buy property in Turkey as it does in other countries (Ludvigson, Steindel, and Lettau 2002).

Second, the housing market plays a vital role in the Turkish economy. It is known that the Turkish Construction Industry (TCI) is one of the crucial tools that Turkish governments use to boost the Turkish economy since the industry is connected to subsectors and other sectors. As a part of the TCI, the housing market is closely affected by these developments (Akseki, Çatık, and Gok 2014). Moreover, the housing market, together with TCI, contributes to the GDP of Turkey and provides significant employment in the country (Demir and Yıldırım 2017). Besides, the intense relationship with macroeconomic aggregates of Turkey reveals the importance of the housing market to prevent economic crises as in the U.S. economy (Yıldırım and Ivrendi 2018).

Third, Turkish governments have employed some crucial monetary policies to accelerate the Turkish housing market long ago. To begin with, Turkey succeeded in having economic stabilization after effective monetary and inflation regime policies in the 2000s. Thus, money supply and credit capacity increased, which created a trust for people to invest in the housing market. Besides, Turkey put a law to force in 2007 that provided long-run loans to purchase a house. The governments also encouraged public banks in Turkey to provide mortgage loans with low-interest rates. Even though increasing house prices, house demand rose significantly thanks to these developments, and housing estate projects were encouraged by the governments to meet this demand (Kargi 2013). Moreover, foreigners gained the right to buy a property in Turkey thanks to a law published in 2013 (Sumer and ÖZorhon 2020).

Using a series of models, Hepşen and Kalfa (2009) examine the period over 2002 and 2007 to identify how the housing market reacts to macroeconomic shocks in Turkey. The researchers state that there is a Granger causality from economic activities to housing permits. Moreover, the industrial production index has the most significant impact on housing permits in the market. Furthermore, mortgage loans and interest rates are the other essential variables that affect housing permits. Moreover, Akseki, Çatık, and Gok (2014) employ a Markov Regime Switching VAR model to determine how the housing market responds to macroeconomic shocks in Turkey between 1992 and 2012. As a result, these reactions differ significantly according to the monetary policies of Turkey, and they have become more robust in the recent years of the examined period. The authors also state that housing permits are affected by M1 narrow money and the interbank rate changes significantly during the economic stabilization.

Similarly, Yıldırım and Ivrendi (2018) seek to demonstrate the dynamic linkage between macroeconomic aggregates and house prices in Turkey. They employ a series of SVAR models for 2003 and 2016 and find that monetary shocks and Gross Domestic Product (GDP) significantly impact the Turkish housing market. The authors also state that house prices increase against positive mortgage rates, income, and housing demand shocks.

Öztürk and Fitöz (2009) employ OLS and cointegration methods to analyze how supply and demand shock affect the Turkish housing market between 1968 and 2006. The research uncovers a positive relationship between housing demand and housing prices due to high inflation in the Turkish economy. Moreover, a similar relationship appears between mortgage rates and housing demand. Additionally, GDP per capita rises result in an increase in the housing demand. Kargi (2013) employs a series of different models, including regression analysis for the period over 2000 and 2012, to reveal the link between economic developments and the housing market in Turkey. The author emphasizes that growing credit capacity and increasing housing investment in Turkey show no housing bubble exists in the market. Moreover, housing credit shocks result in an increase in the domestic and housing prices in Turkey. In addition, GDP plays a pivotal role in house demand rises by lowering the domestic prices and mortgage rates in Turkey. Deniz Karakoyun and Yildirim (2017) investigate the Turkish housing market to determine whether demand-side factors create a house price bubble in the long term between 2003 and 2015. Using the structural VAR model, the authors find that these factors have an impact on house price rises in the long term. However, it is not likely to assess house prices as a bubble since any short-term relationship between these demand-side variables and increasing house prices does not exist.

Similarly, Coskun et al. (2020) investigate any house price bubble by determining the relationship between house prices and the factors affecting house price increases in the Turkish housing market, using a series of different models for the period over 2007 and 2014. The authors uncover that housing rent and construction cost increases positively affect housing prices, although the mortgage rate has the reverse effect. Moreover, the long-run relationship between housing price and other determinants reveals that there is no bubble; however, the prices are overvalued in the market.

Ewing, Sari, and Aydin (2007) employ a series of VAR models to show how the housing market is affected by macroeconomic variables in Turkey between 1961 and 2000. The authors show that the housing market is significantly affected by macroeconomic shocks and money supply shocks have a more significant effect on the housing market than Turkey's employment rate. Moreover, the size of the interest rate pass-through to the housing market indicates that the credit channel operates in Turkey.

Akkas and Sayilgan (2015) investigate whether house prices in Turkey react to mortgage rate shocks between 2010 and 2015, using the Toda-Yamamoto test. The study uncovers that there is only one casual relationship: from mortgage rates to housing prices in Turkey. They also indicate that the prices of existing and new houses experience a sharp decline with a lag when the mortgage rates increase.

Yıldırım and Ivrendi (2018) employ a structural VAR model to reveal the linkage between macroeconomic variables and the housing market in turkey between 2003 and 2016. The authors state that monetary policies significantly affect the housing market in Turkey. Besides, the housing mortgage rates have the most significant impact on house prices.

Gebeşoğlu (2019) uses Vector Error Correction models to analyze how the house price index is affected by some selected macroeconomic variables in Turkey from 2010 to 2018. The author indicates a long-run relationship between exchange rate, mortgage rate, and the house price index.

Canbay and Mercan (2020) seek to demonstrate how the interest rate and growth impact house prices in Turkey, using VAR models between 2010 and 2019. They state that house prices decline after an increase in these two variables. Furthermore, house price increases have a negative impact on interest rates.

CHAPTER 3

METHODOLOGY

3.1. House Sales in Turkey

Buying a residential property is an important investment tool in Turkey for a long time, and the reasons lying behind this importance have been explained in detail in the previous chapter. Thus, house sales are relatively high in Turkey, although the sales are somewhat affected by the economic environment.

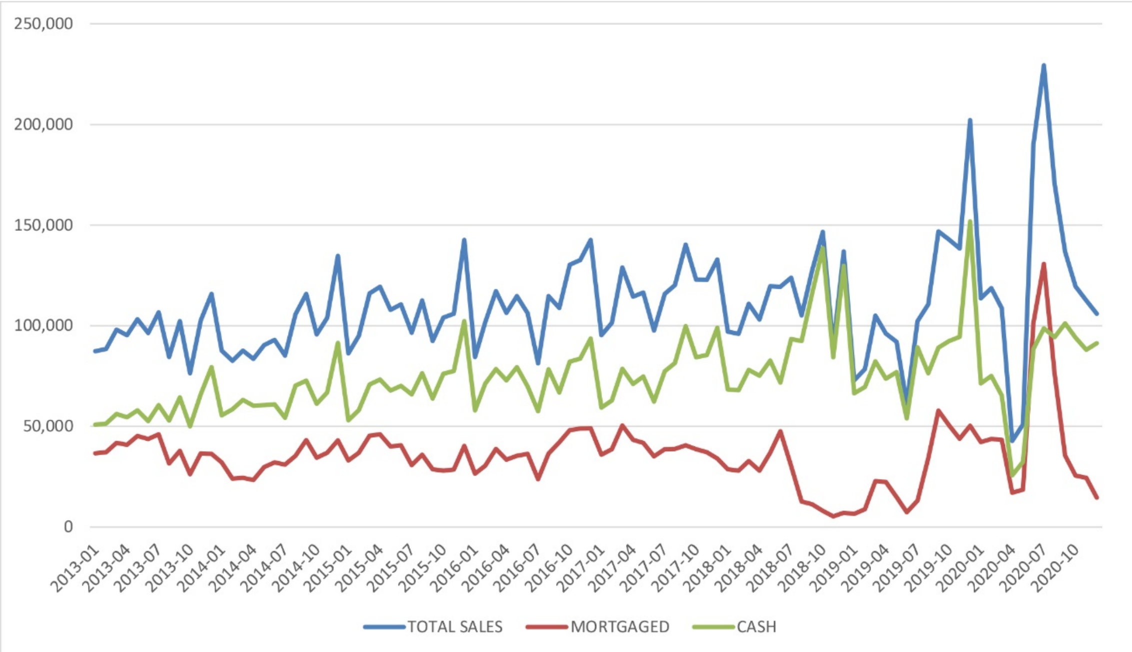

Figure 1. House Sales between 2013 and 2020 in Turkey
(Source: CBRT Electronic Data Delivery System)

Figure 1 shows the house sales in Turkey as total, mortgaged, and cash for the period of January 2013 and December 2020. The highest monthly total sale is almost 230 thousand in July of 2020, although the lowest monthly total sale is around 43 thousand in April in the same year. Moreover, the average monthly sale in the examined period is about 110 thousand. The table clearly indicates that the house sales in cash are much more than the number of sales with a mortgage, and they consist of more than two-thirds of total sales.

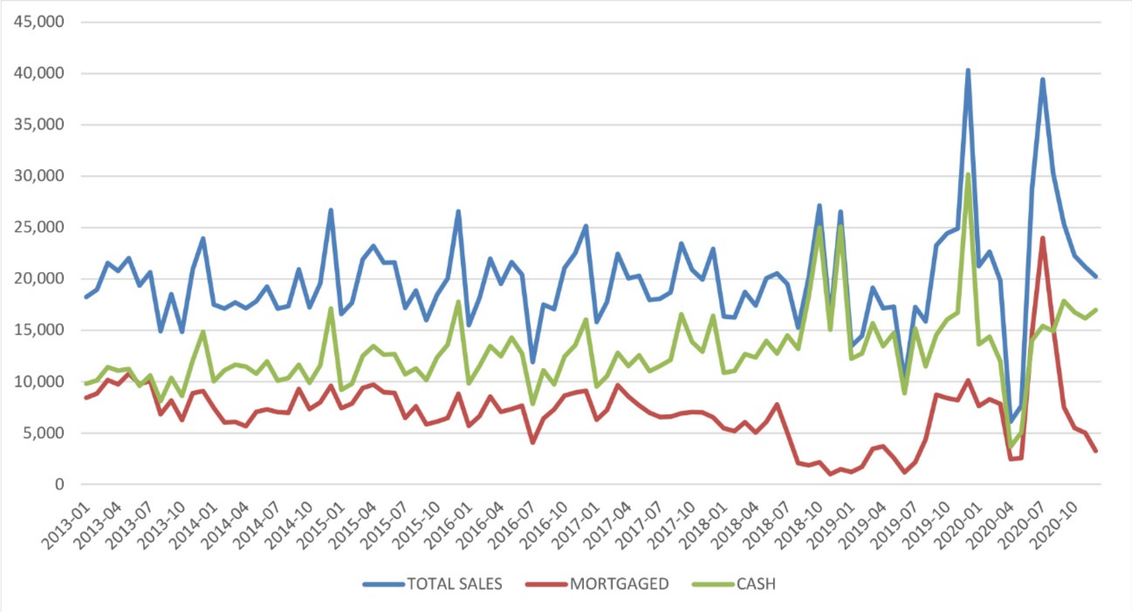

Figure 2. House Sales between 2013 and 2020 in İstanbul
(Source: CBRT Electronic Data Delivery System)

İstanbul is the most crowded city in Turkey, with more than 15 million people. Moreover, the total house sales in İstanbul consist of almost one-five of the total sales of Turkey. Figure 2 indicates the house sales in İstanbul for the same period. The highest monthly total sale is more than 40 thousand in December of 2019, although the lowest monthly total sale is around 6 thousand in April of 2020. Furthermore, almost 20 thousand houses are sold every month in İstanbul. The sales with a mortgage are around 35% of total sales in the city.

In addition to being the most crowded, İstanbul is a city with house oversupply. The city is an attraction center because of its history and geographic location. These encourage the local and foreign people to invest in this city, which results in an uncontrolled city transformation. Thus, the city has a significant housing surplus, although there is no clear evidence about the exact number. All in all, comparing the HUP of İstanbul with Turkey's and determining the similarities and differences become essential research for the Turkish CI, real estate market, and economy.

Moreover, the CI plays a vital role in the overall Turkish economy because of its relations with the subsectors and other sectors. Besides, the CI is an industry that is generally used to boost the economy because of its contribution to the overall economy. However, the CI is highly affected by the country's economic environment because of these strong relationships. Thus, the Construction Cost Index is an important indicator to identify a general situation of the Turkish CI.

3.2. Methodology

Figure 3 shows the procedure followed in this thesis for the models. After collecting data, each time series should be tested using Unit Root Test to identify any trend or seasonality, resulting in misinterpretation. If the previous period impacts the following period in any time series, the series is not stationary at the level, and it has a unit root. On the contrary, the series is stationary and does not have a unit root if that type of impact does not exist. One standard method commonly used to identify whether any time series is stationary or not is the Augmented Dickey-Fuller (ADF) unit root test. The ADF unit root test identifies the ADF t-statistics (t_{adf}) of the series and compares it with the MacKinnon critical values (t_{mk}) to determine if the time series is stationary at the level or not (Dickey and Fuller 1981). The ADF unit root test equations are listed below:

$$\Delta_{y_t} = (\rho - 1)y_{t-1} + \sum_{j=2}^{P} \rho_j \left(\Delta y_{t-j+1}\right) + \varepsilon_t \tag{2.1}$$

$$\Delta_{y_t} = \alpha + (\rho - 1)y_{t-1} + \sum_{j=2}^{P} \rho_j \left(\Delta y_{t-j+1}\right) + \varepsilon_t \tag{2.2}$$

$$\Delta_{y_t} = \alpha + \beta T + (\rho - 1)y_{t-1} + \sum_{j=2}^{P} \rho_j \left(\Delta y_{t-j+1}\right) + \varepsilon_t \tag{2.3}$$

Eq 2.1 shows the ADF unit root test equation without constant and trend. Eq 2.2 represents the same test with constant, and Eq 2.3 represents it with constant and trend. Although α is used for constant, T is used for trend. In this thesis, Eq 2.3, which is the

ADF with constant and trend, is used. The ADF unit root test hypotheses are H_0 and H_1 as follows:

H_0 hypothesis: $\rho - 1 = 0$, the series has a unit root, if $|t_{adf}| < |t_{mk}|$,

H_1 hypothesis: $\rho - 1 \neq 0$, the series does not have a unit root, if $|t_{adf}| > |t_{mk}|$.

