AN EMPIRICAL ANALYSIS ON THE EFFECT OF OIL PRICES ON PRODUCER PRICE INFLATION IN TÜRKİYE

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An Empirical Analysis on the Effect of Oil Prices

on Producer Price Inflation in Türkiye

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ABSTRACT

An Empirical Analysis on the Effect of Oil Prices

on Producer Price Inflation in Türkiye

Oil is one of the backbones of the economic structure of the world we live in today and plays an important role in Türkiye's economy. Since Türkiye is an energy importing country, it is deemed important to investigate how the changes in global oil prices would affect inflation in Türkiye. The methodology utilized in this thesis was using a ARDL model for the relationship between the changes in the domestic producer price in Türkiye, the changes in the exchange rates, the changes in the Eurozone total industrial producer price index, the changes in the prices of futures contracts of oil, the changes in the minimum wages and the changes in the money supply and a dummy variable. The outcome suggests that there is a statistically significant and positive relationship between the changes in the prices of futures contracts of oil and the changes in the domestic PPI of Türkiye in the above mentioned forms.

ÖZET

Petrol Fiyatlarının Türkiye’deki Üretici Fiyat Enflasyonuna Etkisi Üzerine Ampirik Bir Analiz

Petrol, günümüz ekonomilerinin bel kemiklerinden birini oluşturmaktadır ve Türkiye Cumhuriyeti'nin de ekonomisinde önemli bir rol oynamaktadır. Türkiye, enerji ithal eden bir ülke olduğundan, global petrol fiyatları ile Türkiye’deki enflasyon arasındaki ilişkinin incelenmesinin önemli olduğu düşünülmüştür. Bu analiz; petrol kontratları fiyatlarındaki, yerli üretici fiyat endeksindeki, kurdaki, asgari ücretlerdeki, Eurozone toplam endüstriyel üretici fiyat endeksindeki ve para arzındakındaki aylık birim değişim verileri kullanılarak ve bir dummy değişken kullanılarak kurulan bir ARDL modeli ile yapılmıştır. Sonuçlar, bahsi geçmiş birimlerde, Türkiye’deki yerli üretici fiyat endeksindeki değişimler ile petrol kontratlarının fiyatlarının değişimleri arasında istatistiksel olarak anlamlı ve pozitif bir ilişki göstermektedir.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION……...…..1

CHAPTER 2: LITERATURE REVIEW……..……6

CHAPTER 3: METHODOLOGY & EMPIRICAL ANALYSIS…….....…12

3.1 Data description…….……..12

3.2 Methodology & empirical analysis……..…14

CHAPTER 4: RESULTS & DISCUSSION……...…29

CHAPTER 5: CONCLUSION…….…….31

APPENDIX: UNIT ROOT TEST RESULTS…….……...…33

REFERENCES……..….40

LIST OF TABLES

Table 1. The Correlation Matrix……..……...……...……18

Table 2. Estimations of the ARDL Model……...…..……20

Table 3. Ramsey RESET Test Outcome……...……..…….24

Table 4. Serial Correlation LM Test……...…..….……26

Table 5. Normality Test Results……...…..……...….27

Table 6. Heteroskedasticity Test Results…….....…….……..28

Table 7. ADF Test Outcome for “dppi_change”……..…….....…....…33

Table 8. ADF Test Outcome for “dppi_change” in first differences…..…...……..34

Table 9. ADF Test Outcome for “e_rate_change”.....35

Table 10. ADF Test Outcome for “m3_change”……..…....……36

Table 11. ADF Test Outcome for “oil_futures_change”.....37

Table 12. ADF Test Outcome for “min_wage_change”.....38

Table 13. ADF Test Outcome for “eurozone_total_ind_change”.....39

LIST OF FIGURES

Figure 1. The plot of “dppi_change”.....14

Figure 2. The plot of “e_rate_change”.....15

Figure 3. The plot of “m3_change”.....15

Figure 4. The plot of “oil_futures_change”.....16

Figure 5. The plot of “min_wage_change”.....16

Figure 6. The plot of “eurozone_total_ind_change”.....17

Figure 7. The plot of “dummy”.....17

Figure 8. CUSUM results.....22

Figure 9. CUSUM of squares results.....23

CHAPTER 1

INTRODUCTION

Global oil prices have been historically dynamic while inflation rates in most of the countries have been unstable including Türkiye. The policies in the Turkish economy to stabilize the inflation while supplying the necessary energy demands is vital. The investigation of the relation between these two important variables is deemed to reveal insight. Understanding this relationship in the case of Türkiye is amongst the motivations of this thesis.

In the most generalized definition, inflation is the constant monitoring of where the general price levels of goods & services are trending towards (Humpage, 2008). There are numerous types of inflation. Consumer Price Index (CPI) is used to estimate the general price changes in the economy from the view of the final consumer. Another type of inflation is the producer price inflation which is tracked by the producer price index (PPI). Since the supply chains can be made up of multiple links between the producers and the final consumers, this index tracks the prices received by the producers for their efforts, not from the final consumers but at the backstage of the supply chains (Majaski, 2024). The PPI keeps track of what has been paid to the producers (Majaski, 2024). In this regard, the CPI approaches the inflation from the consumers' perspective and the PPI approaches from the other side of the equation. The CPI & PPI are not necessarily alternatives to each other but more of different pieces to the same puzzle where when they are used together one can get a clearer image of the general situation in the economy.

Determining the causes of inflation is a highly important step in macroeconomic studies (Humpage,2008; Fernando, 2022; Fernando, 2024). The

Keynesian approach has two general classifications of inflation regarding the causes: “Demand-pull” and “Cost-push” types of inflation. The “Cost-push” type suggests that when the costs of production increases in a way to affect the economy as a total, the general prices of goods and services increase as well, that is, the producers reflect the increased production costs to their customers in order to maintain their margins on the profit (Fernando, 2022). The “Demand-pull” type suggests that the inflation is caused due to the shift of balance between the aggregate supply and aggregate demand (Fernando, 2022). It is suggested that when there is an imbalance of aggregate supply and aggregate demand in favor of aggregate demand, inflation occurs (Fernando, 2022). Monetarist approaches offer another view regarding the cause of inflation, suggesting that the inflation moves are positively correlated with the money supply in the economy (Fernando, 2022).

Türkiye has always had a dynamic relationship with inflation. When the last fifty years alone are investigated, it can be seen that In 1980, the inflation (CPI) rate was hovering around %130, then it dropped to about 25% in 1982 (corresponds to the time after when the January 24th decisions were passed in order to reform Türkiye’s economy dramatically to a more liberal one) and it rose to %130 again in 1990. It was 35.9% in the beginning of 2001 and was 68.5% at the end of it (corresponds to the 2001 crisis) (Trading Economics, n.d.-a). The inflation hovered around 10% in the mid 2000’s and as of July 2024 it is 61.78% (Trading Economics, n.d.-a).

Oil, one of the backbones of the industrial world, can be considered an actor regarding the effects on CPI (Sek, Teo & Wong, 2015). A similar statement regarding the dynamism about the inflation can also be articulated about the global crude oil prices. In July 2008 the Brent Europe crude oil was sold for about 132 USD per

barrel and in the last month of that same year the price was about 40 USD (Federal Reserve Bank of St. Louis, n.d.). The prices climbed to about 125 USD per barrel in early 2012 where the USD per barrel was at about 32 early 2016 (Federal Reserve Bank of St. Louis, n.d.) . Yet how do these prices move so much? The factors that play into the prices of oil have been divided into groups (Kosakowski, 2024). The first one is how demand & supply works together as in the very basics of economic theory. The second one is the cost structure and situation regarding the production of oil and the final one is the conditions of the market participants & expectations etc (Kosakowski, 2024). These all make sense however, when it comes to oil, there is another very important player that is “OPEC”. “OPEC” is an organization that is made up of some of the countries that export oil which collectively account for the two fifths of the global production and the thing about OPEC is that the organization has “control” to affect the global market (Kosakowski, 2024).

Another key term is the total energy supply (TES). TES is a parameter that keeps track of the difference between the inflow (production, import) and the outflow (export, storage) of energy in a nation (International Energy Agency, n.d.). As of 2022, according to the International Energy Agency (n.d.), natural gas & oil are two highest shareholders of the “total energy supply” in Türkiye. This value alone is sufficient to show how important the dynamics of oil and natural gas is to Türkiye. In addition, Türkiye, historically, has been an energy importing country (International Energy Agency, n.d.), referring that the energy generated is lower than the energy consumed by the country (Gökmen & Temiz, 2014). The net energy imports of Türkiye accounts for 73.6% of the total energy supply as of 2022 (International Energy Agency, n.d.). When we look at the data from the period 2000-2022, there is a very clear upwards trend in the net energy importer position of Türkiye and it is

also noteworthy that Türkiye ranks 5th in Europe and 12th globally (as of 2021) by the amount (terajoules) of energy imports (International Energy Agency, n.d.). The concentration of the world oil reserves and the geographical locations of the industrialized, oil heavy nations are not necessarily aligned which makes oil a globally traded commodity (Aka, 2020).