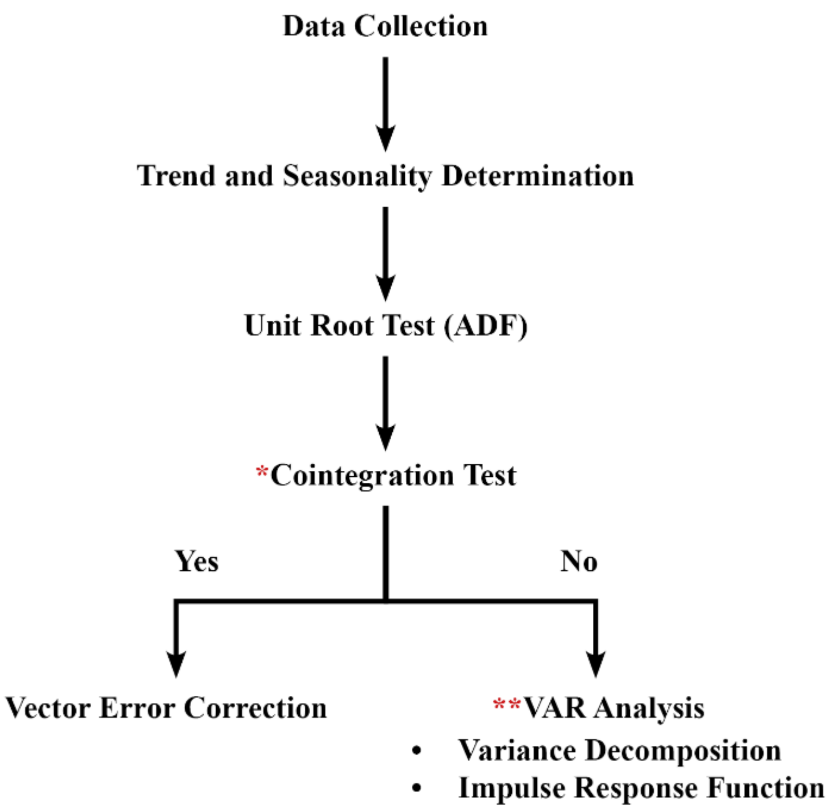

Figure 3. Flowchart

The series is stationary at the level and called I (0), when it does not have a unit root. If the series has a unit root, it is not stationary at the level. In order to make it stationary, the first difference of the series is taken, and test the new t_{adf}. If it does not have a unit root, it is stationary at the first difference, I (1). This process is repeated until the series is stationary. For taking the difference of the series, the value at t-1 time (Y_{t-1}) is subtracted from the value at t time (Y_t) (Nelson and Plosser 1982).

According to the unit root test, if all series are stationary at the first difference I(1), a cointegration test is employed*. If there is one or more cointegration between series, the VEC model is applied. Otherwise, after making each series in the model stationary, a VAR analysis is applied if there is no cointegration. The series is made stationary in VAR analysis by taking the first difference; however, this transformation is not applied in the VEC models**.

Before the cointegration test, the first step is determining the optimal lag order after ADF unit root tests (Ivanov and Kilian 2001). The information criteria used to select the optimal lag order are:

- LR : Sequential modified LR test statistic
- FPE : Final Prediction Error
- AIC : Akaike information criterion
- SC : Schwarz information criterion
- HQ : Hannan-Quinn information criterion

Determining the lag order is necessary to find the time lag when the relationship between variables is optimal and potent. Besides, this selection also shows the relationship without any autocorrelation problem (Ergin 2015). AIC and SC are primarily used to select the optimal lag order. When they suggest different lag orders, the lag order that the others mainly support is selected.

After the lag order selection, the Johansen Cointegration Test (JCT) is used to determine whether there is a long-run relationship between variables (Johansen 1991). Trace Test is one of the components used in JCT to identify a possible cointegration. According to trace test:

H_0 hypothesis: there is no cointegration between variables,

$H_{alternative}$ hypothesis: there is cointegration between variables.

In this thesis, the trace test is used to check for a possible cointegration at the 0.01 level instead of the 0.05 level. Since the models used in this study are related to Construction Industry, a more robust relationship is desired. If the trace test identifies one or more cointegration between variables, the VEC model is employed. The VEC model determines the necessary time for long-run equilibrium and the relationship between variables in the short term (Okyay and Yeşilyurt 2016). These relations are calculated according to the following equations:

$$\Delta y_t = \beta_0 + \sum_{i=0}^{n} \beta_i \, \Delta_{y_{t-i}} + \sum_{i=0}^{n} \delta_i \, \Delta_{x_{t-i}} + \varphi z_{t-1} + \mu \qquad (2.4)$$

$$z_{t-1} = ECT_{t-1} = y_{t-1} - \beta_0 - \beta_1 x_{t-1} \qquad (2.5)$$

$$z_{t-1} = ECT_{t-1} = y_{t-1} - \beta_0 - \beta_1 x1_{t-1} - \beta_2 x2_{t-1} - \cdots - \beta_n xn_{t-1} \qquad (2.6)$$

$$Speed\ of\ Adjustment = \frac{1}{|\varphi|} = \frac{1}{CointEq1} \qquad (2.7)$$

Eq 2.4 shows the long-run relationship between two-time series: y and x, after adding the error correction terms. On the other hand, Eq 2.5 represents the short-run relationship between two variables. However, Eq 2.6 is the expended version of Eq 2.5 with n variables. Moreover, φ is used to calculate the necessary time for long run equilibrium (2.).

According to Figure 3, taking the first difference of a y time series is necessary when there is no cointegration between variables. This process is executed by subtracting the y value at time t-1 from the following value at time t. According to Eq 2.8, the new series is showed as “d1y”.

$$\Delta_y = d1y = y_{(t)} - y_{(t-1)} \qquad (2.8)$$

After differentiating the series, which are stationary at the first difference I(1), a VAR model is constructed, and optimal lag order is selected for this new model. 2.9 and 2.10 show the y1 and y2 series with the relation of itself and the other’s past values for lag 1, respectively. 2. indicates the combination of these two equations in a matrix format for lag 1. ω represents the coefficients in the VAR model. Moreover, α shows the constant and ε shows the error terms. 2. is the extended version of Eq 2.11 for k variables with p lag order.

$$y1_{(t)} = \alpha_1 + \omega_{11} * y1_{(t-1)} + \omega_{12} * y2_{(t-1)} + \varepsilon 1 \qquad (2.9)$$

$$y2_{(t)} = \alpha_2 + \omega_{21} * y1_{(t-1)} + \omega_{22} * y2_{(t-1)} + \varepsilon 2 \qquad (2.10)$$

$$\begin{vmatrix} y1_t \\ y2_t \end{vmatrix} = \begin{vmatrix} \alpha_1 \\ \alpha_2 \end{vmatrix} + \begin{vmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{vmatrix} \begin{vmatrix} y1_{(t-1)} \\ y2(_{t-1)} \end{vmatrix} + \begin{vmatrix} \varepsilon_1 \\ \varepsilon_2 \end{vmatrix} \tag{2.11}$$

$$\begin{vmatrix} y1 \\ y2 \\ . \\ . \\ . \\ yk \end{vmatrix} = \begin{vmatrix} \alpha_1 \\ \alpha_2 \\ . \\ . \\ . \\ \alpha_k \end{vmatrix} + \begin{vmatrix} \omega_{11} & . \\ \omega_{21} & . \\ . & . \\ . & . \\ . & . \\ \omega_{k1} & . \end{vmatrix} \begin{vmatrix} y1_{(t-1)} \\ y2_{(t-1)} \\ . \\ . \\ . \\ yk_{(t-1)} \end{vmatrix} + \cdots + \begin{vmatrix} \omega'_{11} & . \\ \omega'_{21} & . \\ . & . \\ . & . \\ . & . \\ \omega'_{k1} & . \end{vmatrix} \begin{vmatrix} y1_{(t-p)} \\ y2_{(t-p)} \\ . \\ . \\ . \\ yk_{(t-p)} \end{vmatrix} + \begin{vmatrix} \varepsilon_1 \\ \varepsilon_2 \\ . \\ . \\ . \\ \varepsilon_k \end{vmatrix} \tag{2.12}$$

First, The ADF unit root test is executed for each time series in the following models, whether the series is stationary or not. As a result, it is observed that all series have a unit root at the level; however, each of them is stationary at the first difference I(0). After determining lag order, the JCT is applied to determine whether there is a possibility of a long-run relationship between the variables. If there is at least one cointegration between variables, the VEC model is applied to identify short- and long-run relationships. Otherwise, each series is made stationary by differencing. Next, a lag order is determined for the new models. After, IRF and VD methods are applied to identify the relationship between variables.

3.3. Housing Unit Price Models

This section introduces four different models to determine the relationship between housing unit prices (hup) and other variables. The first aim is to identify the long-run relationship between hup for Turkey and the other four variables: exchange rate (exr), housing mortgage rate (hmr), import unit value index (imp), and employment rate (emr), then compare it with the relationship between the consumer price index of Turkey and the same four variables. The second purpose is to identify how hup for Turkey and Istanbul respond to exr and hmr shocks and whether there are any differences or similarities between these two responses in terms of size and duration. Moreover, it also compares these reactions by dividing the examined time into smaller periods as relative economic stabilization and economic fluctuation. Although the Turkish currency depreciated against the U.S. dollar and Euro for ten years, between 2010 and 2020, this depreciation is much more significant between 2015 and 2020 compared to the period from 2010 to 2014. Thus, the period from 2010 to 2014 is evaluated as economic stabilization, and the other is economic fluctuation. This section consists of data collection, unit root tests, and the introduction of the models.

3.3.1. Data Collection

Table 1 indicates the all-time series used in this part with their variable names. The collected monthly data covers eleven years, from January 2010 to December 2020. All data is collected from The Central Bank of The Republic of Turkey website called Electronic Data Delivery System. All series are complete, without any gap, and there are 132 observations for each series. In the following parts, each time series is explained in detail with data statistics to observe their movement clearly in this examined period. They also allow understanding the character of the data before the ADF unit root test.

Table 1. Collected Data for Housing Unit Price Models

Time Series	Variable	Period	Source
Exchange Rate	exr	01.2010 - 12.2020	CBRT
Housing Mortgage Rate	hmr	01.2010 - 12.2020	CBRT
Import Unit Value Index	imp	01.2010 - 12.2020	CBRT
Employment Rate	emr	01.2010 - 12.2020	CBRT
Consumer Price Index	cpi	01.2010 - 12.2020	CBRT
Housing Unit Prices (TUR)	hup1	01.2010 - 12.2020	CBRT
Housing Unit Prices (İST)	hup2	01.2010 - 12.2020	CBRT

3.3.1.1. Exchange Rate

In this study, Euro and the U.S. dollar are used for nominal exchange rates since both are used commonly in Turkey as foreign currency while trading with other countries. 50% of each currency is used to create a basket rate according to the following formula.

$$\text{Basket Rate} = \left(\frac{1}{2} \text{ x Monthly Euro Value}\right) + \left(\frac{1}{2} \text{ x Monthly the U.S. dollar Value}\right)$$

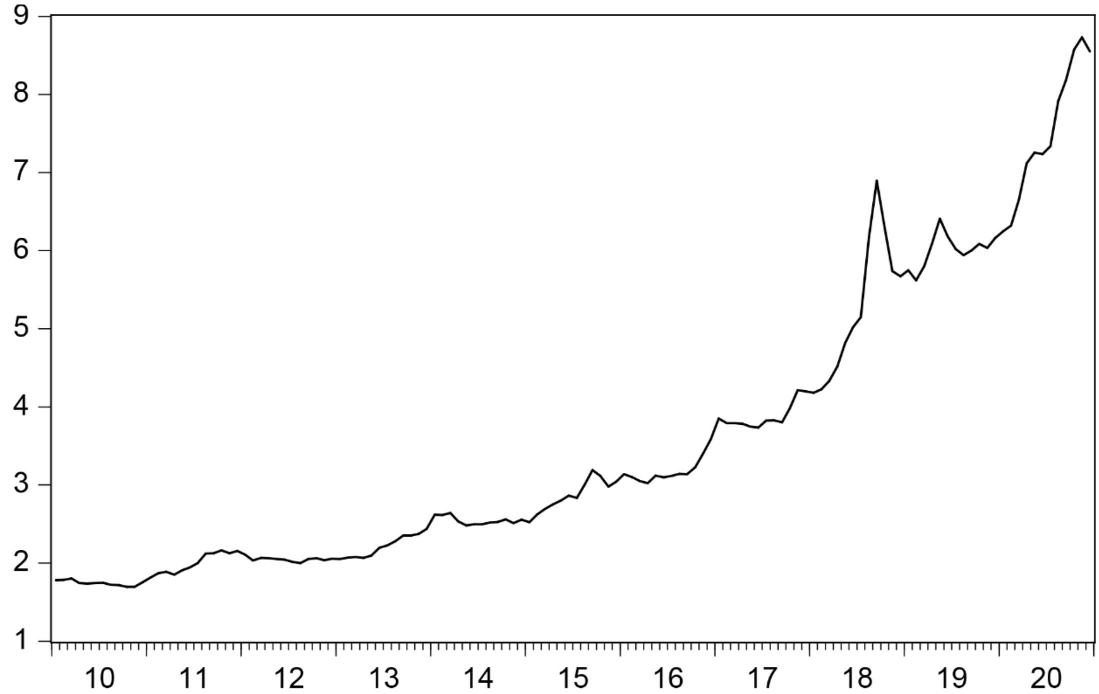

Figure 4. Nominal Exchange Rate (exr) 01.2010 - 12.2020

Figure 4 clearly shows that there is an upward trend in the nominal exchange rate in general. Between 2015 and 2020, the trend is more severe and exr skyrockets, and hits over eight against Turkish Lira (TL) in 2020. Table 2 indicates the descriptive statistics of the exr series. As shown in the table, the minimum value against TL is 1.69 in November 2010, and the maximum value is 8.73 in November 2020.

Table 2. exr Descriptive Statistics

Mean	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**
3.57	2.85	8.73	1.69	1.86	1.08	3.07

3.3.1.2. Housing Mortgage Rate

After the effective monetary policies at the beginning of the 2000s, Turkey gained significant economic stabilization. In the following years, people were encouraged to buy property thanks to a series of new laws. As described in the previous chapter, these laws allow Turkish citizens to buy a house with low mortgage rates and a more extended payment period, especially for low-income and middle-income groups. Thus, the housing mortgage rate became a critical indicator in the HM since it impacts the demand for houses in Turkey, housing unit prices, and house sales.

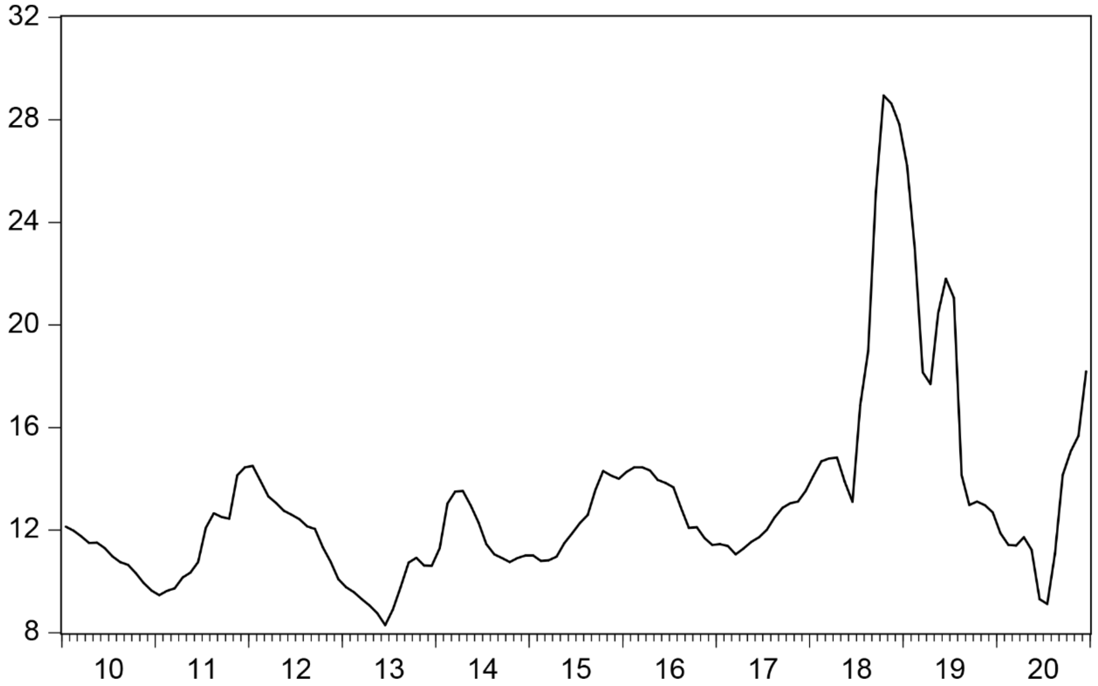

Figure 5. Housing Mortgage Rate (hmr) 01.2010 - 12.2020

The housing mortgage rate (hmr) represents weighted average interest rates for housing bank loans in Turkey as a percentage. Figure 5 shows the monthly hmr values between 2010 and 2020. The values brutally fluctuate in this period, and this fluctuation affects house sales, and the housing unit prices for Turkey. As shown in Table 3, the mean value for hmr is around 13%. Furthermore, the maximum value is almost 29% in 2018, and the minimum value is 8.30 in 2013.