Tagliapietra (2016) states in his article that there has been a notable climb in the consumption of energy in Türkiye due to two factors of which are: Increase in the population and economic growth especially after the early 2000s. According to Tagliapietra (2016), the energy requirement of Türkiye has increased more than one and a half fold from 2000 to 2014. In 2023 Türkiye imported about 31,4 million tons worth of crude oil, about 12,5 million tons worth of diesel and imported some other petroleum products as well (where crude oil and diesel together account for the great majority of the imports regarding petroleum products) (Statista, n.d.). The energy usage and industrialization level of a country are significantly related (Aka, 2020). It is underlined that there is a global recognition regarding the role the energy plays on the path to economic development and industrialization of nations (Gökmen & Temiz, 2014)

Up to this point there have been few key points presented. Those are: oil is a globally very important commodity, oil prices and inflation can be connected terms, inflation is very dynamic in Türkiye and oil is also important for Türkiye. All the arrows direct to the same point, that is, the core point and the motivation of this thesis. How does oil prices affect the inflation in Türkiye? The thesis here is that there exists a relationship between the changes in the domestic procedure price index of Türkiye and the changes in the prices of the Europe Brent oil futures contract prices. It is expected that there is a statistically significant relationship between said

parameters. The data used are the changes in the domestic PPI of Türkiye, the changes in the M3 money supply, the changes in the exchange rates, the changes in the Eurozone total industrial PPI, the changes in the gross minimum wages and a dummy variable.

Following sections will be organized as “Literature review”, “Methodology & Empirical Analysis”, “Results & Discussion” and “Conclusion”. The “Literature Review” will cover some outlook on the energy economics outlook of Türkiye with special regards to oil, the work done mostly on relations between oil prices and CPI and PPI. The “Methodology & Empirical Results” section will outline the methods used to evaluate the relationships between select parameters and the empirical results. The “Results & Discussion” will elaborate on the results and “Conclusion” will summarize the work, outline the limitations and make suggestions on future works.

CHAPTER 2

LITERATURE REVIEW

Sek, Teo and Wong (2015) in their research have investigated the relationship between the changes in the prices of oil and inflation between 1980 and 2010 for numerous countries. They classified countries according to their oil dependance as “high” and “low” (Sek et al., 2015). The model used was an autoregressive distributed lag model (Sek et al., 2015). The findings supported a long-run relationship between the consumer price index and the shifts in the prices of oil (Sek et al., 2015). The effects of oil price changes were direct in the low oil dependent countries whereas it was indirect in the 6 high oil dependent countries where the high oil countries were affected by these shocks through the changes in the exchange rates and the production costs of exporters (Sek et al., 2015).

Bala and Chin (2018) investigated the relation between oil price shifts and CPI. The countries they studied were Nigeria, Angola, Libya and Algeria where their range of time was between 1995 and 2014. They separated the shifts in the oil price changes in positive (increasing) and negative (decreasing) where they found that both shifts increase the inflation but the second type of shift is more significant in terms of its impact (Bala & Chin, 2018).

LeBlanc and Chinn (2004) studied whether the oil prices affect the inflation in some industrialized countries where he used an augmented Phillips Curve model. They found that the changing oil prices only scraped inflation in the United States and European Union as in, a ten percent increase only leads to one to zero point eight percent increase in inflation directly (LeBlanc & Chinn, 2004).

Lacheheb and Sirag (2016) used an NARDL model to study the dynamics between shifts in the oil prices and CPI for Algeria between 1970 and 2014. Regarding the long run relationship, they found that positive movements in the oil prices tend to affect CPI positively and the same mechanism is found for the short run and on the other hand, regarding the long run, the negative movement of the oil prices seems to not be significant regarding inflation (Lacheheb & Sirag, 2016).

Davari and Kamalian (2018) has also investigated the relationship between CPI and oil prices, where their study was conducted for Iran within the time range between 2003 and 2015 and they used an NARDL model. They found that, regarding the long run, when the revenue generated from said commodity goes down, the CPI also goes down whereas the reverse (as in, the increase of revenue) does not affect CPI (Davari & Kamalian, 2018).

Chen and Zhu (2021) used a structural vector autoregressive model for the impacts of oil price shocks on 36 sub industries in China between the years 1996 and 2017. They did not take a black box approach to oil shocks, instead, they used the classification by Kilian (2009) and classified oil shocks into three categories: “aggregate demand shocks”, “oil-specific demand shocks” and “oil supply shocks” (Chen & Zhu, 2021). Their findings indicate that different types of shock cause different types of responses amongst industries (Chen & Zhu, 2021). Their findings were interesting, such that the industrial producer price index did not respond the same to every type of oil shock, as in, it decreased with the last type of aforementioned shocks whilst increased with the rest where they also found out that the weight of importance of the type of shocks also follows the order that the shocks were listed in (Chen & Zhu, 2021). However, this situation has been altered after a structural break due to the 2008 financial crisis, after which, the major factor of oil

shocks became “oil-specific demand shocks” (Chen & Zhu, 2021). There are differences in responses between the industries that they evaluated and they rationalize those differences through how energy eager the industry is (for the shocks excluding the demand driven type of shock) and how export oriented it is (Chen & Zhu, 2021).

Niyimbanira (2014) investigated the relationship between oil prices and inflation in South Africa using no other explanatory variables in the model. Being an oil importing country as Türkiye, the study may reflect some results that can be compared with results of this thesis. Niyimbanira (2014) used “MundiIndex” which is a relatively straightforward approach to measure oil prices by the weighted average of three benchmarks of oil prices (Dubai, Brent and WTI) (Index Mundi, n.d.). As the explanatory variable, the core inflation was taken into account. Core inflation measures inflation when the price differences of goods & services from the energy sector and food sector are excluded (Kenton, 2022). In justifying the use of core inflation, Niyimbanira referred to Cavallo (2008) where he emphasizes that excluding probable volatility caused by seasonal changes of food and energy prices by using core inflation allows one to investigate the economy more clearly in this regard. In this study findings revealed a long run relationship and a single way granger causality between the differences in oil prices and the differences in core inflation in South Africa (Niyimbanira, 2014).

On a side note, Segal (2021) points out that the effect of oil prices is over-extended in terms of its perceived effects. However, Segal (2021) states that the scope of his study does not encapsulate developing countries where he implies that the effect of oil prices may as well be dramatical (in a positive or a negative manner) if the said countries are heavily dependent on whether importing or exporting oil.

Numerous research around this topic was also conducted regarding Türkiye. Çelik and Akgül (2011) investigated the relationship between the inflation and fuel oil price in Türkiye between 2005 and the end of 2009. They used the consumer price index and oil price index constructed through gasoline and diesel prices (Çelik & Akgül, 2011). Using the vector error correction model, found that one point increase in the aforementioned prices were reflected upon the CPI as 1.26 percent (Çelik & Akgül, 2011). Çelik and Akgül (2011) also conducted a granger causality test and revealed a one-way causality relationship that the changes in the oil prices granger cause changes in the consumer price index.

Gokmenoglu, Azin and Taspinar (2015) also conducted a study where they investigated the relationship between the oil prices and the several aggregates namely: gross domestic product, industrial production (IP) and inflation (the consumer price index) in Türkiye where the time period covered were from 1961 to 2012. They conducted their research in such a way that they used the Philips Perron test for the checking of the stationarity of the data (where all the variables were I(1)), and the Johansen test for the cointegration where they found a long-term relationship between aforementioned variables (Gokmenoglu, Azin & Taspinar, 2015). Granger causality test showed a granger causality from oil prices to IP which was the only causal relationship among tested variables (Gokmenoglu et al. 2015).

Bayar and Karamelikli (2015) focused on the effect of oil prices and natural gas prices on the trade in Türkiye between early 1997 and early 2015 taking structural breaks into account. Their study revealed that there was a cointegrated relationship amongst variables and a causal relationship from said commodities to the balance of foreign trade (Bayar & Karamelikli, 2015).

Rasasi and Yilmaz (2016) has conducted research on probable macroeconomic effects of oil shocks in Türkiye. The parameters used in the study were the real gross domestic product, oil prices (specifically West Texas Intermediate prices), consumer price index and the nominal exchange rate. The selected model was structural vector error correction (SVEC). Consumer price index responded positively (as in an increasing manner) to the positive oil shock with a delay and responded negatively (as in a decreasing manner) to the negative oil price shocks (Rasasi & Yilmaz 2016).

Akçelik and Öğünç (2016) have investigated the impact of crude oil prices on import prices, producer price index and consumer price index on a covering-ground basis between 2004 and 2014 in Türkiye using a VAR model (Akçelik & Öğünç, 2016). Their study revealed that an increase in the oil prices were followed by an increase in both CPI and PPI where the pass through of the price increase on the producer price index is twice the amount compared to the consumer price index (Akçelik & Öğünç, 2016). The findings supported theoretical multiplier models and showed that the increased prices of energy-related products affected the inflation expectations and nominal wages and hence triggered further consumer price inflation (Akçelik & Öğünç, 2016).

Aka (2020) has examined the relationship between oil prices and numerous macroeconomic variables of which some were CPI, PPI, economic growth and some others between the first quarter of 2004 and the last quarter of 2019 in a comprehensive study in Türkiye. Findings supported a unidirectional granger causality from oil prices to PPI as well as to CPI (Aka,2020).

Köse and Ünal (2021) used a SVAR model to investigate the relationship between oil prices and producer price index between early 1988 and mid 2019 in

Türkiye. As variables, they used the producer price index, prices of oil, the volatility of the prices of oil, exchange rates and the hourly earnings of workers (Köse & Ünal, 2021). They found that the prices themselves and their volatility were becoming stronger players regarding the increased inflation as months progressed (Köse & Ünal, 2021).

CHAPTER 3

METHODOLOGY & EMPIRICAL ANALYSIS

3.1 Data description

The study covers the time span between April of 2018 and November of 2022 within a monthly frequency. The main focus here is the relationship between the changes of the variables rather than the corresponding absolute values. Hence, each time series is constructed as the unit difference per previous month. Within the scope of this thesis, there are a total of seven variables. Those are:

1. The changes of the domestic producer price index of Türkiye. The data was retrieved from TURKSTAT (2024). In the model, it is represented as: "dppi_change"
2. The changes in the exchange rates (Turkish Lira against the United States Dollar). This variable was selected because oil is a globally traded commodity and is traded with the United States Dollar. Hence the exchange rate is deemed to play a direct role. The data was retrieved from the Central Bank of Republic of Turkey (2024). In the model, it is represented as: "e_rate_change"
3. The changes of the gross minimum wages in Türkiye. This variable was selected because it is one of the most direct production costs. The data was retrieved from the Ministry of Labor and Social Security of the Republic of Türkiye. In the model, it is represented as: "min_wage_change"

4. The changes of the Europe Brent oil futures contract prices in USD. The data was retrieved from investing.com. In the model, it is represented as: "oil_futures_change"
5. The changes in the total industrial producer price index for the Eurozone. The data is retrieved from the Federal Reserve Bank of St.Louis (n.d.) of whom retrieved from the OECD. In the model, it is represented as: "eurozone_total_ind_change"
6. The changes in money supply (M3). The money supply was selected because the amount of money in the economy is deemed to be related to inflation. The money supply data was retrieved from the Central Bank of Republic of Turkey (2024). In the model, it is represented as: "m3_change"
7. A dummy variable. The variable corresponds to the ends of 2021 and the rest of the investigated timeline. The graph of "dppi_change" illustrates the structural break at the end of 2021. A structural break is when there is a dramatic alter in the parameters that make up the times series (STATA, n.d.). Any disrupting event such as a political turmoil, a global demand/supply shock etc. can trigger a structural break in the data (Antoch, Hanousek, Horváth, Hušková and Wang, 2019). These structural breaks are important because such breaks in the series alter the utilization and rationale of the outcome of the statistical instruments (Shrestha and Bhatta, 2018).

3.2 Methodology and empirical analysis

There have been observed a fairly common approach (in an abstract sense) to the empirical analysis in such time series in the literature. The researchers generally assess the stationary characteristic of the series, check the cointegration characteristic (if there exists a non-stationarity) and select a model. This thesis also follows a similar structure. Since this approach is fairly common, it is not possible to pinpoint the approach in this thesis to a single source. The illustrations of the time series at their investigated levels can be seen in Figures 1 through 5.

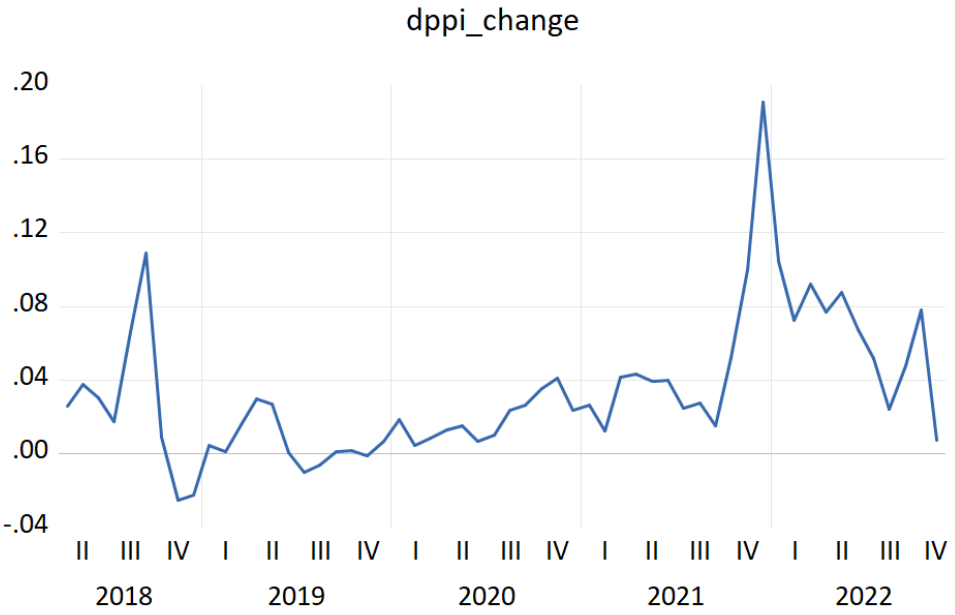


Figure 1. The plot of “dppi_change”

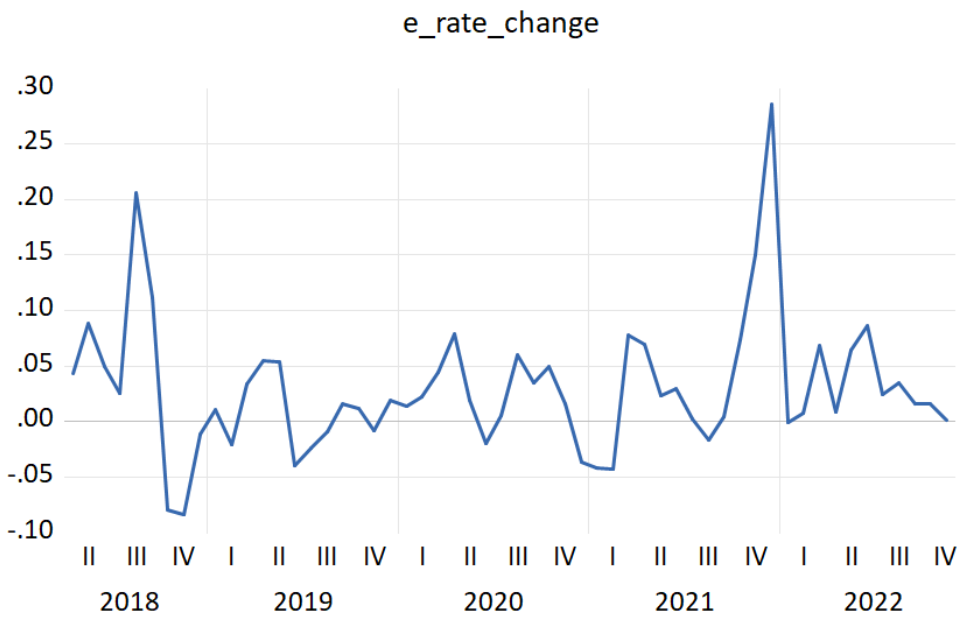


Figure 2. The plot of "e_rate_change"