Table 3. hmr Descriptive Statistics

Mean	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**
13.09	12.12	28.95	8.30	3.80	2.36	9.18

3.3.1.3. Import Unit Value Index

Import Unit Value index shows the changes in the import of Turkey with other countries. For the CI and HM, imp changes are crucial since it is expected to affect these industries. After globalization, the trade between countries enormously increased. Turkey also showed a similar trend in this period; however, there is a general decreasing trend in imp in the last years.

Figure 6. Import Unit Value Index (imp) 01.2010 - 12.2020

Figure 6 indicates the changes in imp between 2010 and 2020. Although the figure fluctuates in this period, the general trend is downward after 2011. According to Table 4, the minimum value of imp is under 80, which is in 2020, and the maximum is almost 119 in 2011.

Table 4. imp Descriptive Statistics

Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
97.30	93.52	118.70	78.54	11.67	0.23	1.63

3.3.1.4. Employment Rate

The employment rate indicates the amount of working people in Turkey as a percentage. This value plays a vital role in the Turkish economy since it affects the economic environment enormously. Although the construction procedure is changing day by day, the Turkish CI is generally still labor-intensive. Since the Turkish CI has an intense relationship with its sub-sectors and other sectors, as described in the previous chapter, it is affected by emr, impacting house prices.

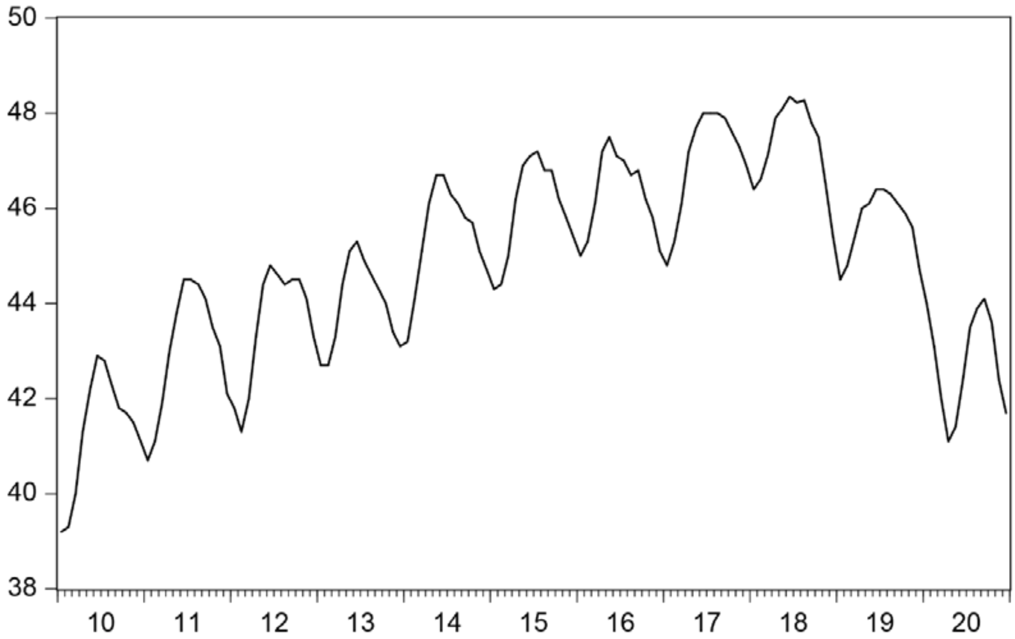

Figure 7. Employment Rate (emr) 01.2010 - 12.2020

Figure 7 shows how emr changes between 2010 and 2020 as a percentage. Although there is an apparent seasonality effect, it generally increased until 2019. According to Table 5, the mean value is slightly under 45%, and the difference between the minimum and maximum emr is less than 10% in the examined period.

Table 5. emr Descriptive Statistics

Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
44.78	44.85	48.35	39.20	2.12	-0.39	2.47

3.3.1.5. Consumer Price Index

The consumer price index shows the price changes, paid to buy a product or service, according to the previous period, and it is used to measure the inflation in the economy. ERPT to consumer prices and the relationship between macroeconomic variables and consumer prices have been extensively covered in the literature, as described in the previous chapter.

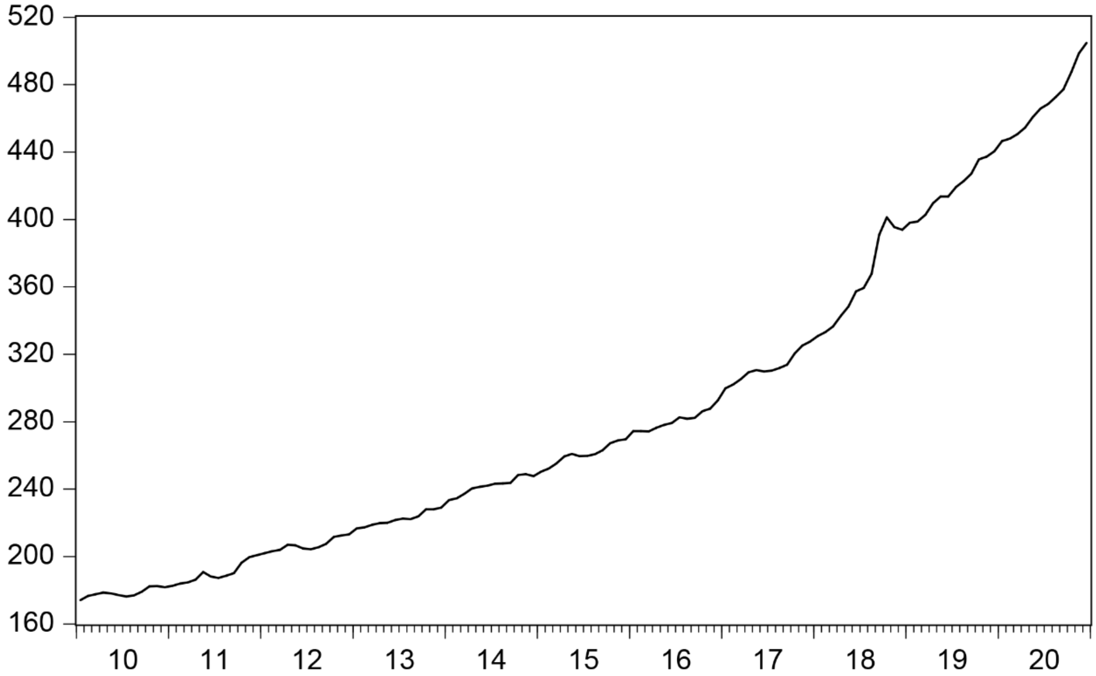

Figure 8. Consumer Price Index (cpi) 01.2010 - 12.2020

Figure 8 shows the changes in cpi between 2010 and 2020, and there is a clear increasing trend in the examined period. According to Table 6, the mean value is around 285. Moreover, cpi tripled in the last 11 years from slightly over 174 to almost 505.

Table 6. cpi Descriptive Statistics

Mean	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**
285.82	260.26	504.81	174.07	92.28	0.75	2.40

3.3.1.6. Housing Unit Prices for Turkey

Housing unit price is the average amount of money paid for one square meter of a house. The importance of buying a property in Turkey was described in the previous chapter. Thus, housing unit prices are expected to be extensively affected by the economic environment of Turkey.

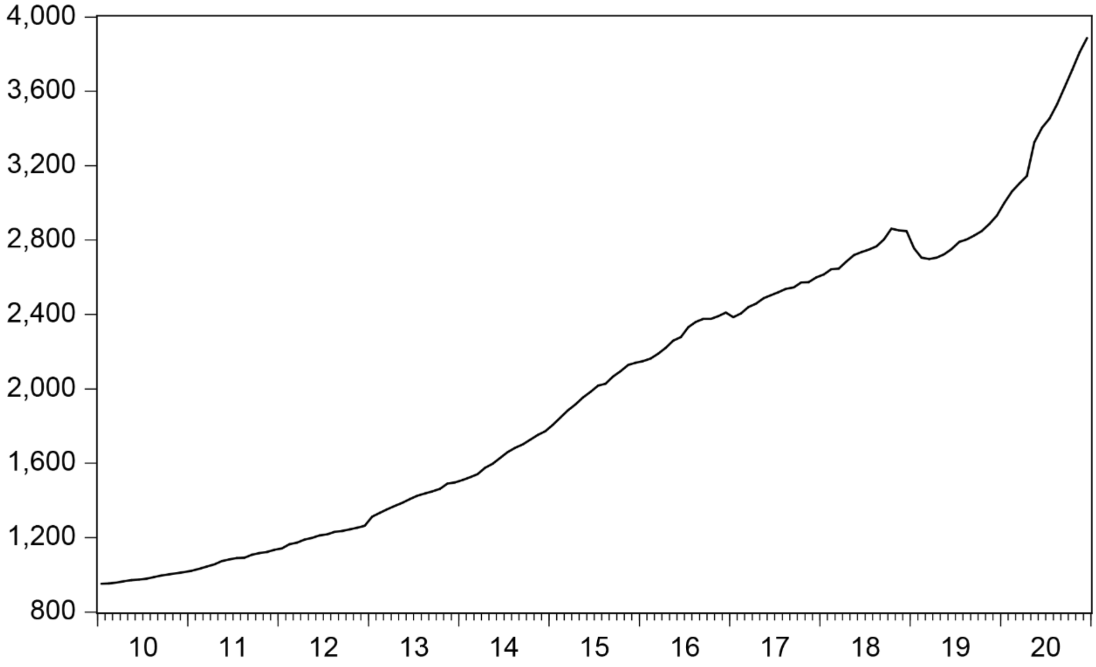

Figure 9. Housing Unit Prices for Turkey (hup1) 01.2010 - 12.2020

Figure 9 represents hup1 movements between 2010 and 2020, indicating a clear upward trend in the examined period. According to Table 7, the minimum square meter price is 3886 TL as average in Turkey. Until the end of 2020, the price increases more than 300%, from 952 TL/m^2 to 3886 TL/m^2.

Table 7. hup1 Descriptive Statistics

Mean	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**
2004.96	2000	3886	952	780.18	0.31	2.05

3.3.1.7. Housing Unit Prices for İstanbul

İstanbul is the most crowded city in Turkey, with more than 15 million people, and it is the most expensive city. Hup for İstanbul is over Turkey's average, although the extensive housing oversupply.

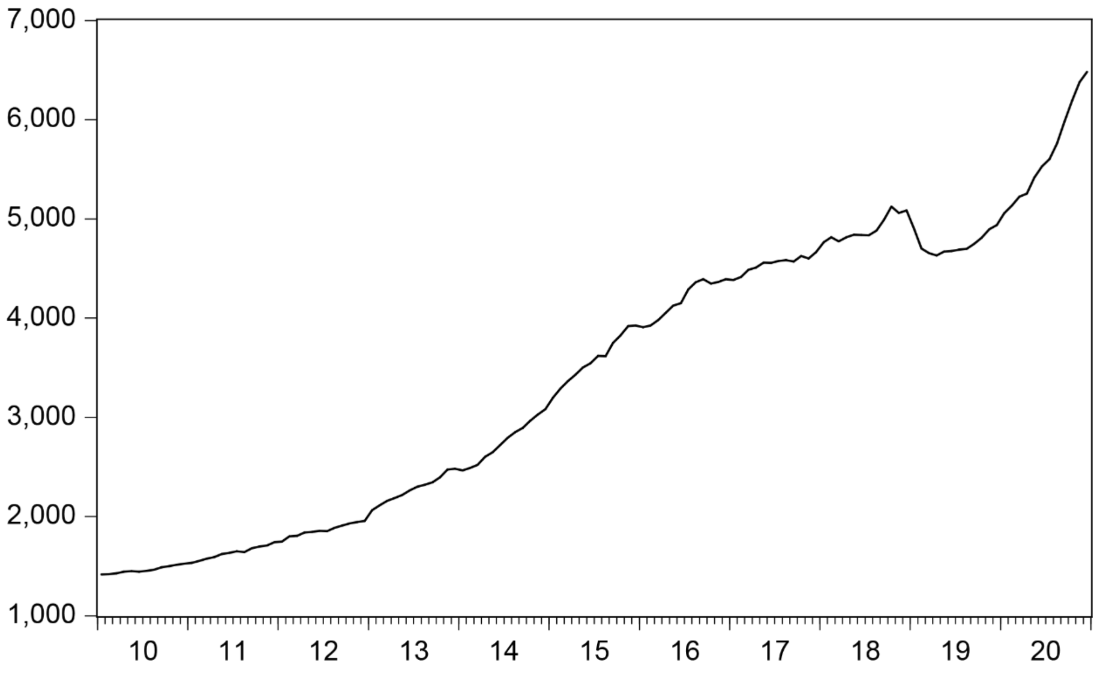

Figure 10. Housing Unit Prices for İstanbul (hup2) 01.2010 - 12.2020

Figure 10 shows the hup2 changes for 11 years period from 2010 to 2020. Although the housing oversupply, the prices are still increasing. According to Table 8, the mean value is almost 75% more than hup1's mean, and the increase between 2010 and 2020 is more than 350%.

Table 8. hup2 Descriptive Statistics

Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
3420.79	3579.50	6481	1415	1435.68	0.05	1.65

3.3.2. Unit Root Tests

Unit root tests are employed to determine the time series properties used in housing unit price models. After determining $t_{(adf)}$ values of the series, they are compared with $t_{(mk)}$ values at a 1% significance level, as shown in Table 9. According to the results, each series has a unit root at the level, so they are not stationary. However, the table shows that they are stationary at the first difference, which means each of them is I(1).

Table 9. Unit Root Test for the Variables

	At the level			At the first difference		
Variable	**$t_{(mk)}$ (1%)**	**$t_{(adf)}$**	**Prob.**	**$t_{(mk)}$ (1%)**	**$t_{(adf)}$**	**Prob.**
exr	-4.031	-0.075	0.995	-4.031	-9.900	0.000
hmr	-4.030	-3.900	0.015	-4.031	-6.995	0.000
imp	-4.030	-2.040	0.574	-4.030	-8.505	0.000
emr	-4.036	1.714	1.000	-4.036	-4.311	0.004
cpi	-4.032	1.178	1.000	-4.032	-6.566	0.000
hup1	-4.030	0.269	0.998	-4.030	-6.008	0.000
hup2	-4.030	-1.560	0.803	-4.030	-6.158	0.000

3.3.3. Models

In this part, four models are introduced. The relation between the variables in each model is tested according to the procedure explained in Figure 3. In each model, the first time series represents the dependent variable, and the followings represent the independent variables.

[cpi, exr, hmr, imp, emr] Model (1)

[hup1, exr, hmr, imp, emr] Model (2)

Model 1 investigates the relationship between the consumer price index (cpi) and the other four variables: exchange rate, housing mortgage rate, import unit value index, and employment rate from January 2010 to December 2020. Model 2 seeks to demonstrate a similar linkage between housing unit prices for Turkey and the same four variables. Then, the results of these two models will be compared to determine any difference between these two variables since house prices are also consumer prices.