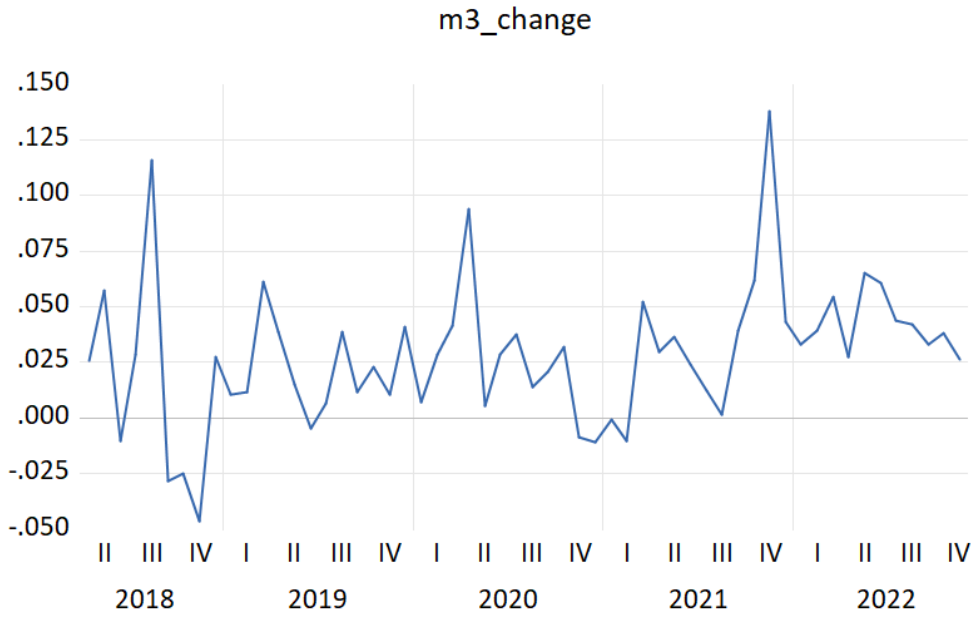


Figure 3. The plot of "m3_change"

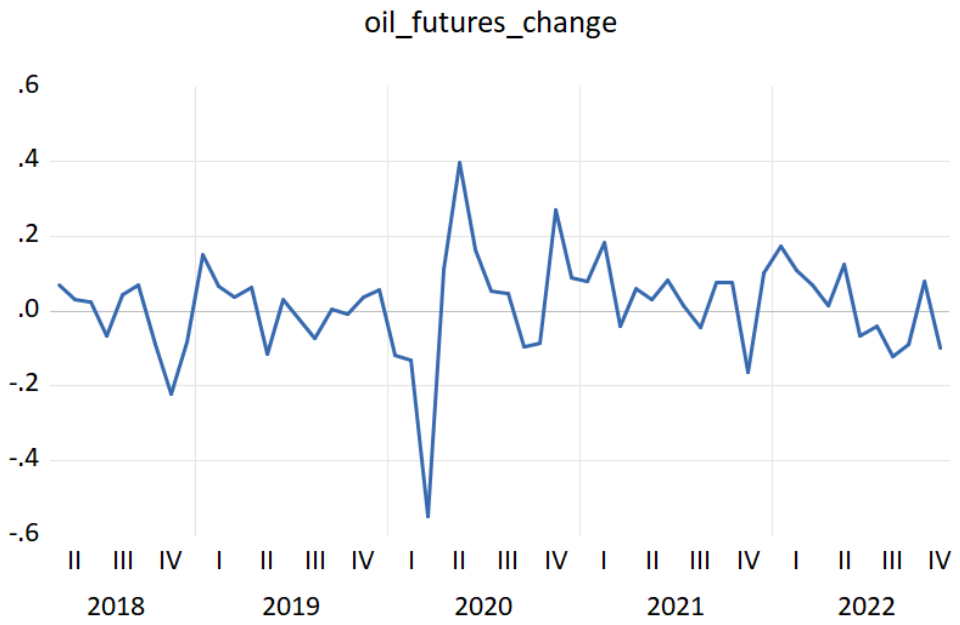


Figure 4. The plot of "oil_futures_change"

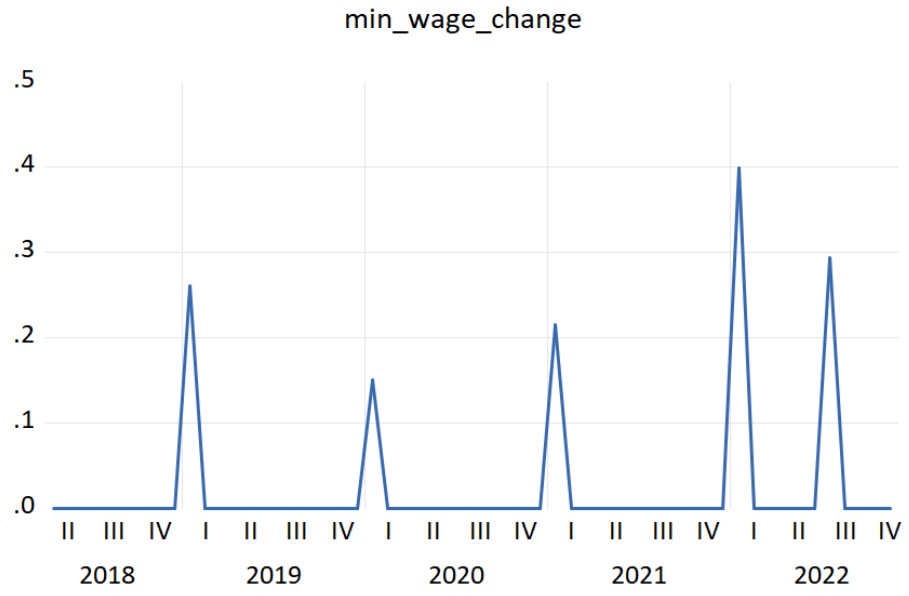


Figure 5. The plot of "min_wage_change"

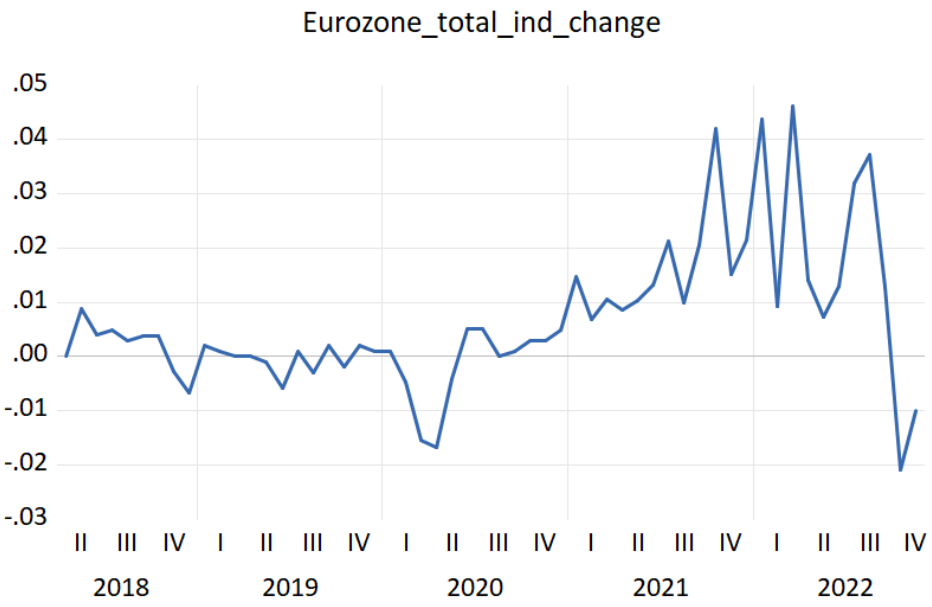


Figure 6. The plot of "eurozone_total_ind_change"

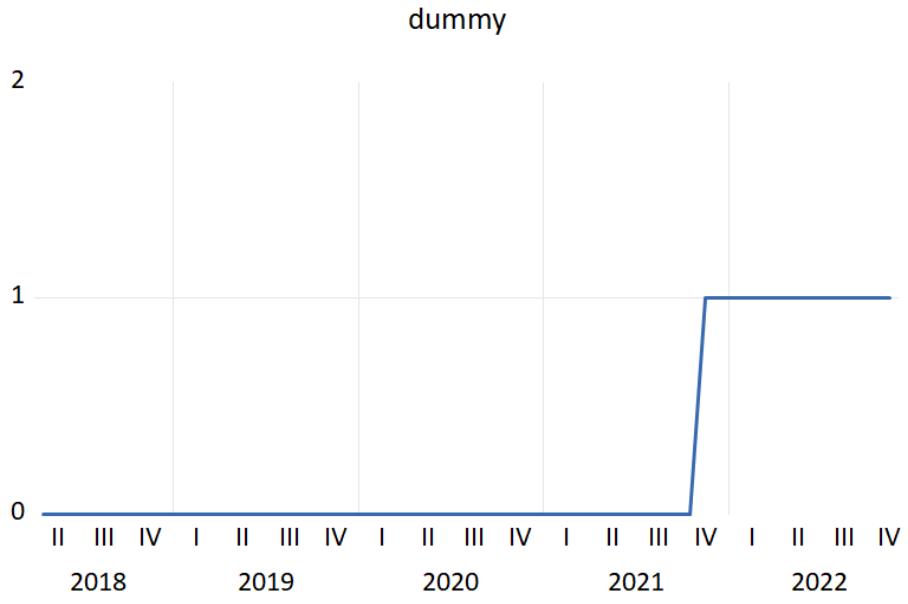


Figure 7. The plot of "dummy"

3.2.1 Correlation matrix

Before moving on to the unit root tests of the variables, the correlation matrix is checked to bypass the problem of multicollinearity. The results indicate a no higher than or equal to 0.80 value hence there is deemed to be no issue. The correlation matrix is illustrated in Table 1.

Table 1. The Correlation Matrix

	DPPI_CHA...	M3_CHANGE	MIN_WAGE...	E_RATE_C...	EUROZON...	OIL_FUTU...
DPPI_CHANGE	1.000000	0.369053	0.134888	0.712000	0.476735	0.210624
M3_CHANGE	0.369053	1.000000	-0.054783	0.628117	0.183319	-0.079341
MIN_WAGE_...	0.134888	-0.054783	1.000000	-0.136567	0.364199	0.131806
E_RATE_CH...	0.712000	0.628117	-0.136567	1.000000	0.182691	0.027487
EUROZONE_...	0.476735	0.183319	0.364199	0.182691	1.000000	0.169551
OIL_FUTURE...	0.210624	-0.079341	0.131806	0.027487	0.169551	1.000000

3.2.2 Unit root tests

Checking for the existence of a unit root is one of the most fundamental initial steps of such research because there are two very fundamental impacts of the existence or absence of a unit root. First one is that the existence of a unit root gives the researcher an idea regarding the fundamental characteristic of the time series. If a unit root exists, that means the time series is nonstationary. Meaning some combination of the mean, the variance or the covariance of the time series changes (Krishnan, 2021). Second one is that the stationarity characteristic of a series limits the selection of models. For example, a VAR model is constructed to work only with stationary series (Etuk, 2020). Using a non-stationary series for a VAR model could lead to spurious regression. On the contrary, a model such as ARDL can utilize both the I(0) and I(1) series. There are conventional tests to see whether or not a times series is stationary, some of which are the ADF test, the PP test (Ozbun, 2021). In this thesis, the ADF Test test has been used to assess the stationarity characteristic of

each series. All series (the unit change per previous month) except for one are shown to be stationary at the investigated levels (unit change per previous month). The “dppi_change” series which corresponds to the unit difference per previous month for the domestic producer price of Türkiye is non-stationary. Said series becomes stationary at the first differences from the investigated levels hence is labeled I(1). The unit root tests were conducted including “Intercept” (where other options were including “Trend and intercept” and “None”) in the test equation. The lag length was automatically selected with Schwarz info criterion with maximum of 10. Results of the said tests are shown in Table 7 through Table 13 in the “Appendix” section.

3.2.3 Model selection

The stationary characteristic of the series under investigation are one of the main filters regarding the selection of a model. For example, a VAR model only works with times series that are stationary (I(0)) at the investigated level. Since the variables under investigation are a mixture of stationary and non-stationary at the aforementioned levels (unit changes from previous months), the selected model for this study can be and is the ARDL model. The ARDL model allows the usage of both I(0) and I(1) times series at the same time and allows the expansion of nature on both short term and long term dynamics. Another difference from ARDL to the VAR is that ARDL is able to utilize different numbers of lagged values for different variables. The VAR model works with the same number of lags for each variable (Eric, 2021). In the case of this thesis, this is also important because it is deemed that the nature of the parameters tends to require different numbers of lags to make intuitive sense. One crucial step here is to assess the number of lags used. The

selection of lags is based on the Akaike Information Criterion (AIC). The AIC finds the balance between explaining the relationships between the variables and increasing the complexity of the model (Manikantan, 2021). The setup of the model was such that the maximum lag length for both dependent and independent variables were 2, the money supply variable was introduced from first lagged values (the current period was excluded), the dummy variable had a fixed lag length of zero and "Rest. trend" option was selected for the trend specification option. ARDL estimation outputs can be seen in Table 2.

Table 2. Estimations of the ARDL Model

Dependent Variable: DPPI_CHANGE
Method: ARDL
Date: 08/26/24 Time: 13:52
Sample (adjusted): 2018M06 2022M11
Included observations: 54 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, partial automatic): M3_CHANGE(-1) MIN_WAGE_CHANGE E_RATE_CHANGE EUROZONE_TOTAL_IN D_CHANGE OIL_FUTURES_CHANGE @FL(DUMMY,0)
Fixed regressors: C @TREND
Number of models evaluated: 486
Selected Model: ARDL(1, 0, 1, 0, 2, 1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DPPI_CHANGE(-1)	0.349080	0.054059	6.457372	0.0000
M3_CHANGE(-1)	0.220821	0.068755	3.211722	0.0026
MIN_WAGE_CHANGE	0.058753	0.021067	2.788838	0.0080
MIN_WAGE_CHANGE(-1)	-0.029093	0.019075	-1.525201	0.1349
E_RATE_CHANGE	0.285152	0.035407	8.053606	0.0000
EUROZONE_TOTAL_IND_CHANGE	-0.327778	0.147790	-2.217867	0.0322
EUROZONE_TOTAL_IND_CHANGE(-1)	0.639957	0.147205	4.347395	0.0001
EUROZONE_TOTAL_IND_CHANGE(-2)	1.008863	0.188967	5.338841	0.0000
OIL_FUTURES_CHANGE	0.032852	0.011123	2.953423	0.0052
OIL_FUTURES_CHANGE(-1)	0.029353	0.011656	2.518171	0.0158
DUMMY	-0.011433	0.006817	-1.677073	0.1011
C	-0.000296	0.003714	-0.079740	0.9368
@TREND	-4.79E-05	0.000142	-0.337317	0.7376

R-squared	0.951185	Mean dependent var	0.033469
Adjusted R-squared	0.936898	S.D. dependent var	0.038546
S.E. of regression	0.009683	Akaike info criterion	-6.230865
Sum squared resid	0.003844	Schwarz criterion	-5.752035
Log likelihood	181.2334	Hannan-Quinn criter.	-6.046199
F-statistic	66.57606	Durbin-Watson stat	1.903024
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

The estimations results suggests that within 10% significance criteria are as follows:

- The first lag of the changes in DPPI has a positive effect. If the changes in the first lag of DPPI increases by 1%, the DPPI changes increase by 0.35 %.
- The changes in the first lag of M3 have a positive effect. A 1% increase in the first lag of changes of the M3 increases the changes of the DPPI by 0.22 %.
- The changes in minimum wages have a positive effect. 1% increase in the changes in the minimum wages increases the changes of the DPPI by 0.06 %.
- The changes in exchange rates have a positive effect. 1% increase in the changes in the exchange rates leads to a 0.29 % increase in the changes in the DPPI.
- The changes in Eurozone total industrial PPI has a negative yet the first and second lags of the said variable has a positive effect. 1% increase in the said variable leads to a 0.33% decrease in the changes of the DPPI. A 1% increase of the first lagged values leads to a 0.64% and a 1% increase in the second lagged values lead to a 1% increase.
- The changes in the prices of the oil futures contracts and the first lag of it has a positive effect. 1% increase in the said variable leads to a 0.033% increase and the increase in the first lagged values leads to a 0.029% increase.

Most of the results make almost instant intuitive sense given that, when the costs regarding factors of production increase, it is reflected in the prices of the producers hence the increase of the domestic producer price index.

3.2.4 Model stability check

Before moving on to the residual tests and evaluation of the model, the stability of the model must be assessed. In this ARDL model, there have been three different diagnostics to assert this criteria. Those are: the Ramsey RESET Test to investigate functional misspecification, the CUSUM Test and the CUSUM of Squares Test.

The first test that has been conducted regarding the stability of the model is the "CUSUM" Test. This test has a straightforward and very useful tool in regards to detecting structural changes in a time series analysis. If the plotted line with the test is bound within the confidence intervals, it is deemed that no structural changes occur and if the opposite happens, then there is a structural change and that needs to be addressed (Temuçin, 2013). The CUSUM Test result of the aforementioned ARDL model is illustrated in Figure 8.