[hup1, exr, hmr] Model (3)

[hup2, exr, hmr] Model (4)

Model 3 seeks to determine how hup1 responds to exr and hmr shock by examining the data from 2010 to 2020. Similarly, model 4 investigates the reaction of hup2 to exr and hmr changes in the same period. Then, these two models will then be compared to determine whether the size or the duration of these reactions differ.

Next, the period is divided into two: from January 2010 to December 2014 and from January 2015 to December 2020, as the exchange rate fluctuation is much more severe after 2015. Then, models 3 and 4 are employed to investigate whether house prices reaction to those shocks differs in economic stability and economic instability.

3.4. Construction Cost Index Models

3.4.1. Data Collection

Table 10 indicates all series with variable names. The monthly data covers six years, from January 2015 to December 2020. All data is collected from The Central Bank of The Republic of Turkey website called Electronic Data Delivery System. All series are complete, and there are 72 observations for each.

The producer price index and construction cost index series are explained in detail with data statistics in the following parts since the other three have already been mentioned in the previous parts. Table 11 indicates the descriptive statistics of exr, imp, and emr time series for the examined period.

Table 10. Collected Data for Construction Cost Index Models

Time Series	Variable	Period	Source
Exchange Rate	exr	01.2015 - 12.2020	CBRT
Import Unit Value Index	imp	01.2015 - 12.2020	CBRT
Employment Rate	emr	01.2015 - 12.2020	CBRT
Producer Price Index	ppi	01.2015 - 12.2020	CBRT
Construction Cost Index	cci1	01.2015 - 12.2020	CBRT
Construction Cost Index (mat.)	cci2	01.2015 - 12.2020	CBRT

Table 11. exr, imp and emr Descriptive Statistics between 01.2015 - 12.2020

Series	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**	**Skewness**	**Kurtosis**
exr	4.78	4.21	8.73	2.52	1.73	0.56	2.18
imp	87.74	87.35	96.26	78.54	4.46	-0.16	2.01
emr	45.87	46.20	48.35	41.10	1.77	-0.87	3.20

3.4.1.1. Producer Price Index

The producer price index shows the price changes, paid to produce a product, or provide a service, according to the previous period, and it is commonly used to measure inflation in the economy. ERPT to producer prices and the relationship between macroeconomic variables and producer prices have been extensively covered in the literature, as described in the previous chapter.

Figure 11 shows the monthly movement of ppi in Turkey from 2015 to 2020. It seems that the general trend is upward, and after 2016 the index skyrockets over 550. According to Table 12, the change in six years is over 140%, starting from around 237 and ending with over 568. Besides, the mean value in the examined period is almost 355.

Table 12. ppi Descriptive Statistics

Mean	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**
354.81	318.04	568.27	236.61	98.63	0.39	1.71

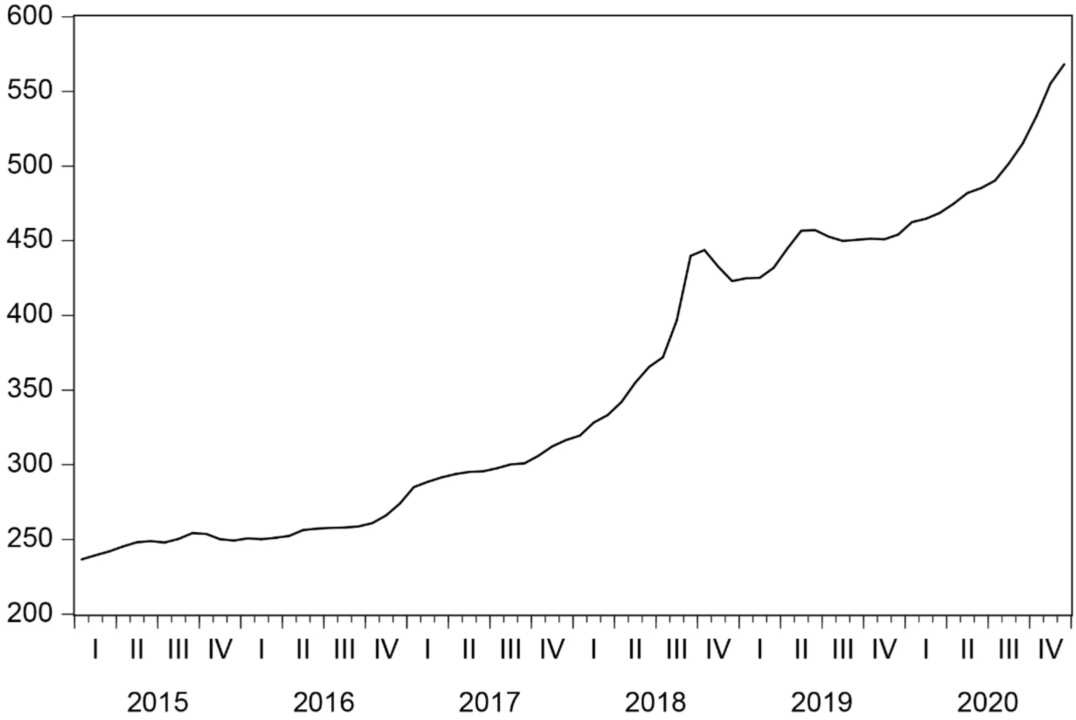

Figure 11. Producer Price Index (ppi) 01.2015 - 12.2020

3.4.1.2. Construction Cost Index

The construction cost index (cci1) represents changes in labor and material cost between two sequential periods. Turkish CI is a crucial industry that contributes to the Turkish economy insensitively, as described in the literature. Thus, cci is a significant indicator for governments and investors in Turkey.

As shown in Figure 12, there is an increasing trend between 2015 and 2020. The index rises almost 150% in six years. Table 13 shows that the mean value is around 150, and it heats over 240 at the end of 2020.

Table 13. cci1 Descriptive Statistics

Mean	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Skewness**	**Kurtosis**
151.70	141.53	240.35	97.13	42.63	0.30	1.70

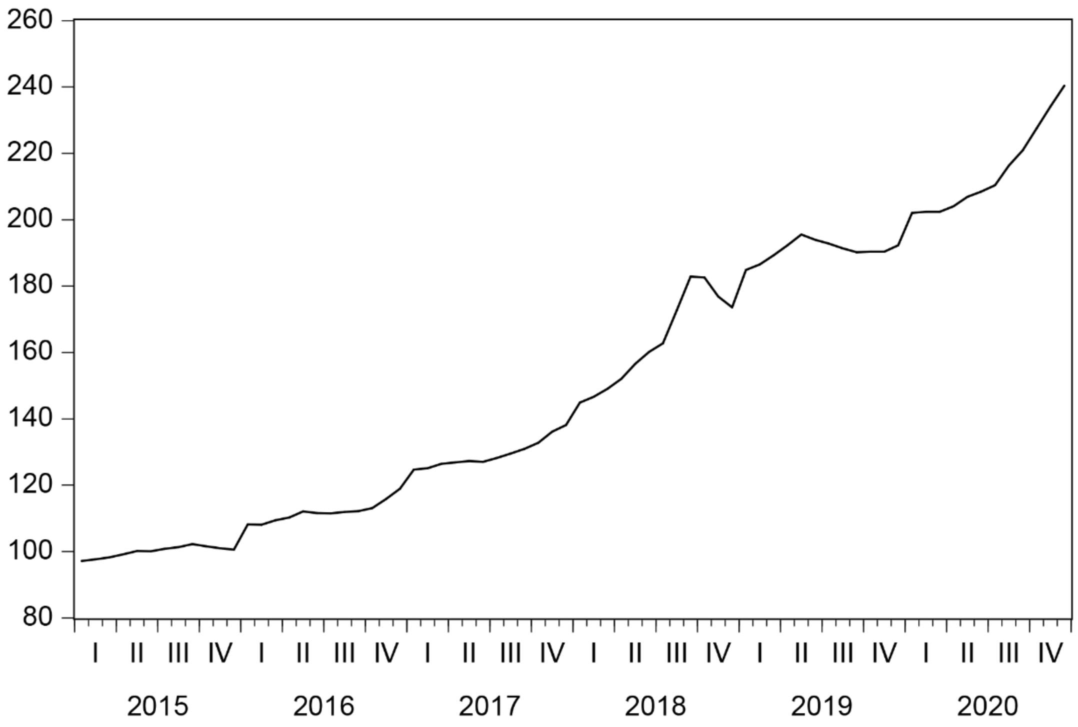

Figure 12. Construction Cost Index (cci1) 01.2015 - 12.2020

3.4.1.3. Construction Cost Index (Material)

The construction cost index for material (cci2) represents changes only material cost between two sequential periods. As described in the literature, the relationship between macroeconomic variables and material costs might differ from the one between macroeconomic variables and labor. The variable was added to compare with the general cci in Turkey.

Figure 13 shows the movement of the cci2 for six years, and the general trend is upward in the examined period as it is in cci1. Although the minimum and the maximum values are almost the same with cci1, the mean value of cci2 is smaller than cci1's, as shown in Table 14.

Table 14. cci2 Descriptive Statistics

Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
146.99	136.61	241.55	97.72	41.60	0.34	1.76

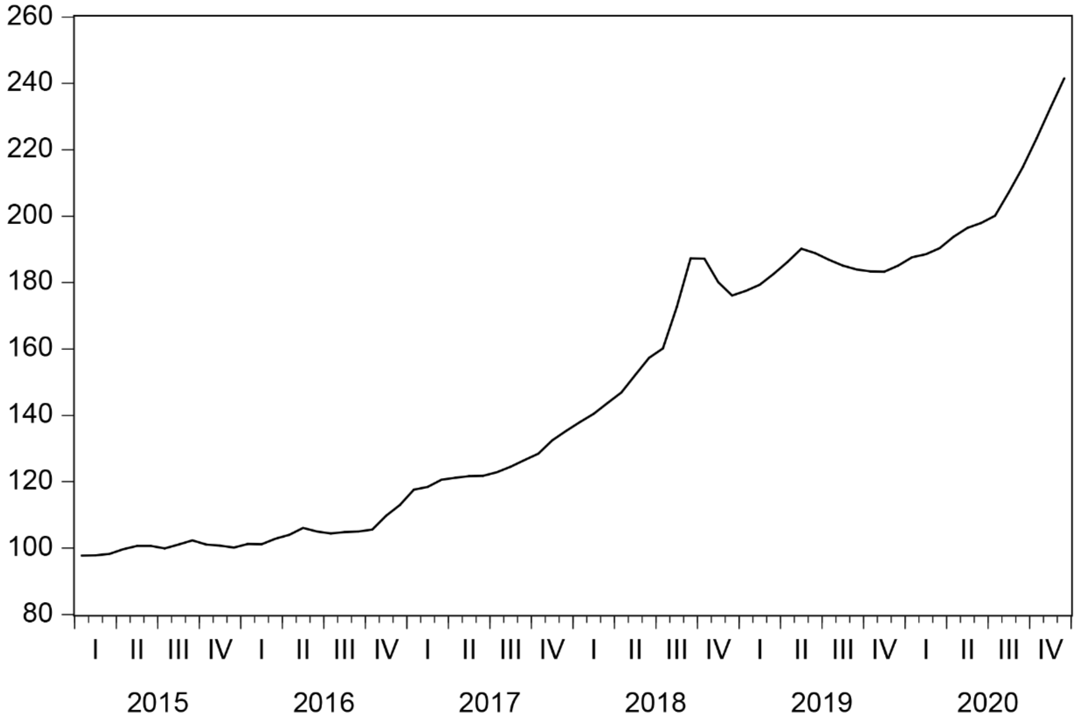

Figure 13. Construction Cost Index - Material (cci2) 01.2015 - 12.2020

3.4.2. Unit Root Tests

Unit root tests are employed to determine the time series properties used in housing unit price models. After determining $t_{(adf)}$ values of the series, they are compared with $t_{(mk)}$ values at 1% significance level, as shown in Table 15. According to the results, each series has a unit root at the level, and so they are not stationary. However, the table shows that they are stationary at the first difference, which means they are I(1).

Table 15. Unit Root Test for the Variables

	At the level			At the first difference		
Variable	**$t_{(mk)}$ (1%)**	**$t_{(adf)}$**	**Prob.**	**$t_{(mk)}$ (1%)**	**$t_{(adf)}$**	**Prob.**
exr	-4.099	-2.181	0.492	-4.097	-7.402	0.000
imp	-4.093	-1.930	0.629	-4.095	-6.708	0.000
emr	-4.116	-0.116	0.994	-3.171	-3.198	0.094
ppi	-4.097	-1.569	0.795	-4.097	-5.862	0.000
cci1	-4.095	-1.870	0.659	-4.095	-6.424	0.000
cci2	-4.097	-1.395	0.854	-4.097	-5.123	0.000

3.4.3. Models

This part investigates how construction cost indexes and producer price index react to exchange rate, import unit value index, and employment rate shocks by examining data from January 2015 to December 2020. In each model, the first time series represents the dependent variable, and the followings represent the independent variables. Three models are introduced as follows:

[ppi, exr, imp, emr] Model (5)

[cci1, exr, imp, emr] Model (6)

[cci2, exr, imp, emr] Model (7)

ERPT to producer prices and the relation between macroeconomic variables and these prices have already been investigated extensively. However, models 5 and 6 are employed to investigate the similar effects for construction costs and compare them with producer prices in Turkey. Furthermore, model 7 explores whether the size and duration of these effects are different for the construction cost index for materials.

CHAPTER 4

RESULTS

4.1. Results for Housing Unit Price Models

4.1.1. Model 1

[cpi, exr, hmr, imp, emr] Model (1)

This section investigates the long relationship between the consumer price index and the other four variables: exr, hmr, imp and emr by analyzing the collected data between 2010 and 2020 in Turkey. Table 16 shows the lag order selection criteria for Model 1. According to the table, the 8th lag order is selected as optimal length since two more criteria support AIC.

Table 16. Lag Order Selection for Model 1

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1748.420	NA	1317936.000	28.281	28.395	28.327
1	-721.837	1953.819	0.127	12.126	12.809	12.404
2	-605.943	211.226	0.029	10.660	11.911*	11.168*
3	-569.919	62.752	0.025	10.483	12.302	11.222
4	-532.906	61.489	0.021	10.289	12.677	11.259
5	-501.367	49.853	0.019	10.183	13.140	11.384
6	-486.103	22.896	0.022	10.340	13.866	11.772
7	-443.943	59.840	0.018	10.064	14.158	11.727
8	-408.977	46.809*	0.0156*	9.902*	14.565	11.797

After, the Johansen Cointegration test is employed with 1 to 8 lag intervals to determine whether there is a long-run relationship between variables. Table 17 shows the result of the trace test at 1% significance level. According to the table, the test rejects the first two hypotheses and indicates two cointegration at the 0.01 level. Therefore, there might be a long-run relationship between these variables.

Table 17. Unrestricted Cointegration Rank Test (Trace) for Model 1

No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.291	114.105	77.819	0.000
At most 1 *	0.274	71.784	54.682	0.000
At most 2	0.134	32.434	35.458	0.024
At most 3	0.088	14.764	19.937	0.064
At most 4	0.027	3.398	6.635	0.065

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

In the next step, the Vector Error Correction model is employed to determine the relationship between variables. In order to determine whether the model itself and each of the variables are statistically significant, their t-statistics are compared with the t-table values. It is known that t-table values for more than 120 observations at %1, 5, and 10 significance levels are 2.61, 1.98, and 1.65, respectively. Table 18 shows the estimated results of the VEC model. As a result, the relation between cpi and hmr is not significant, as expected. However, there is a long-run relationship between cpi, exr, imp, and emr according to the t-statistics value at the 1% level. Moreover, the model itself is successful according to its t-statistics value, which indicates a long-run relationship at the 1% level. According to 2., the necessary time for the system equilibrium is:

$Time = \frac{1}{|\varphi|} = \frac{1}{|-0.098|} \cong 10$ period, which means approximately ten months.

$$ECT_{t-1} = 1 * CPI_{t-1} - 59.226 * EXR_{t-1} - 0.542 * HMR_{t-1} - 0.721 * IMP_{t-1} - 10.226 * EMR_{t-1} + 485.520$$

According to the result, there is a positive relationship between cpi and the other four variables. One unit increase in the exchange rate results in approximately 60 unit increases in the consumer price index.