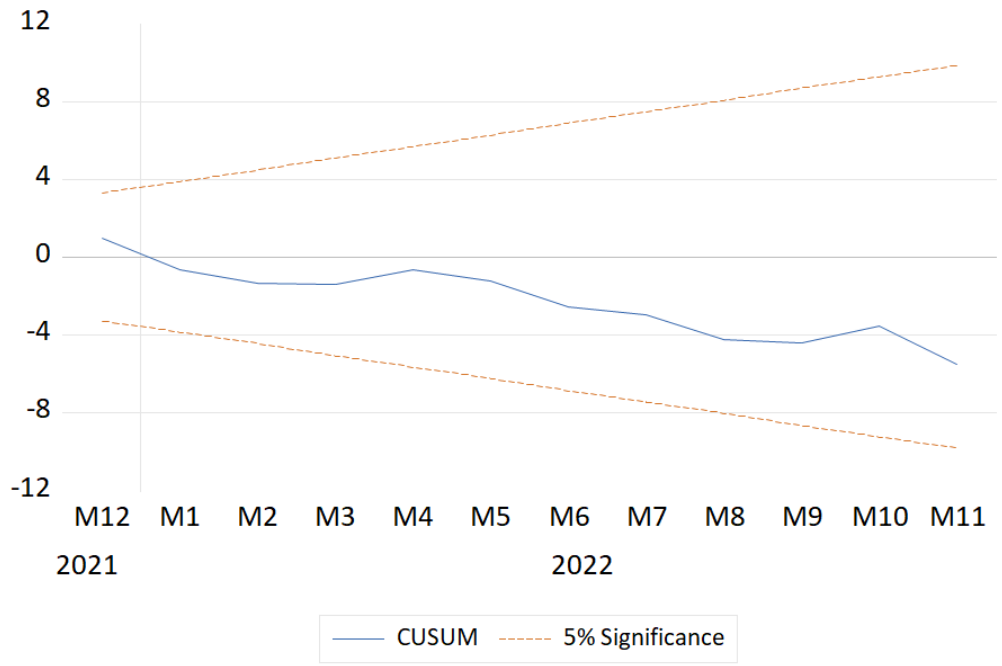


Figure 8. CUSUM results

Since the CUSUM line is within the intervals, the test is deemed to be successful. A similar approach compared to CUSUM Test is the CUSUM of Squares Test. The interpretation of the results are the same as the CUSUM Test. Since the "CUSUM of Squares" line is within the intervals, the test is deemed to be successful. The plot is illustrated in Figure 9.

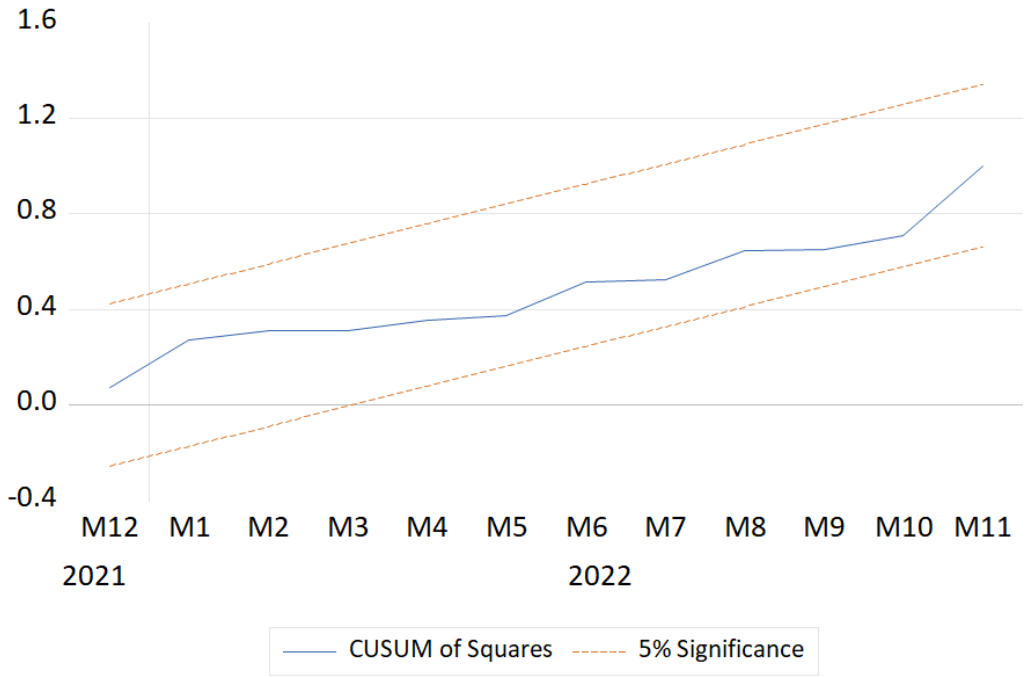


Figure 9. CUSUM of squares results

For the final test the functional misspecification is checked. The model misspecification may occur when the addition of powers and cross products of independent variables would explain the variance better (Lambert, 2013). In the Ramsey test, the fitted values of the original estimations are added to the equation with squared values (which automatically would include the squared and cross product values of the original estimations) and cubics etc (Lambert, 2013) depending on the scope. The coefficients are estimated again. The desire here is that the f statistic of the added variables' coefficients to be insignificant (Lambert, 2013). That

would mean the original estimations were fine. The results of the mentioned test with the number of fitted terms as “1” are presented in Table 3.

Table 3. Ramsey RESET Test Outcome

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: DPPI_CHANGE DPPI_CHANGE(-1) M3_CHANGE(-1) MIN_WAGE_CHANGE MIN_WAGE_CHANGE(-1) E_RATE_CHANGE EUROZONE_TOTAL_IND_CHANGE EUROZONE_TOTAL_IND_CHANGE(-1) EUROZONE_TOTAL_IND_CHANGE(-2) OIL_FUTURES_CHANGE OIL_FUTURES_CHANGE(-1) DUMMY C @TREND

	Value	df	Probability
t-statistic	2.929572	40	0.0056
F-statistic	8.582392	(1, 40)	0.0056
Likelihood ratio	10.49661	1	0.0012

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000679	1	0.000679
Restricted SSR	0.003844	41	9.38E-05
Unrestricted SSR	0.003165	40	7.91E-05

LR test summary:

	Value
Restricted LogL	181.2334
Unrestricted LogL	186.4817

Unrestricted Test Equation:
Dependent Variable: DPPI_CHANGE
Method: Least Squares
Date: 08/26/24 Time: 12:04
Sample: 2018M06 2022M11
Included observations: 54

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPPI_CHANGE(-1)	0.284164	0.054381	5.225407	0.0000
M3_CHANGE(-1)	0.194585	0.063794	3.050235	0.0040
MIN_WAGE_CHANGE	0.049017	0.019637	2.496170	0.0168
MIN_WAGE_CHANGE(-1)	-0.028064	0.017527	-1.601197	0.1172
E_RATE_CHANGE	0.222650	0.038899	5.723756	0.0000
EUROZONE_TOTAL_IND_CHANGE	-0.295479	0.136215	-2.169216	0.0361
EUROZONE_TOTAL_IND_CHANGE(-1)	0.596982	0.136024	4.388814	0.0001
EUROZONE_TOTAL_IND_CHANGE(-2)	0.787006	0.189395	4.155371	0.0002
OIL_FUTURES_CHANGE	0.027022	0.010411	2.595644	0.0131
OIL_FUTURES_CHANGE(-1)	0.028721	0.010710	2.681587	0.0106
DUMMY	-0.012319	0.006270	-1.964805	0.0564
C	-0.000750	0.003415	-0.219540	0.8273
@TREND	6.91E-05	0.000137	0.506017	0.6156
FITTED^2	1.650679	0.563454	2.929572	0.0056

R-squared	0.959809	Mean dependent var	0.033469
Adjusted R-squared	0.946747	S.D. dependent var	0.038546
S.E. of regression	0.008895	Akaike info criterion	-6.388210
Sum squared resid	0.003165	Schwarz criterion	-5.872547
Log likelihood	186.4817	Hannan-Quinn criter.	-6.189339
F-statistic	73.48025	Durbin-Watson stat	1.852786
Prob(F-statistic)	0.000000		

The results indicate that there is some form of functional misspecification. However, the appropriation of the Ramsey RESET Test for the ARDL model is considered one of the potential limitations.

3.2.5 Residual tests

Regarding residuals there are four assumptions to check within the residuals to see if the model is actually functioning in a reliable manner. Some of which are: there should not be serial correlation (autocorrelation) of residuals, the residuals should be normally distributed and the check for heteroskedasticity (PremalMatalia, 2020). In essence, the residuals should be following the characteristic of white noise and that's what is being checked here. Regarding the testing of the residuals, three different tests were applied regarding the characteristics of the residuals. Those are to check for the serial correlation, the heteroskedasticity and the distribution of the residuals.

Firstly the serial correlation is checked. The serial correlation is the phenomena where the values of sequential residuals are correlated. This means that based on the past values of the residuals, it is possible to get an idea of the values of residuals (they depend on the previous values). Generally, there exists two different reasons for autocorrelation of residuals to occur (zedstatistics, 2019). First one is that there may be a variable that would add information to the model but it is not included. Adding new explanatory variables may solve the problem of residual autocorrelation because those new explanatory variables may be the one that explains the variance (zedstatistics, 2019). Second reason may be due to the model selection (zedstatistics, 2019). The problem that autocorrelation causes is that standard errors and the p values are not reliable in its presence (zedstatistics, 2019). The ideal

scenario is that the residuals are not autocorrelated. The results are presented at Table 4 which show no evidence of autocorrelation.

Table 4. Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.008649	Prob. F(2,39)	0.9914
Obs*R-squared	0.023941	Prob. Chi-Square(2)	0.9881

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 08/26/24 Time: 13:54
Sample: 2018M06 2022M11
Included observations: 54
Presample missing value lagged residuals set to zero.

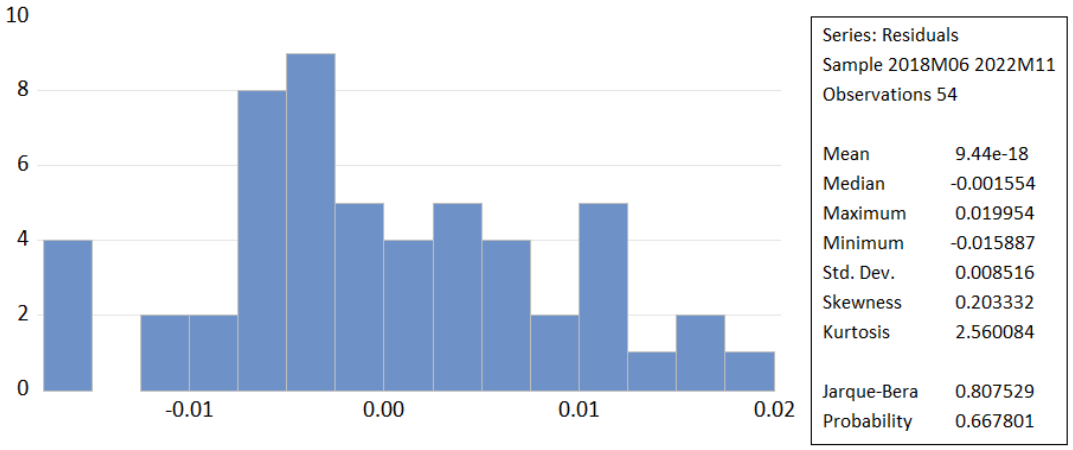
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPPI_CHANGE(-1)	0.001406	0.058219	0.024148	0.9809
M3_CHANGE(-1)	-0.001947	0.073297	-0.026566	0.9789
MIN_WAGE_CHANGE	0.000279	0.021789	0.012801	0.9899
MIN_WAGE_CHANGE(-1)	4.13E-05	0.020345	0.002030	0.9984
E_RATE_CHANGE	-0.000280	0.036552	-0.007661	0.9939
EUROZONE_TOTAL_IND_CHANGE	-0.003514	0.154154	-0.022793	0.9819
EUROZONE_TOTAL_IND_CHANGE(-1)	-0.000383	0.151154	-0.002534	0.9980
EUROZONE_TOTAL_IND_CHANGE(-2)	-0.002827	0.204939	-0.013793	0.9891
OIL_FUTURES_CHANGE	0.000492	0.012014	0.040914	0.9676
OIL_FUTURES_CHANGE(-1)	-0.000101	0.012442	-0.008141	0.9935
DUMMY	9.19E-05	0.007094	0.012955	0.9897
C	-2.15E-07	0.003807	-5.66E-05	1.0000
@TREND	1.30E-06	0.000146	0.008873	0.9930
RESID(-1)	-0.022613	0.194783	-0.116093	0.9082
RESID(-2)	-0.010991	0.189815	-0.057902	0.9541

R-squared	0.000443	Mean dependent var	9.44E-18
Adjusted R-squared	-0.358372	S.D. dependent var	0.008516
S.E. of regression	0.009926	Akaike info criterion	-6.157234
Sum squared resid	0.003842	Schwarz criterion	-5.604739
Log likelihood	181.2453	Hannan-Quinn criter.	-5.944158
F-statistic	0.001236	Durbin-Watson stat	1.872823
Prob(F-statistic)	1.000000		

Secondly, distribution of the residuals is checked. The distribution of the residuals is also an important assessment regarding the model. The ideal scenario is that the residuals of the model are distributed normally (zedstatistics, 2018). This indicates that there is no systematic governance amongst the residuals. The presence of a non normal distribution could indicate that there is a lack of variables in the model, meaning, an addition of a new variable may explain the systematic variance.

Results of the normality test are illustrated in Table 5 which show the residuals are normally distributed.

Table 5. Normality Test Results



Lastly the heteroskedasticity is checked. Heteroskedasticity is also another property of the residuals that should be checked to see if the residuals follow a white noise characteristic. Ideally, it is aimed for the residuals to be homoskedastic, meaning, the variance should be constant (should not increase, decrease, cluster etc. over observations) (zedstatistics, 2018). The results of the heteroskedasticity test results are presented in Table 6 which show residuals are not heteroskedastic.

Table 6. Heteroskedasticity Test Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.030327	Prob. F(12,41)	0.4408
Obs*R-squared	12.51130	Prob. Chi-Square(12)	0.4055
Scaled explained SS	5.626011	Prob. Chi-Square(12)	0.9337

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/26/24 Time: 13:55
Sample: 2018M06 2022M11
Included observations: 54

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.06E-05	3.43E-05	1.183637	0.2434
DPPI_CHANGE(-1)	0.000417	0.000499	0.835210	0.4084
M3_CHANGE(-1)	0.001069	0.000635	1.683248	0.0999
MIN_WAGE_CHANGE	-9.64E-06	0.000195	-0.049546	0.9607
MIN_WAGE_CHANGE(-1)	4.51E-05	0.000176	0.255799	0.7994
E_RATE_CHANGE	1.80E-05	0.000327	0.055085	0.9563
EUROZONE_TOTAL_IND_CHANGE	-0.000327	0.001365	-0.239237	0.8121
EUROZONE_TOTAL_IND_CHANGE(-1)	-0.001890	0.001360	-1.389730	0.1721
EUROZONE_TOTAL_IND_CHANGE(-2)	0.002721	0.001746	1.559088	0.1267
OIL_FUTURES_CHANGE	-1.49E-05	0.000103	-0.144977	0.8854
OIL_FUTURES_CHANGE(-1)	9.65E-05	0.000108	0.895813	0.3756
DUMMY	-7.42E-05	6.30E-05	-1.178352	0.2455
@TREND	-1.27E-07	1.31E-06	-0.096663	0.9235

R-squared	0.231691	Mean dependent var	7.12E-05
Adjusted R-squared	0.006820	S.D. dependent var	8.97E-05
S.E. of regression	8.94E-05	Akaike info criterion	-15.59991
Sum squared resid	3.28E-07	Schwarz criterion	-15.12108
Log likelihood	434.1976	Hannan-Quinn criter.	-15.41525
F-statistic	1.030327	Durbin-Watson stat	1.999200
Prob(F-statistic)	0.440758		

CHAPTER 4

RESULTS & DISCUSSION

The key focus of the thesis is the relationship between the producer price index in Türkiye and the global oil prices. Specifically the nature of the changes of the domestic producer price index of Türkiye to the changes of the prices of the futures contracts of global oil. The ARDL model suggests that the changes of the domestic PPI of Türkiye is affected by the first lagged values of the changes of domestic PPI of Türkiye, the changes of the minimum wages, the changes in the exchange rates, the first and second lagged values of the changes in the Eurozone total industrial PPI, the changes in the prices of oil futures contracts and the first lagged value of it in a positive manner. On the other hand the same period changes in the Eurozone total industrial PPI affects the changes in the domestic PPI of Türkiye negatively.

The changes in minimum wage and the first lagged values of money supply effect the changes in the domestic PPI positively. This can be deemed congruent with theory since increased minimum wage is an increase in production costs and increased money supply (for certain conditions) can be a driver of inflation. The changes in the exchange rates also play a similar role. Since Türkiye needs to obtain USD in order to buy oil, a stronger USD would mean the buyers would have to spend more Turkish Lira's for the same amount of USD and this would mean an increase in production costs Turkish Lira wise.

The changes in the Eurozone total industrial PPI has a mixed effect. The current values decrease, however, the first and second lagged values increase the changes in the domestic PPI of Türkiye. The relationship with the lagged values is as expected, the imports from the Europe continent takes the major share of Türkiye's

imports in 2022 (Trading Economics, n.d.-b). The same relationship regarding the same period however can be due to numerous reasons of which some might be not included in this model.

Finally, regarding the oil prices, the results of the ARDL model suggest that the differences in the current and the first lagged values statistically affect the changes of the domestic PPI of Türkiye positively. The results confirm the initial intuition regarding the effect, considering that oil is a vital input for the supply chains as an economic input. Regarding transportation of goods & services, the production of them etc.