Table 18. Vector Error Correction Estimates for Model 1

CointEq1	CPI (-1)	EXR (-1)	HMR (-1)	IMP (-1)	EMR (-1)	C
-0.098	1.000	-59.226	-0.542	-0.721	-10.735	485.520
(-0.022)		(-2.917)	(-0.890)	(-0.260)	(-1.689)	
[-4.561]		[-20.300]	[-0.609]	[-2.772]	[-6.359]	

Standard errors in ( ) & t-statistics in [ ]

4.1.2. Model 2

[hup1, exr, hmr, imp, emr] Model (2)

This section investigates the long-run relationship between the housing unit prices for Turkey and the other four variables: exr, hmr, imp and emr by analyzing the collected data between 2010 and 2020. Table 19 shows the lag order selection criteria for Model 2. According to the table, the seventh lag order is selected as optimal length since two more criteria support AIC.

Table 19. Lag Order Selection for Model 2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2026.050	NA	1.16E+08	32.759	32.873	32.805
1	-1014.160	1925.856	14.186	16.841	17.524	17.118
2	-886.232	233.159	2.702	15.181	16.432*	15.689*
3	-854.041	56.075	2.418	15.065	16.885	15.804
4	-830.100	39.773	2.483	15.082	17.470	16.052
5	-792.044	60.154	2.042	14.872	17.828	16.073
6	-758.189	50.782	1.810	14.729	18.254	16.161
7	-719.690	54.644*	1.503*	14.511*	18.605	16.174
8	-696.571	30.949	1.618	14.541	19.204	16.436

Then, the JCT is employed with 1 to 7 lag intervals to determine whether there is a long-run relationship between variables. Table 20 shows the result of the trace test at the 1% significance level. According to the table, the test rejects the first three hypotheses and indicates three cointegrations at the 0.01 level. Therefore, there might be a long-run relationship between these variables.

Table 20. Unrestricted Cointegration Rank Test (Trace) for Model 2

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.260	107.944	77.819	0.000
At most 1 *	0.220	70.658	54.682	0.000
At most 2 *	0.183	39.849	35.458	0.003
At most 3	0.100	14.784	19.937	0.064
At most 4	0.013	1.681	6.635	0.195

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

After, the Vector Error Correction model is employed to determine the relationship between variables. In order to determine whether the model itself and each of the variables are statistically significant, their t-statistics are compared with the t-table values. Table 21 shows the estimated results of the VEC model. As a result, the relation between hup1 and the other four variables is statistically significant. However, the model's t-statistics value is not significant even at the 10% level.

Table 21. Vector Error Correction Estimates for Model 2

CointEq1	HUP1(-1)	EXR (-1)	HMR (-1)	IMP (-1)	EMR (-1)	C
0.004	1.000	-336.652	25.354	8.172	-137.271	4224.653
(-0.033)		(-19.634)	(-7.681)	(-1.454)	(-8.697)	
[0.129]		[-17.147]	[3.301]	[5.622]	[-15.784]	

Standard errors in ( ) & t-statistics in [ ]

Next, New models that explore the relationship between housing unit prices, exchange rate and housing mortgage rate are employed in the following sections.

4.1.3. Model 3

[hup1, exr, hmr] Model (3)

For the monthly data from 2010 to 2020, this section explores the long-run relationship between the housing unit prices for Turkey and the other two variables: exr and hmr, by using VAR models. Table 22 shows the lag order selection criteria for Model 3. According to the table, the sixth lag order is selected as optimal length since three more criteria support AIC.

Table 22. Lag Order Selection for Model 3

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1445.773	NA	2824029.000	23.367	23.436	23.395
1	-694.653	1453.781	17.887	11.398	11.671	11.508
2	-639.792	103.528	8.539	10.658	11.136*	10.852
3	-621.723	33.223	7.382	10.512	11.194	10.789
4	-612.559	16.407	7.372	10.509	11.396	10.869
5	-591.737	36.271	6.105	10.318	11.410	10.762
6	-576.380	26.008*	5.526*	10.216*	11.512	10.742*
7	-569.688	11.009	5.759	10.253	11.754	10.863
8	-561.436	13.176	5.861	10.265	11.971	10.958

Then, the Johansen Cointegration Test is employed with 1 to 6 lag intervals to determine whether there is a long-run relationship between variables. Table 23 shows the result of the trace test at the 1% significance level. According to the table, the test accepts the first hypotheses and indicates no cointegration at the 0.01 level. Therefore, there is no long-run relationship between series. Thus, the first difference of each series is taken, and a VAR analysis is applied to identify the short-run relationship between variables. Differencing process is executed according to Eq 2.8.

[d1hup1, d1exr, d1hmr] Model (3-A)

Table 23. Unrestricted Cointegration Rank Test (Trace) for Model 3

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.260	107.944	77.819	0.000
At most 1	0.220	70.658	54.682	0.000
At most 2	0.183	39.849	35.458	0.003

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

After taking the first difference of the series, a new lag order is selected for the model. Table 24 shows the lag order selection criteria for Model 3-A. According to the table, the sixth lag order is selected as optimal length since FPE supports AIC. After, IRF is employed to identify how each variable in the model responds to the shocks originating from other variables. Moreover, VD is applied to the model, and how much of the changes in Housing Unit Prices for Turkey can be explained by itself and the other two variables in two years.

Table 24. VAR D-Lag Order Selection for Model 3-A

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-746.665	NA	39.490	12.190	12.258	12.218
1	-664.310	159.353	11.981	10.997	11.271*	11.108
2	-644.019	38.273	9.975	10.813	11.293	11.008
3	-626.036	33.042	8.625	10.667	11.353	10.946
4	-606.533	34.884	7.281	10.496	11.388	10.859
5	-591.661	25.874*	6.631	10.401	11.498	10.847*
6	-581.679	16.880	6.546*	10.385*	11.688	10.914
7	-574.615	11.602	6.784	10.417	11.925	11.029
8	-564.293	16.448	6.676	10.395	12.110	11.092

Figure 14 represents the impulse response function of the variables used in Model 3-A to the shocks causing one standard deviation in the variables, indicated with the blue lines. Moreover, the red dashed lines show the 95% confidence bands. After a shock bringing in one standard deviation change in the exchange rate, housing unit prices for Turkey are affected positively in the first six months. Afterward, this effect turns negative and almost disappears after the nineteenth month. In the first two months, the response of hup1 to d1exr shock increases dramatically, and the upward trend remains until the fourth month. After, it goes down dramatically until the seventh month. Then, it converges to zero by fluctuating in the next one-year period. On the other hand, housing unit prices respond negatively to a one standard deviation shock in housing mortgage rate until the nineteenth month. This negative response hits the lowest point in the fifth month and afterward converges to zero by fluctuating until the nineteenth month.

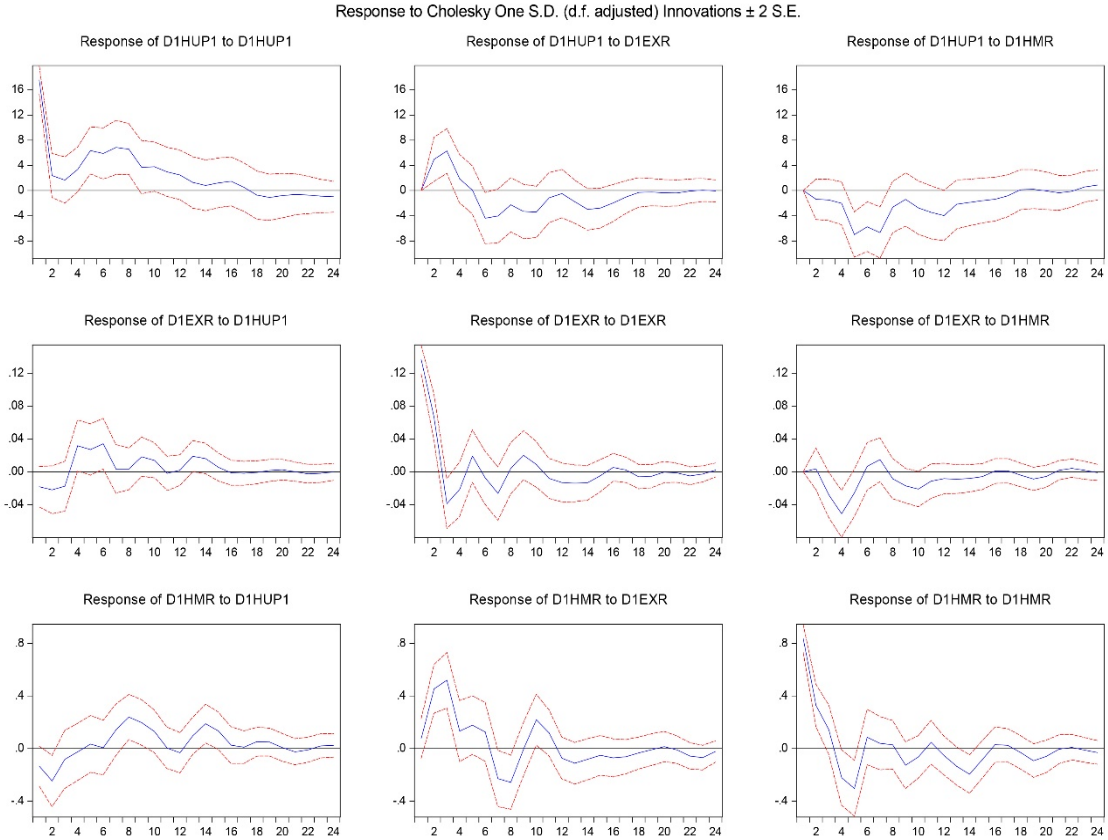

Figure 14. Impulse Response Function of Model 3-A between 2010 - 2020

Table 25 represents the variance decomposition of housing unit prices for Turkey between January 2010 and December 2020. This table shows the number of changes in hup1 for two years and how much of this change can be explained by itself and the other two variables. In the first month, 100% of the changes in d1hup1 are explained by themselves. In the short run, over 82% of the changes in d1hup1 is originated from itself. This percentage decreases until the twelfth month and hits slightly over 63%. Then, it remains almost stable until the end of the second year.

Table 25. Variance Decomposition for Model 3-A between 2010 – 2020

Period	S.E.	D1HUP1	D1EXR	D1HMR
1	17.558	100.000	0.000	0.000
2	18.452	92.225	7.232	0.542
3	19.621	82.290	16.662	1.048
4	20.099	81.243	16.741	2.016
5	22.204	74.783	13.718	11.499
6	24.079	69.584	14.952	15.465
7	26.218	65.555	14.961	19.484
8	27.254	66.510	14.528	18.961
9	27.742	65.991	15.452	18.556
10	28.337	65.044	16.244	18.711
11	28.725	64.370	15.967	19.663
12	29.106	63.417	15.578	21.006
13	29.269	62.908	15.770	21.322
14	29.492	62.037	16.553	21.409
15	29.690	61.385	17.208	21.407
16	29.822	61.082	17.495	21.423
17	29.855	60.977	17.574	21.449
18	29.866	60.992	17.571	21.437
19	29.887	61.034	17.553	21.413
20	29.900	61.052	17.553	21.394
21	29.911	61.049	17.558	21.393
22	29.919	61.070	17.548	21.382
23	29.938	61.078	17.527	21.395
24	29.966	61.067	17.494	21.439

Cholesky Ordering: D1HUP1 D1EXR D1HMR

Table 26. Variance Decomposition for Model 3-A between 2010 – 2014

Period	S.E.	D1HUP1	D1EXR	D1HMR
1	7.975	100.000	0.000	0.000
2	8.819	86.747	0.250	13.004
3	9.221	85.985	2.003	12.013
4	9.496	83.461	2.193	14.346
5	9.785	80.166	5.940	13.894
6	10.219	80.739	6.513	12.748
7	10.233	80.567	6.715	12.718
8	10.267	80.232	6.676	13.092
9	10.307	80.212	6.751	13.037
10	10.364	79.519	7.398	13.082
11	10.396	79.289	7.691	13.020
12	10.461	78.344	8.574	13.082
13	10.505	77.875	8.707	13.418
14	10.515	77.861	8.691	13.448
15	10.524	77.801	8.682	13.517
16	10.532	77.774	8.674	13.552
17	10.539	77.733	8.706	13.561
18	10.569	77.506	8.673	13.821
19	10.581	77.401	8.653	13.946
20	10.583	77.407	8.650	13.943
21	10.586	77.387	8.649	13.964
22	10.588	77.385	8.647	13.968
23	10.591	77.378	8.643	13.978
24	10.594	77.345	8.643	14.013

Cholesky Ordering: D1HUP1 D1EXR D1HMR

Moreover, the exchange rate's effect on d1hup1 changes is over 16.5 % and much more extensive than the effect of the housing mortgage rate in the short run. At the end of the third month, the effect of d1hmr is shallow and almost 1% level. However, d1hmr skyrockets afterward and hits over 21% at the end of the first year. Then, it remains almost steady and slightly increases to over %21.4 at the end of the second year. In contrast, the number for d1exr is roughly 15.5% at the end of the first year and almost 17.5% at the end of the second year. To conclude, the effect of the exchange rate is much severe in the short run; however, the effect of the housing mortgage rate is more extensive than d1exr's at the end of the second year. The average number for d1exr and d1hmr in two years is 15.4% and 16.8%, respectively.

Then, the period is divided into two: the period from January 2010 to December 2014 and the period from January 2015 to December 2020. The reason lying behind this division is to determine whether these effects change according to the economic environment of Turkey. In the second period, the depreciation of TL is much more intense according to the first period.

Table 26 shows the variance decomposition values of housing unit prices for Turkey from January 2010 to December 2014, in the economic stabilization period. The table indicates how much d1exr and d1hmr can explain d1hup1's movement and how much can be explained by itself for two years. As a result, a hundred percent of the changes in d1hup1 can be explained by themselves. However, the number drops to under 87% in the following month. After decreasing to around 78% at the end of the first year, the number stays steady and goes down only one percent until the second year. The average of this effect is slightly over 80% in two years.

Likewise, the effect of d1hmr on the d1hup1 changes is almost six times bigger than the effect of d1exr in the short run. They are around 12% and 2%, respectively, in the third month. Although the number for d1hmr remains steady at around 13% at the end of the first year, d1exr's effect increases to over 8% in the same period. After, the effects of both variables on d1hup1 changes are almost stable until the end of the second year. The average of these effects for d1exr and d1hmr are around 7% and 13%, respectively, in two years.

Table 27 shows the variance decomposition values of housing unit prices for Turkey from January 2015 to December 2020 in the economic fluctuation period. The table demonstrates how d1hup1 changes are affected by d1exr and d1hmr variables. In the first month, d1hup1 is affected by its movements one hundred percent; however, this number drops to around 83% in the short run. After hitting slightly over 59% at the end of the first year, the number rests steadily during the following months and finished around 57% at the end of the second year. The average number for this effect is around 65% in two years.

Table 27. Variance Decomposition for Model 3-A between 2015 – 2020

Period	S.E.	D1HUP1	D1EXR	D1HMR
1	22.454	100.000	0.000	0.000
2	23.235	93.650	6.082	0.268
3	24.688	82.987	15.879	1.134
4	25.171	82.329	15.532	2.139
5	28.332	74.512	12.487	13.001
6	31.171	67.661	15.819	16.520
7	34.531	62.732	17.184	20.084
8	36.057	63.778	17.202	19.020
9	36.833	62.346	19.363	18.291
10	37.701	60.971	20.935	18.094
11	38.204	60.290	20.797	18.914
12	38.677	59.265	20.391	20.344
13	38.870	58.715	20.791	20.493
14	39.183	57.784	21.842	20.374
15	39.414	57.195	22.595	20.210
16	39.549	56.931	22.941	20.128
17	39.565	56.888	22.988	20.124
18	39.645	56.980	22.904	20.116
19	39.752	57.111	22.795	20.094
20	39.807	57.186	22.735	20.079
21	39.834	57.244	22.704	20.052
22	39.865	57.276	22.701	20.024
23	39.938	57.241	22.689	20.070
24	40.033	57.187	22.619	20.194

Cholesky Ordering: D1HUP1 D1EXR D1HMR

Besides, the effect of d1exr on the d1hup1 changes is fourteen times bigger than the d1hmr's in the short run, which are 15.8% and 1.1%, respectively. However, both of them rise to slightly over 20% at the end of the first year. In the following year, the effect of d1exr increases over 22.5%, while the same number for d1hmr rests around 20%. The average of these effects for d1exr and d1hmr are around 19% and 16%, respectively, in two years.

Moreover, the effect of d1exr on the d1hup1 changes is fourteen times bigger than the d1hmr's in the short run, which are 15.8% and 1.1%, respectively. However, both of them rise to slightly over 20% at the end of the first year. In the following year, the effect of d1exr increases over 22.5%, while the same number for d1hmr rests around 20%. The average of these effects for d1exr and d1hmr are around 19% and 16%, respectively, in two years.

To sum up, the changes in housing unit prices for Turkey are affected by the housing mortgage rate more than they are affected by the nominal exchange rate between 2010 and 2020. However, their effects on the d1hup1 dramatically decreased during the economic stabilization period from 2010 to 2014. Moreover, the effect of d1exr on d1hup1 is more significant than the effect of d1hmr in the short term and the long term while economic instability in the Turkish economy between 2015 and 2020.

4.1.4. Model 4

[hup2, exr, hmr] Model (4)

This section seeks to determine any possible long-run relationship between the housing unit prices for Istanbul (hup2), the nominal exchange rate, and the housing mortgage rate analyzing the monthly data from January 2010 to December 2020. The lag order criteria for Model 4 are indicated in Table 28. As a result, the sixth lag order is selected as optimal length since two more criteria support AIC.

In the next step, JCT is applied to the series 1 to 6 lag intervals to investigate a possible long-run linkage between these variables. Table 29 demonstrates the trace test result for Model 4 at the 1% significance level. As a result, the table accepts the first hypotheses and indicates no cointegration at the 0.01 level. Therefore, there is no long-run relationship between variables. Thus, the first difference of each series is taken, and a VAR analysis is applied to identify the short-run relationship between variables.

Table 28. Lag Order Selection for Model 4

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1553.595	NA	16074482	25.106	25.175	25.134
1	-799.612	1459.322	97.218	13.091	13.363	13.201
2	-743.848	105.233	45.740	12.336	12.814*	12.530
3	-725.922	32.961	39.635	12.192	12.875	12.470*
4	-718.494	13.298	40.704	12.218	13.105	12.578
5	-698.123	35.484	33.952	12.034	13.126	12.478
6	-685.351	21.630*	32.043*	11.973*	13.270	12.500
7	-679.018	10.419	33.588	12.016	13.518	12.626
8	-673.599	8.653	35.778	12.074	13.780	12.767

Table 29. Unrestricted Cointegration Rank Test (Trace) for Model 4

No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None	0.116	30.163	35.458	0.045
At most 1	0.104	14.765	19.937	0.064
At most 2	0.009	1.070	6.635	0.301

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

[d1hup2, d1exr, d1hmr] Model (4-A)

After taking the first difference of the series, a new lag order is selected for the model. Table 30 indicates the lag order selection criteria for Model 4-A. According to the table, the eighth lag order is optimal since FPE and LR support AIC. Next, IRF is applied to the model to identify how series in the model respond to one standard deviation shock on themselves and other series. Besides, how much of the changes in housing unit prices for Istanbul the nominal exchange rate and the housing mortgage rate are responsible for is identified with the VD model.

Figure 15 shows the impulse response function of the variables used in Model 4-A to the shocks causing one standard deviation in the variables, indicated with the blue lines. Moreover, the red dashed lines show the 95% confidence bands. After a shock bringing in one standard deviation change in the exchange rate, housing unit prices for Istanbul react positively in the first five months. Afterward, this reaction becomes negative and almost vanishes after the twenty-third month. In the first two months, the response of hup2 to d1exr shock rises dramatically, and after in declines to around zero until the fourth month and remains steady during the fifth month. Then, it goes down again dramatically until the seventh month. Next, it converges to zero at the end of the second year. In contrast, housing unit prices for Istanbul respond negatively to a one standard deviation shock in housing mortgage rate until the twentieth month. This negative response hits the lowest point in the seventh month and afterward converges to zero by fluctuating until the twentieth month.

Table 30. VAR D-Lag Order Selection for Model 4-A

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-831.983	NA	158.116	13.577	13.646	13.605
1	-761.196	136.969	57.901	12.572	12.847*	12.684
2	-746.940	26.890	53.174	12.487	12.967	12.682
3	-732.397	26.720	48.626	12.397	13.083	12.675
4	-714.195	32.557	41.922	12.247	13.139	12.609*
5	-703.333	18.898	40.756	12.217	13.314	12.663
6	-689.660	23.123	37.889	12.141	13.444	12.670
7	-681.681	13.103	38.685	12.157	13.666	12.770
8	-666.402	24.347*	35.125*	12.055*	13.770	12.752

Table 31 demonstrates the variance decomposition of the housing unit price changes in Istanbul between 2010 and 2020. The table reveals how much of the changes in d1hup2 for two years can be explained by itself and the other two variables. In the first month, d1hup2 is entirely responsible for the changes in itself. However, this number dramatically goes down to around 85% at the end of the first quarter and slightly over 65% at the end of the second quarter. This downward movement continues in the following months and hits under 54% at the end of the first year and finishes off the second year around 50%. Besides, the average number for d1hup2 is around 60% in two years.

Furthermore, d1hup2 changes are affected by d1exr more according to d1hmr in the short run, and this effect is a bit over 13% and around 1.5% for d1exr and d1hmr in the third month, respectively. Although d1hmr’s effect on d1hup2 changes skyrockets to almost 29% at the end of the first year, d1exr’s impact increases to around 17.5% in the same period. Until the end of the second year, d1hmr’s effect reaches over 31.5%. However, d1exr’s impact on d1hup2 changes finishes off the second year slightly under 18.5%. In the examined period, the average impact of d1hmr’s in the first two years is more significant than d1exr’s average impact, which is 23.7% and 16.2, respectively.

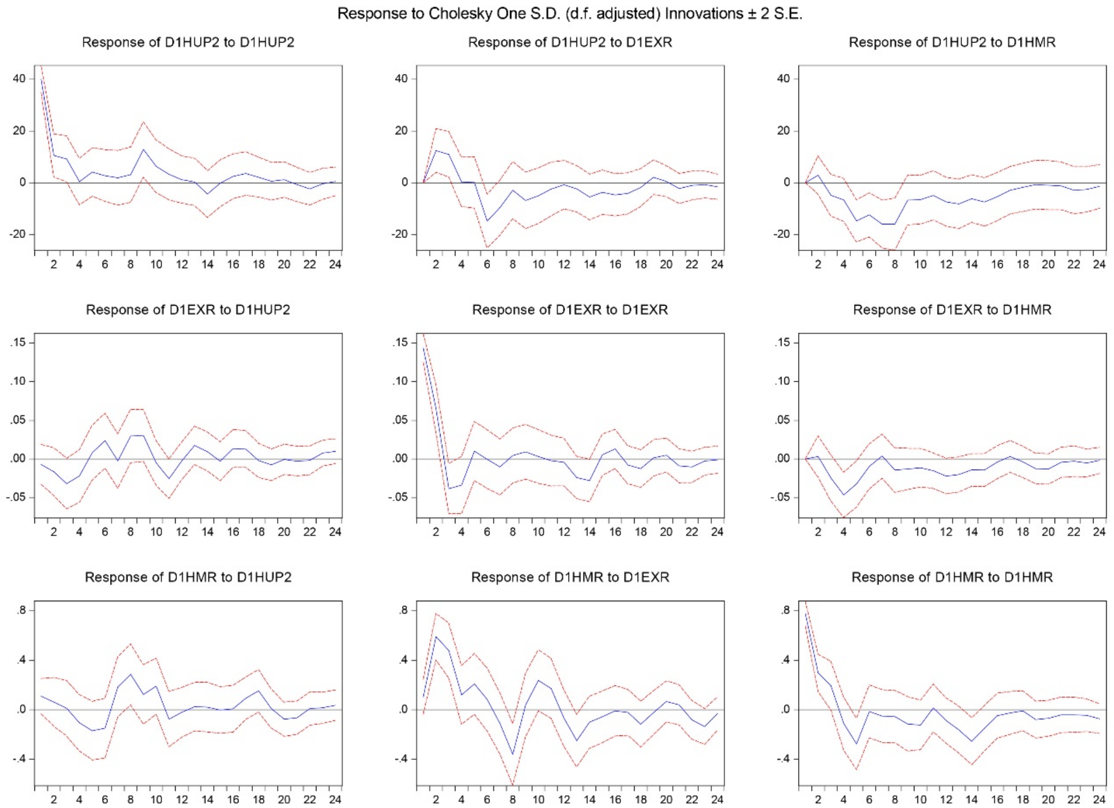

Figure 15. Impulse Response Function of Model 4-A between 2010 – 2020

After, the same VD model is examined by dividing the period into two sub-periods: the period from January 2010 to December 2014 and the period from January 2015 to December 2020. The reason lying behind this division is to determine whether these effects vary according to the economic environment of Turkey. In the second period, the depreciation of TL is much more intense according to the first period.

Table 31. Variance Decomposition for Model 4-A between 2010 – 2020

Period	S.E.	D1HUP2	D1EXR	D1HMR
1	40.100	100.000	0.000	0.000
2	43.415	91.252	8.288	0.460
3	45.991	85.360	13.133	1.507
4	46.464	83.641	12.873	3.486
5	48.903	76.243	11.622	12.135
6	52.633	66.102	17.898	16.000
7	55.854	58.819	18.815	22.365
8	58.235	54.404	17.550	28.046
9	60.401	55.140	17.584	27.276
10	61.283	54.650	17.743	27.607
11	61.608	54.361	17.702	27.938
12	62.058	53.617	17.459	28.924
13	62.631	52.642	17.277	30.081
14	63.315	51.982	17.647	30.371
15	63.851	51.112	17.675	31.213
16	64.292	50.570	17.962	31.468
17	64.584	50.425	18.196	31.379
18	64.670	50.405	18.226	31.369
19	64.713	50.348	18.315	31.337
20	64.734	50.353	18.312	31.335
21	64.785	50.284	18.398	31.319
22	64.897	50.239	18.358	31.403
23	64.950	50.160	18.337	31.503
24	64.983	50.116	18.371	31.513

Cholesky Ordering: D1HUP2 D1EXR D1HMR

Table 32 shows the variance decomposition of d1hup2 for the period from January 2010 to December 2014. The table indicates that d1hup2 is responsible for the changes in itself one hundred percent in the first month. In the short run, this number goes down to over 96%; however, it drops to under 79% at the end of the first year. This decrease slows down in the following year, and it finished off the second year around 76.5%. The average number for d1hup2's impact is slightly over 82% in the first two years.

On the other hand, d1hmr's impact on d1hup2 is almost six times bigger than d1exr's impact in the short run, which is over 3.2% and 0.5 for d1hmr and d1exr, respectively at the end of the first quarter. The number for d1hmr reaches 11.7% at the end of the first year. Moreover, the number for d1exr increases to over 9.5% in the same period. However, this upward movement speeds down for both. Thus, d1hmr's and d1exr's effect on d1hup2 changes finish off the second year around 13% and 10%, respectively. Besides, the average number for them in two years is 10% and 8%, respectively.

Table 33 demonstrates the variance decomposition of d1hup2 between January 2015 and December 2020. The table shows changes in hup2 for two years and how much of this change can be explained by itself and the other two variables. As a result, d1hup2 is entirely responsible for the changes in itself in the first month. However, this number decreases dramatically to under 80% in the following two months. This downward trend continues, and it hits around 43.5% at the end of the first year. However, this decrease winds down in the following period, finishing off the second year under 41%.

Moreover, during economic instability, d1exr's effect on d1hup2 changes are almost seven times bigger than d1hmr's effect on d1hup2 changes in the short run. Although d1exr's impact is over 17.5% in the third month, d1hmr's effect is slightly over 2.6% in the same period. Afterward, the number for d1exr rises to slightly over 21.7% at the end of the first year. On the contrary, the number for d1hmr skyrockets to almost %35 in the same period. At the end of the second year, d1exr's impact and d1hmr's impact on d1hup2 changes finish off the year around 24% and 35%, respectively. In the examined period, the average impact of d1hmr's in the first two years is more significant than d1exr's average impact, which is 27.8% and 20.6, respectively.

All in all, housing unit price changes in Istanbul are affected by the housing mortgage rate more than by the nominal exchange rate between 2010 and 2020. Nevertheless, their effects on the d1hup1 dramatically decrease under 10% during the economic stabilization period from 2010 to 2014. Moreover, the effect of d1exr on d1hup1 is more significant than the effect of d1hmr in the short term during economic instability in the Turkish economy. However, d1hmr is responsible for a more considerable change in d1hup2 at the end of the two years between 2015 and 2020.