CHAPTER 5

CONCLUSION

The thesis here presented a general view of the inflation, oil prices and how these terms play a role in Türkiye's economy. A portion of the relevant literature regarding the relationship between oil prices and inflation was presented where a connection between said variables were observed. For the research conducted in this study, an ARDL model was utilized to model the relationship between above-mentioned variables. The results suggest there is a statistically significant relationship between the domestic PPI of Tükiye and oil prices in the forms of their investigated forms and said relationship is in a positive manner.

The results are loosely affirmant with the work of Akçelik and Öğünç (2016). As mentioned before, they found that an increase in oil prices is followed by an increase in PPI (Akçelik & Öğünç, 2016). Even though there are differences between the time frames and the nature of the variables, this study found a positive relationship between changes in the oil prices and changes in the domestic PPI of Türkiye in the studied forms.

There are limitations to this study. One of them is the time frame. The inflation dynamics may differ over time, hence the nature of the relationship between the changes of domestic PPI of Türkiye and the changes of the prices of futures contracts of oil. The changing time frame may affect the stationarity property of the series as well. Also, the stationarity tests were conducted using the ADF test which does not account for structural breaks (Bayar & Karamelikli, 2015). Tests, such as Lumsdaine & Papell may be more appropriate in this regard depending on the nature

of the series (Bayar & Karamelikli, 2015). Another limitation is the aforementioned functional misspecification. The test results suggest there is some sort of a misspecification. Even though the Ramsey RESET Test results indicate a functional misspecification, the appropriateness of the Ramsey RESET Test for ARDL model is also another concern. Hence, this aspect requires further investigation.

Some of the future work done can be the investigation of the relationship between oil prices and sub-industries in Türkiye. Domestic PPI is a single parameter that encompasses many industries however the industries may react differently. Another work may be the investigation of the effect of what (if there is one) causes the intermediary effect on the same period of changes in the Eurozone total industrial PPI and the domestic PPI of Türkiye to move in different directions. The study may also be further advanced with more advanced unit root tests that account more appropriately for structural breaks. The resolving of the functional misspecification ambiguity could also lead to better/ more appropriate results.

APPENDIX

UNIT ROOT TEST RESULTS

Table 7. ADF Test Outcome for "dppi_change"

Null Hypothesis: DPPI_CHANGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.102905	0.0321
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DPPI_CHANGE)
Method: Least Squares
Date: 08/26/24 Time: 13:45
Sample (adjusted): 2018M05 2022M11
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPPI_CHANGE(-1)	-0.311458	0.100376	-3.102905	0.0031
C	0.010217	0.005088	2.008148	0.0497

R-squared	0.153733	Mean dependent var	-0.000338
Adjusted R-squared	0.137766	S.D. dependent var	0.030216
S.E. of regression	0.028058	Akaike info criterion	-4.273413
Sum squared resid	0.041724	Schwarz criterion	-4.200419
Log likelihood	119.5188	Hannan-Quinn criter.	-4.245185
F-statistic	9.628018	Durbin-Watson stat	1.741009
Prob(F-statistic)	0.003071		

Table 8. ADF Test Outcome for "dppi_change" in First Differences

Null Hypothesis: D(DPPI_CHANGE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.119979	0.0000
Test critical values:	1% level	-3.557472	
	5% level	-2.916566	
	10% level	-2.596116	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DPPI_CHANGE,2)
Method: Least Squares
Date: 08/26/24 Time: 13:46
Sample (adjusted): 2018M06 2022M11
Included observations: 54 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DPPI_CHANGE(-1))	-1.040009	0.146069	-7.119979	0.0000
C	-0.000526	0.004183	-0.125807	0.9004

R-squared	0.493642	Mean dependent var	-0.001533
Adjusted R-squared	0.483904	S.D. dependent var	0.042764
S.E. of regression	0.030722	Akaike info criterion	-4.091346
Sum squared resid	0.049080	Schwarz criterion	-4.017680
Log likelihood	112.4664	Hannan-Quinn criter.	-4.062936
F-statistic	50.69410	Durbin-Watson stat	1.924407
Prob(F-statistic)	0.000000		

Table 9. ADF Test Outcome for “e_rate_change”

Null Hypothesis: E_RATE_CHANGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.013046	0.0001
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(E_RATE_CHANGE)
Method: Least Squares
Date: 08/26/24 Time: 13:47
Sample (adjusted): 2018M05 2022M11
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
E_RATE_CHANGE(-1)	-0.644923	0.128649	-5.013046	0.0000
C	0.018934	0.008759	2.161649	0.0352

R-squared	0.321649	Mean dependent var	-0.000775
Adjusted R-squared	0.308850	S.D. dependent var	0.069824
S.E. of regression	0.058048	Akaike info criterion	-2.819402
Sum squared resid	0.178588	Schwarz criterion	-2.746408
Log likelihood	79.53354	Hannan-Quinn criter.	-2.791174
F-statistic	25.13063	Durbin-Watson stat	1.792637
Prob(F-statistic)	0.000006		

Table 10. ADF Test Outcome for “m3_change”

Null Hypothesis: M3_CHANGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.908549	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(M3_CHANGE)
Method: Least Squares
Date: 08/26/24 Time: 13:48
Sample (adjusted): 2018M05 2022M11
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
M3_CHANGE(-1)	-0.794212	0.134417	-5.908549	0.0000
C	0.022598	0.005743	3.934969	0.0002

R-squared	0.397117	Mean dependent var	9.49E-06
Adjusted R-squared	0.385742	S.D. dependent var	0.040552
S.E. of regression	0.031782	Akaike info criterion	-4.024137
Sum squared resid	0.053536	Schwarz criterion	-3.951143
Log likelihood	112.6638	Hannan-Quinn criter.	-3.995910
F-statistic	34.91095	Durbin-Watson stat	1.976459
Prob(F-statistic)	0.000000		

Table 11. ADF Test Outcome for "oil_futures_change"

Null Hypothesis: OIL_FUTURES_CHANGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.899121	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL_FUTURES_CHANGE)
Method: Least Squares
Date: 08/26/24 Time: 13:49
Sample (adjusted): 2018M05 2022M11
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL_FUTURES_CHANGE(...	-0.797753	0.135233	-5.899121	0.0000
C	0.009443	0.017979	0.525204	0.6016

R-squared	0.396353	Mean dependent var	-0.003069
Adjusted R-squared	0.384963	S.D. dependent var	0.168830
S.E. of regression	0.132404	Akaike info criterion	-1.170234
Sum squared resid	0.929131	Schwarz criterion	-1.097240
Log likelihood	34.18143	Hannan-Quinn criter.	-1.142007
F-statistic	34.79962	Durbin-Watson stat	1.886635
Prob(F-statistic)	0.000000		

Table 12. ADF Test Outcome for “min_wage_change”

Null Hypothesis: MIN_WAGE_CHANGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.969379	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MIN_WAGE_CHANGE)
Method: Least Squares
Date: 08/26/24 Time: 13:49
Sample (adjusted): 2018M05 2022M11
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MIN_WAGE_CHANGE(-1)	-1.090215	0.136800	-7.969379	0.0000
C	0.026134	0.011400	2.292487	0.0259

R-squared	0.545107	Mean dependent var	0.000000
Adjusted R-squared	0.536524	S.D. dependent var	0.118936
S.E. of regression	0.080971	Akaike info criterion	-2.153776
Sum squared resid	0.347480	Schwarz criterion	-2.080782
Log likelihood	61.22885	Hannan-Quinn criter.	-2.125549
F-statistic	63.51099	Durbin-Watson stat	2.017891
Prob(F-statistic)	0.000000		

Table 13. ADF Test Outcome for “eurozone_total_ind_change”

Null Hypothesis: EUROZONE_TOTAL_IND_CHANGE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.785933	0.0052
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EUROZONE_TOTAL_IND_CHANGE)
Method: Least Squares
Date: 08/26/24 Time: 13:50
Sample (adjusted): 2018M05 2022M11
Included observations: 55 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EUROZONE_TOTAL_IND_CHANGE(-1)	-0.437522	0.115565	-3.785933	0.0004
C	0.002895	0.001754	1.650304	0.1048

R-squared	0.212871	Mean dependent var	-0.000183
Adjusted R-squared	0.198019	S.D. dependent var	0.012871
S.E. of regression	0.011527	Akaike info criterion	-6.052609
Sum squared resid	0.007042	Schwarz criterion	-5.979616
Log likelihood	168.4468	Hannan-Quinn criter.	-6.024382
F-statistic	14.33329	Durbin-Watson stat	2.164987
Prob(F-statistic)	0.000392		

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