Table 32. Variance Decomposition for Model 4-A between 2010 – 2014

Period	S.E.	D1HUP2	D1EXR	D1HMR
1	24.458	100.000	0.000	0.000
2	26.003	96.357	0.048	3.594
3	27.462	96.169	0.568	3.263
4	28.583	88.776	4.661	6.563
5	29.989	85.446	7.877	6.678
6	30.922	85.307	8.322	6.371
7	31.261	83.844	8.279	7.877
8	31.443	83.036	8.428	8.536
9	31.602	82.705	8.812	8.483
10	32.379	81.679	8.517	9.803
11	32.903	80.319	9.775	9.907
12	33.248	78.715	9.580	11.705
13	33.445	78.225	9.497	12.278
14	33.703	78.545	9.352	12.103
15	34.196	77.714	9.501	12.786
16	34.305	77.788	9.440	12.772
17	34.421	77.379	9.702	12.919
18	34.616	76.946	9.594	13.460
19	34.806	76.936	9.500	13.564
20	34.996	76.712	9.845	13.443
21	35.047	76.767	9.823	13.410
22	35.097	76.713	9.914	13.373
23	35.208	76.653	10.036	13.311
24	35.280	76.688	10.045	13.267

Cholesky Ordering: D1HUP2 D1EXR D1HMR

Table 33. Variance Decomposition for Model 4-A between 2015 – 2020

Period	S.E.	D1HUP2	D1EXR	D1HMR
1	49.935	100.000	0.000	0.000
2	54.220	88.578	10.769	0.654
3	58.203	79.584	17.747	2.669
4	58.993	77.495	17.339	5.166
5	62.669	68.775	15.500	15.725
6	68.868	57.002	22.996	20.001
7	74.204	49.101	22.974	27.925
8	78.296	44.305	20.859	34.836
9	81.773	45.503	20.925	33.573
10	82.818	44.676	21.539	33.785
11	83.338	44.251	21.656	34.093
12	84.051	43.511	21.778	34.711
13	85.140	42.418	21.979	35.604
14	86.718	42.049	22.757	35.194
15	87.607	41.215	22.742	36.042
16	88.335	40.780	23.228	35.992
17	88.886	40.768	23.654	35.578
18	88.972	40.792	23.693	35.515
19	89.058	40.741	23.795	35.464
20	89.077	40.752	23.786	35.461
21	89.255	40.676	24.001	35.323
22	89.520	40.863	23.919	35.218
23	89.593	40.796	23.885	35.319
24	89.635	40.777	23.931	35.292

Cholesky Ordering: D1HUP2 D1EXR D1HMR

4.2. Results for Construction Cost Index Models

4.2.1. Model 5

[ppi, exr, imp, emr] Model (5)

This section investigates the long-run relationship between the producer price index in Turkey and the other three variables: exr, imp, and emr, by analyzing the collected data between January 2015 and December 2020. Table 34 shows the lag order selection criteria for Model 5. According to the table, the second lag order is selected as optimal length since three more criteria support SC.

Table 34. Lag Order Selection for Model 5

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-681.123	NA	12207.6	20.761	20.894	20.814
1	-327.938	652.857	0.446	10.544	11.207	10.806
2	-263.520	111.268*	0.104*	9.076	10.270*	9.548*
3	-248.334	24.390	0.108	9.101	10.826	9.783
4	-231.055	25.658	0.106	9.062*	11.318	9.954
5	-218.969	16.481	0.125	9.181	11.968	10.282
6	-207.063	14.791	0.151	9.305	12.623	10.616

Then, the JCT is employed with 1 to 2 lag intervals to determine whether there is a long-run relationship between variables. Table 35 shows the result of the trace test at the 1% significance level. According to the table, the test accepts the first hypotheses and indicates no cointegration at the 0.01 level, showing no long-run relationship between variables. Consequently, the first difference of each series is taken, and a VAR analysis is applied to identify the short-run relationship between variables.

Table 35. Unrestricted Cointegration Rank Test (Trace) for Model 5

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.299	48.170	54.682	0.047
At most 1	0.178	23.702	35.458	0.213
At most 2	0.108	10.178	19.937	0.267
At most 3	0.033	2.323	6.635	0.128

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

[d1ppi, d1exr, d1imp, d1emr] Model (5-A)

After taking the first difference of the series, a new lag order is selected for the model. Table 36 indicates the lag order selection criteria for Model 5-A. According to the table, the first lag order is selected as it is optimal length according to AIC and SC at the same time. After, IRF is employed to identify how each variable in the model responds to the one standard deviation shocks originating from other variables. Moreover, VD is applied to the model, and how much of the changes in the Producer Price Index in Turkey can be explained by itself and the other three variables in the first year.

Table 36. VAR D-Lag Order Selection for Model 5-A

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-366.121	NA	1.038	11.388	11.522	11.441
1	-285.937	148.032	0.144*	9.413*	10.082*	9.677*
2	-270.228	27.067*	0.146	9.422	10.627	9.898
3	-255.270	23.933	0.153	9.454	11.194	10.141
4	-241.197	20.784	0.167	9.514	11.789	10.411
5	-231.241	13.480	0.211	9.700	12.510	10.808
6	-215.342	19.568	0.227	9.703	13.048	11.023

Figure 16 indicates the impulse response function of the variables used in Model 5-A to the shocks causing one standard deviation in the variables, indicated with the blue lines. Moreover, the red dashed lines show the 95% confidence bands. The response of d1ppi to the d1exp shock is positive in the first five months. However, this response turns negative between the fifth and ninth months and afterward converges to zero. This reaction increases dramatically in the first two months and then starts to decline until the seventh month when it hits the lowest point. By increasing slightly, it finishes off the first year.

Regarding the response of d1ppi to d1imp shock, it is positive in the first four months. However, it turns negative then until it converges to equilibrium in the eighth month. Although this response is similar to the response of d1ppi to d1exr in terms of its movement, the size of this response is much smaller. On the other hand, d1ppi's reaction to the shock originated from d1emr is positive in the first seven months when it converges to its equilibrium. This reaction rises in the first three months and remains steady in the following two months. Then, it finishes off the next two months by decreasing.

Table 37 demonstrates the variance decomposition of the producer prices index in Turkey between January 2015 and December 2020. The table indicates the number of changes in d1ppi for one year and how much of this change can be explained by itself and the other three variables. As a result, the changes in d1ppi is one hundred percent

Table 37. Variance Decomposition for Model 5-A between 2015 – 2020

Period	**S.E.**	**D1PPI**	**D1EXR**	**D1IMP**	**D1EMR**
1	5.234	100.000	0.000	0.000	0.000
2	7.131	86.453	11.752	1.572	0.222
3	7.518	79.184	17.496	1.614	1.707
4	7.700	77.768	17.324	1.601	3.307
5	7.897	77.685	16.675	1.739	3.901
6	7.983	77.313	16.908	1.816	3.964
7	7.996	77.113	17.107	1.825	3.956
8	8.000	77.117	17.107	1.824	3.953
9	8.005	77.127	17.098	1.826	3.949
10	8.006	77.114	17.111	1.827	3.948
11	8.007	77.108	17.115	1.826	3.951
12	8.007	77.107	17.113	1.827	3.953

Cholesky Ordering: D1PPI1 D1EXR D1IMP D1EMR

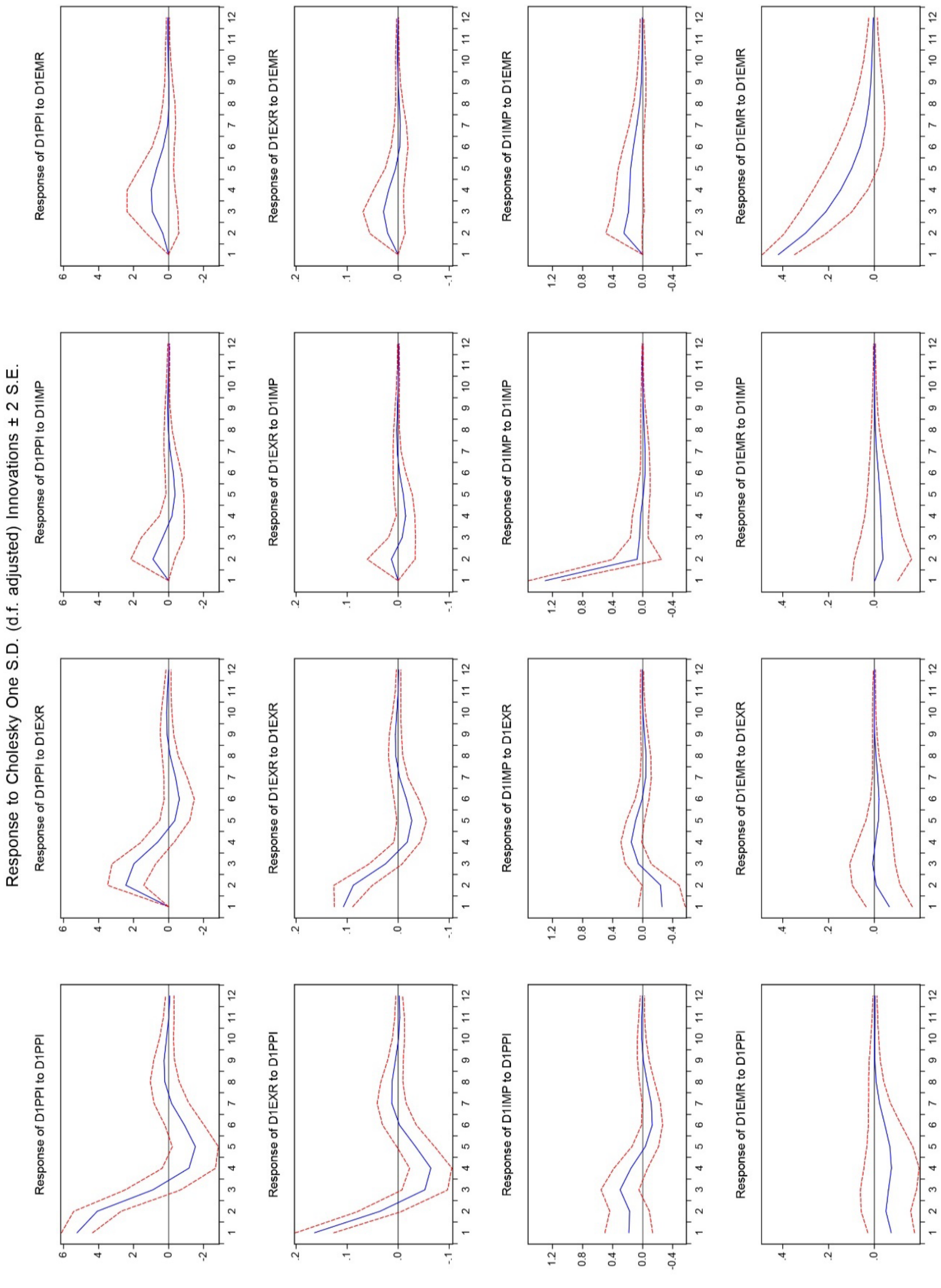

Figure 16. Impulse Response Function of Model 5-A between 2015 – 2020

originated from itself in the first month. However, this number declines sharply to around 80% in the next two months. Then this downward trend speeds down until the end of the year, and it finishes off slightly over 79%.

4.2.2. Model 6

[cci1, exr, imp, emr]   Model (6)

For the monthly data from January 2015 to December 2020, this section explores the long-run relationship between the construction cost index for Turkey and the other three variables: exr, imp, and emr, by using VAR models. Table 38 shows the lag order selection criteria for Model 6. According to the table, the second lag order is selected as optimal length since they all support it simultaneously.

Table 38. Lag Order Selection for Model 6

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-632.403	NA	2788.980	19.285	19.418	19.337
1	-302.139	610.488	0.204	9.762	10.425	10.024
2	-252.956	84.952*	0.075*	8.756*	9.951*	9.228*
3	-239.434	21.717	0.082	8.831	10.557	9.513
4	-223.471	23.704	0.084	8.832	11.088	9.724
5	-217.671	7.908	0.120	9.142	11.928	10.243
6	-208.665	11.190	0.159	9.353	12.671	10.664

In the next step, JCT is applied to the series 1 to 2 lag intervals to investigate a possible long-run relationship between these variables. Table 39 demonstrates the trace test result for Model 6 at the 1% significance level. As a result, the table accepts the first hypotheses and indicates no cointegration at the 0.01 level. Therefore, there is no long-run relationship between variables. Thus, the first difference of each series is taken, and a VAR analysis is applied to identify the short-run relationship between variables.

After taking the first difference of the series, a new lag order is selected for the model. Table 40 shows the lag order selection criteria for Model 6-A. According to the table, the second lag order is selected as optimal length since LR and FPE support AIC. After, IRF is employed to identify how each variable in the model responds to the shocks originating from other variables. Moreover, VD is applied to the model, and how much of the changes in Construction Cost Index for Turkey can be explained by itself and the other three variables in one year.

Table 39. Unrestricted Cointegration Rank Test (Trace) for Model 6

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.297	44.782	54.682	0.095
At most 1	0.178	20.440	35.458	0.394
At most 2	0.061	6.910	19.937	0.588
At most 3	0.036	2.561	6.635	0.110

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

Table 40. VAR D-Lag Order Selection for Model 6-A

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-317.369	NA	0.231	9.888	10.022	9.941
1	-276.123	76.147	0.107	9.111	9.780*	9.376*
2	-259.192	29.172*	0.104*	9.083*	10.287	9.558
3	-246.430	20.420	0.117	9.182	10.922	9.869
4	-237.384	13.359	0.149	9.396	11.671	10.294
5	-230.083	9.885	0.204	9.664	12.474	10.773
6	-218.029	14.836	0.247	9.786	13.131	11.105

Figure 17 shows how each variable responds to one standard deviation shock from itself and the other three variables in the model for one year. These responses are indicated with the blue lines, and the red dashed lines show the 95% confidence bands. The response of d1cci1 to d1exr shock is positive in the first three months and between the sixth and eighth months. In the other months, it is negative until it converges to equilibrium towards the end of the year. This response increases sharply until the second month; then, it decreases until the fourth month and hits the lowest point. Next, it increases and remains stable between the sixth and seventh months. After, it finishes off the year by slightly fluctuating. Additionally, d1cci1 responds positively to d1imp shock, and it converges to the equilibrium before the fourth quarter. This response rises in the first two months; after, it starts to decline. After the stabilization period during the fourth month, it finishes off the year by decreasing. On the other hand, d1cci1's reaction to d1emr's shock is adverse in the first seven months and smaller than the others.

Table 41 demonstrates the variance decomposition of the construction cost index in Turkey between January 2015 and December 2020. The table indicates the variance decomposition of the changes in d1cci1. In the first month, d1cci1 explains one hundred percent of the changes in itself. However, this number declines to slightly under 80% in the third month. By decreasing, it finishes off the year around 72%. On the other hand, d1imp is responsible for almost 3% of the changes in d1cci1 in the short run. Then, it reaches around %4 at the end of the year. However, this number for d1emr is not significant in the short run and under 1% at the end of the year. All in all, one standard deviation shock to the nominal exchange rate affects the producer price index more than it impacts the construction cost index according to Impulse Response Function.

Table 41. Variance Decomposition for Model 6-A between 2015 – 2020

Period	S.E.	D1CCI1	D1EXR	D1IMP	D1EMR
1	2.704	100.000	0.000	0.000	0.000
2	3.171	80.160	17.896	1.936	0.008
3	3.196	79.354	17.620	2.854	0.172
4	3.313	74.092	21.988	3.533	0.387
5	3.341	73.013	22.390	3.885	0.712
6	3.353	72.528	22.640	3.895	0.937
7	3.360	72.248	22.891	3.889	0.972
8	3.361	72.230	22.882	3.915	0.973
9	3.363	72.160	22.924	3.932	0.984
10	3.364	72.150	22.926	3.935	0.989
11	3.364	72.148	22.928	3.934	0.989
12	3.364	72.147	22.930	3.934	0.989

Cholesky Ordering: D1CCI1 D1EXR D1IMP D1EMR

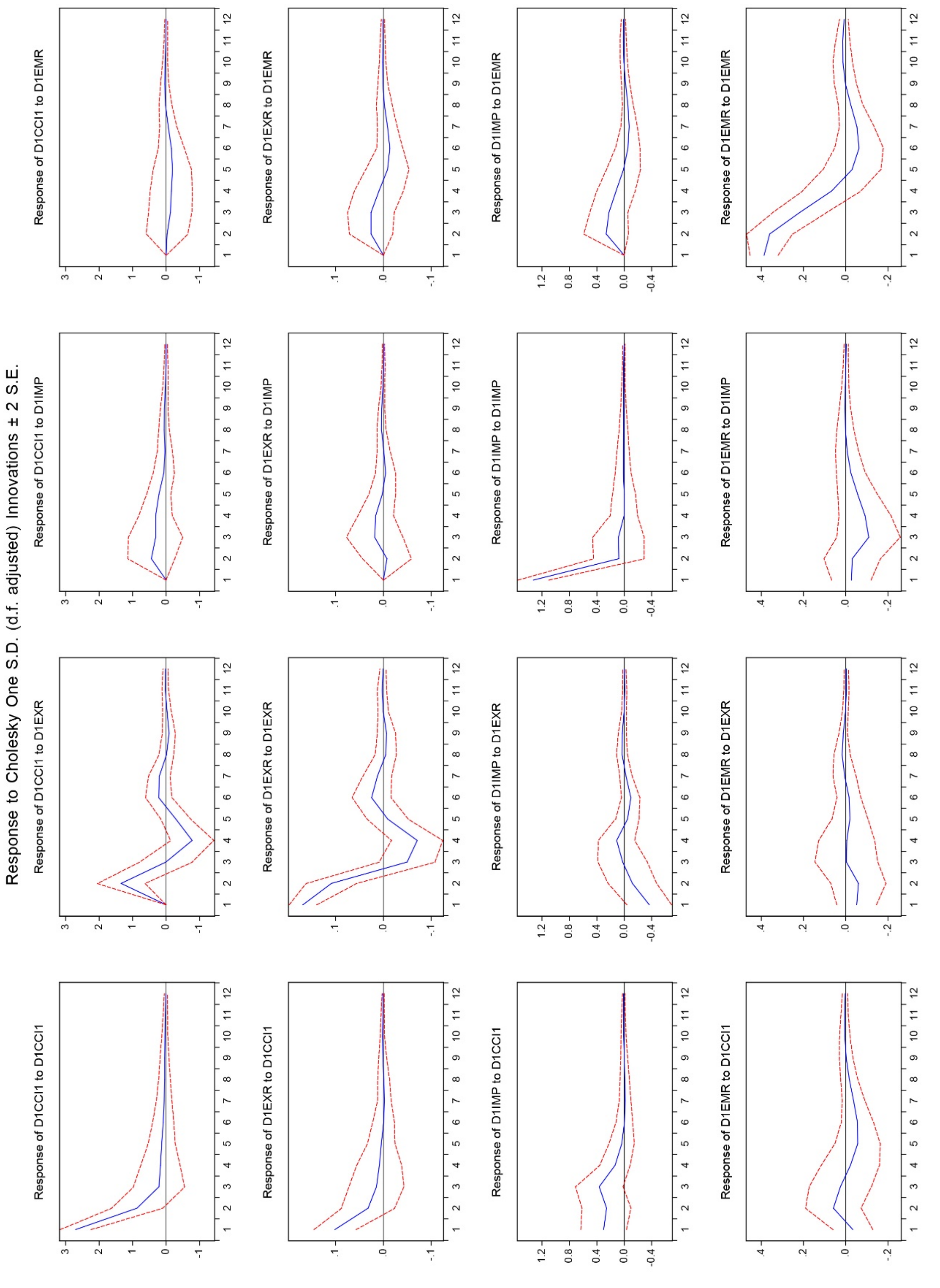

Figure 17. Impulse Response Function of Model 6-A between 2015 – 2020

Moreover, variance decompositions of the dependent variables indicate that the nominal exchange rate is responsible for a more considerable portion of construction cost index changes compared to its responsibility in the producer price index changes.

4.2.3. Model 7

[cci2, exr, imp, emr] Model (7)

This section investigates the long-run relationship between the construction cost index (materials) for Turkey and the other three variables: exr, imp, and emr between January 2015 and December 2020. Table 42 shows the lag order selection criteria for Model 7. According to the table, the third lag order is selected as optimal length since two other criteria support AIC.

Table 42. Lag Order Selection for Model 7

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-611.344	NA	1473.332	18.647	18.779	18.699
1	-275.751	620.338	0.092	8.962	9.626	9.224
2	-210.221	113.188	0.021	7.461	8.656*	7.933*
3	-192.655	28.213*	0.020*	7.414*	9.139	8.095
4	-177.528	22.461	0.021	7.440	9.696	8.332
5	-169.346	11.158	0.028	7.677	10.464	8.778
6	-153.127	20.150	0.030	7.671	10.988	8.981

Then, the Johansen Cointegration Test is employed with 1 to 3 lag intervals to determine whether there is a long-run relationship between variables. Table 43 shows the result of the trace test at the 1% significance level. According to the table, the test accepts the first hypotheses and indicates no cointegration at the 0.01 level. Therefore, there is no long-run relationship between the variables. Thus, the first difference of each series is taken, and a VAR analysis is applied to identify the short-run relationship between them.

Table 43. Unrestricted Cointegration Rank Test (Trace) for Model 7

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.305	46.244	54.682	0.070
At most 1	0.189	21.462	35.458	0.330
At most 2	0.068	7.247	19.937	0.549
At most 3	0.036	2.462	6.635	0.117

* Denotes rejection of the hypothesis at the 0.01 level
** MacKinnon-Haug-Michelis (1999) p-values

[d1cci2, d1exr, d1imp, d1emr] Model (7-A)

After taking the first difference of the series, a new lag order is selected for the model. Table 44 shows the lag order selection criteria for Model 7-A. According to the table, the second lag order is selected as optimal length since LR and FPE support AIC. After, IRF is employed to identify how each variable in the model responds to the shocks originating from other variables. Moreover, VD is applied to the model, and how much of the changes in Construction Cost Index (material) for Turkey can be explained by itself and the other three variables in one year.

Figure 18 represents the impulse response function of the variables used in Model 7-A to the shocks causing one standard deviation in the variables, indicated with the blue lines. Moreover, the red dashed lines show the 95% confidence bands. After a shock bringing in one standard deviation change in the exchange rate, d1cci2 increases until the end of the second month. After decreasing until the fourth month, it starts to incline, and the movement continues by fluctuating in the following periods. On the other hand, d1cci2's response to d1imp is positive throughout the first year. This response rises in the first four months; then, it converges to the equilibrium towards the end of the year. In addition, d1cci2's reaction to one standard deviation shock in d1emr increases in the first two months and remains stable during the next month. Then, it starts to decrease and turn negative in the fourth month. After hitting the lowest point in the sixth month, it goes up until the end of the year.

Table 44. VAR D-Lag Order Selection for Model 7-A

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-307.960	NA	0.173	9.599	9.733	9.652
1	-232.679	138.980	0.028	7.775	8.444*	8.039*
2	-215.114	30.266*	0.027*	7.727*	8.931	8.202
3	-200.797	22.907	0.029	7.778	9.518	8.465
4	-191.868	13.187	0.037	7.996	10.271	8.893
5	-183.512	11.313	0.049	8.231	11.041	9.340
6	-173.817	11.933	0.063	8.425	11.770	9.745

Table 45. Variance Decomposition for Model 7-A between 2015 – 2020

Period	S.E.	D1CCI2	D1EXR	D1IMP	D1EMR
1	2.379	100.000	0.000	0.000	0.000
2	3.335	97.123	2.065	0.175	0.636
3	3.516	95.758	2.236	0.717	1.289
4	3.677	89.330	8.136	1.340	1.194
5	3.848	85.082	11.497	1.452	1.970
6	3.983	84.331	11.335	1.443	2.891
7	4.061	84.153	11.029	1.528	3.290
8	4.108	83.683	11.189	1.701	3.426
9	4.154	83.036	11.648	1.826	3.490
10	4.198	82.702	11.889	1.876	3.533
11	4.233	82.609	11.933	1.902	3.557
12	4.257	82.520	11.977	1.931	3.573

Cholesky Ordering: D1CCI2 D1EXR D1IMP D1EMR

Table 45 demonstrates the variance decomposition of construction cost index (material) changes between 2015 and 2020. The table reveals how much of the changes in d1cci2 for one year can be explained by itself and the other three variables. In the first month, one hundred percent of d1cci2 changes can be explained by its movement. This number decreases to under 96% in the third month, and it finishes off the year around82.5%. In the short run, d1imp's effect and d1emr's effect on d1cci2 changes are around 0.7% and 1.3%, respectively. Then, these numbers increase to over 1.9% and 3.5% at the end of the year.According to IRF figures, Construction Cost Index's response to one standard deviation shock in the exchange rate is more intense and quicker than its material component in the short run. However, the overall movement is similar in these two construction cost indexes in the first twelve months. As a percentage, the nominal exchange rate's impact on the construction cost index changes is more significant than its responsibility in the construction cost index (material) in the first year.

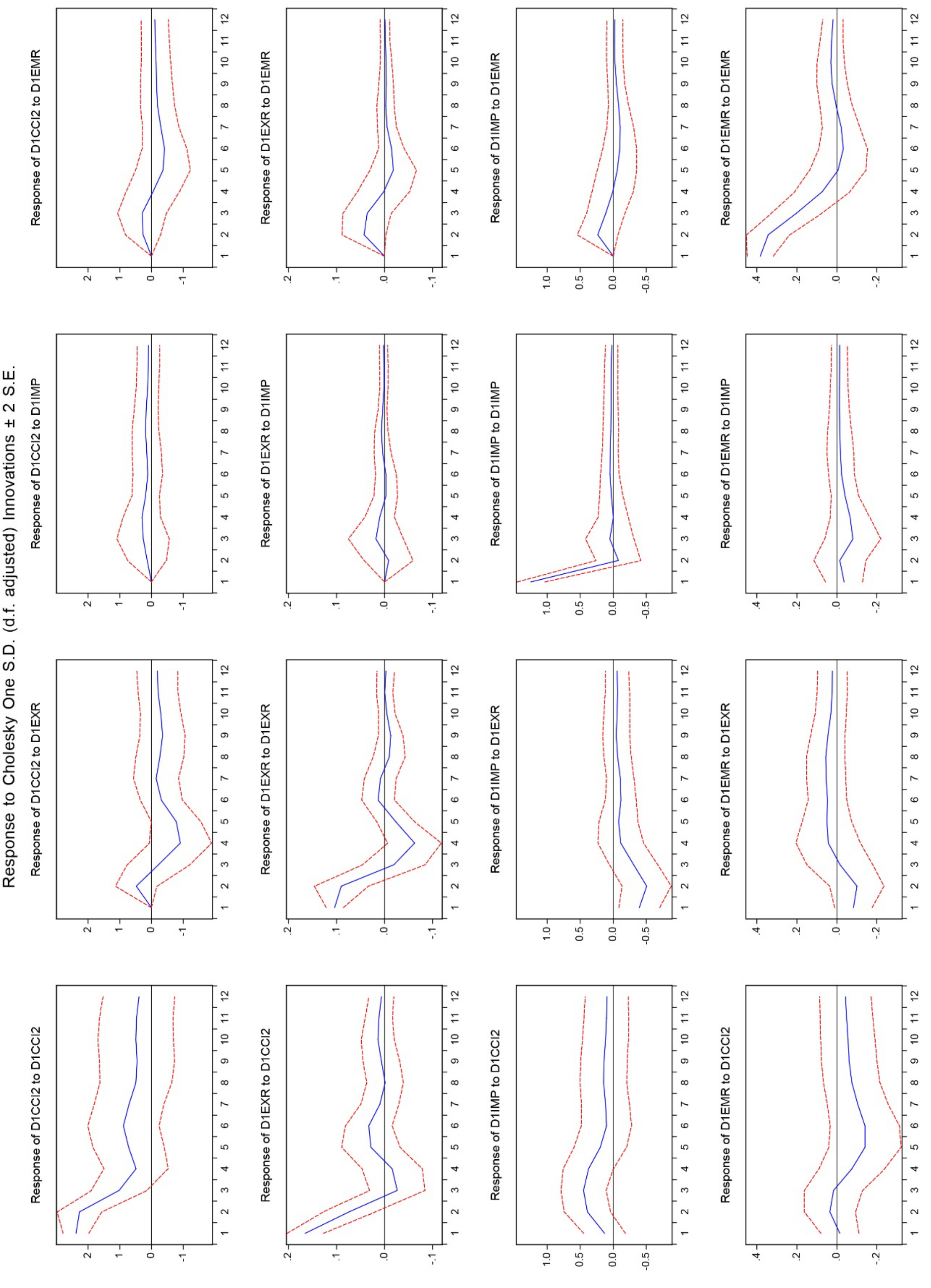

Figure 18. Impulse Response Function of Model 7-A between 2015 – 2020

CHAPTER 5

CONCLUSION

Exchange rate pass-through to domestic prices in Turkey has already been covered extensively in the literature. While determining this effect, other macroeconomic variables have been included in the process to uncover the linkage between these variables and the domestic prices. Because this determination is significant for the governments to control their monetary policies and the others to understand any market or industry fully. In this thesis, the pass-through effect was examined in two parts. First, pass through into housing unit prices in Turkey was examined since buying a house is a popular investment tool in Turkey and the economic environment of Turkey impacts this market intensively. Second, a similar effect on the construction cost index in Turkey was investigated as the construction industry plays a pivotal role in Turkey's economy.

By analyzing the collected monthly data from January 2010 to December 2020 with Vector Error Correction Models, a long-run relationship at the 0.01 level was revealed between the consumer price index and other four macroeconomic variables: the nominal exchange rate, housing mortgage rate, import unit value index and employment rate. In addition, the necessary time for the equilibrium after short-run shocks is around ten months. However, a similar long-run relationship could not be found between housing unit prices for Turkey and the same four macroeconomic variables in the same period.

After differencing the series, Variance Decomposition and Impulse Response Function are employed in the following models since there is no cointegration between the variables. As a result, housing unit prices for Turkey (hup1) between 2010 and 2020 are affected by the nominal exchange rate much more than it is affected by the housing mortgage rate in the first three months. However, the housing mortgage rate's impact on hup1 movements rises over the nominal exchange rate's impact at the end of the second year. During the economic stabilization between 2010 and 2014, both variables' effect on hup1 diminishes in the first two years, although the housing mortgage rate's effect is still more significant than the nominal exchange rate in the first three months and at the end of the second year. On the other hand, the exchange rate's effect on hup1 during economic fluctuation between 2015 and 2020 is more significant at the end of the second year. In simple words, the housing unit prices for Turkey are affected by the nominal exchange rate more than it is affected by the housing mortgage rate in the first two years during economic fluctuation. However, this effect reverses during economic stabilization in the Turkish economy.

On the other hand, housing unit prices for Istanbul (hup2), the most crowded city in Turkey, are affected by the nominal exchange rate more than it is affected by the housing mortgage rate in the first three months between January 2010 and December 2020. However, the housing mortgage rate's effect on hup2 becomes more significant than the nominal exchange rate at the end of the second year. While economic stabilization in the Turkish economy, hup2 is much less affected by these two variables. However, their effects on hup2 increase dramatically during economic fluctuation between 2015 and 2020.

The housing mortgage rate's effect on the housing unit prices for Istanbul is much more significant than its effect on the housing unit prices for Turkey between 2010 and 2020. However, there is no significant difference between the nominal exchange rate's effects on the housing unit prices for Istanbul and Turkey in the same period.

Moreover, the same procedure was followed to determine the relationship between the construction cost index and three macroeconomic variables: the nominal exchange rate, import unit value index, and employment rate in Turkey between 2015 and 2020. Besides, this pass-through effect was compared with the producer price index. In the short run, the nominal exchange rate's effect on the construction cost index and producer price index are almost similar. However, its effect on the construction cost index becomes more significant in the first year. The construction cost index and the producer price index are both affected by the nominal exchange rate most. Although the second most substantial impact on the construction cost index is originated from the import unit value index, the producer prices index is affected by the employment rate more than it is affected by the import unit value index. Moreover, the construction cost index's material component is much less affected by the nominal exchange rate in the short run and at the end of the first year.

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