

An Analysis of Exchange Rate Pass-Through to Domestic Prices: Evidence from Turkey

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Abstract

Assessing the impact of exchange rate shocks on domestic prices (Exchange Rate Pass-through) has a crucial role, particularly for the inflation targeting countries. This paper aims to clarify some aspects of ERPT to domestic prices in Turkey, an emerging country. Specifically, this study investigates if ERPT in Turkey is complete and how the behavior of ERPT has changed after the adoption of a flexible exchange rate regime in 2001. A Vector Auto Regression (VAR) framework is used to analyze the impact of exchange rate shocks on CPI Inflation. This study provides empirical evidence on the incompleteness and the pattern of ERPT on Turkey's CPI inflation based on the VAR Model. The findings demonstrate that ERPT is not only incomplete but also has a different pattern during the floating exchange rate period. The pass-through has decreased from 2001 to 2017, and it has increased dramatically after 2017 to a large extent because of very high inflation and high exchange rate volatility in this period.

Keywords: Exchange Rate Pass-through, Turkey, VAR, small open economy, emerging markets.

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1. Introduction

Assessing the impact of exchange rate shocks on domestic prices has a crucial role in monetary policy, particularly for the inflation targeting countries. The effect of exchange rates on domestic prices is referred to as “exchange rate pass-through” to commodity prices (ERPT henceforth). ERPT is measured in percentage change in local currency (import) price resulting from a 1% change in the exchange rate. (Knetter, 1997). ERPT is especially vital for emerging small open economies where exchange rates are sensitive to capital flows, and dramatic exchange rate changes can have a substantial impact on inflation. The floating exchange rate regime allows significant fluctuations in the exchange rates, which can change the prices in the domestic economy substantially, making it harder to hit the inflation target. Given that volatile exchange rates can pose a major obstacle to price stability, it is imperative to understand the dynamics of ERPT as well as its magnitude for setting monetary policy, economic forecasting, and modeling macroeconomic policymaking.

This study aims to clarify some aspects of ERPT to domestic prices for Turkey, an emerging open economy. Accordingly, this research investigates whether ERPT to Turkey has been complete or not over the last decades. In addition, this study examines whether the behavior of ERPT has changed after May 2001’s adoption of a flexible exchange rate regime and whether it has changed after Turkey started experiencing high exchange rate volatility and high inflation in the last four years. This paper contributes to the extant literature by allowing a better understanding of the dynamics of ERPT to Turkey’s inflation using a data set that includes the 2018-2022 period of very high exchange rate volatility.

This study uses a Vector Auto Regression (VAR) framework to investigate the impact of exchange rate shocks on CPI inflation during the pre-float and floating periods in Turkey. Impulse response functions and variance decompositions are used to analyze the impact of regime change on the behavior and the adjustment speed of ERPT.

This study proceeds as follows. The next section reviews the literature on the ERPT in general and for Turkey. The third and fourth sections present the data, descriptive observations of the data and methodology. The fifth and sixth sections present the findings of the empirical analysis and robustness tests. The last section concludes.

2. Literature Review

2.1. The General ERPT Literature

The open economy macroeconomic models assumed that the “law of one price,” which states that the domestic currency price of any good “ i ” is equal to the exchange rate times the foreign-currency price of the same good, can explain the behavior of exchange rates. The “law of one price” assumption and basic hypothesis connecting the prices with exchange rates (Purchasing Power Parity; PPP in short) in international economics has been invalidated by many empirical tests. The

deviations in relative PPP may result from differences in the transportation costs or different mark-ups charged by different firms in different territories (Burstein & Gopinath, 2014). A considerable literature has evolved, explaining why this assumption is invalid and the implications of this invalidation for monetary policy as a response to a currency's exchange rate depreciation or appreciation, among other things. (Ihrig et al., 2006).

Many studies that examined ERPT using either macro or microdata have similar conclusions on the incompleteness of ERPT and the decline of ERPT in the last decades. ERPT literature is reviewed in the next paragraphs, first in terms of the approach, then in terms of their conclusions.

The ERPT literature, mostly in the 1980s, focuses on explaining the effect of pricing behavior (e.g., the currency used for invoicing, the role of mark-up pricing, price discrimination, and competitive strategy) of the firms on the ERPT (Krugman, 1987; Dornbusch, 1987). In the 1990s and 2000s, the research was also focused on the effect of macroeconomic variables such as macroeconomic stability, inflation, exchange rate regimes, and financial integration on the pass-through. (Taylor, 2000; Devereux, Engel, & Tille, 2003)

Campa and Goldberg (2002) formalize the concept of pass-through in order to examine the prevalence of the "producer currency pricing"-exporter firm sets the prices in its own currency- (PCP) and the "local currency pricing" -exporter firm sets the prices in the currency of the country to which it exports-(LCP), and then they examine the roles of microeconomic versus macroeconomic determinants on ERPT into import prices in the 25 OECD countries. They find that PCP is more prevalent in the long run. They demonstrate that pass-through estimates are consistent with the profit maximization of the industry. They argue that the most significant determinants of ERPT are microeconomic reasons. In fact, the observed decline in ERPT is a consequence of a shift in the composition of the import basket from the goods which are relatively more exchange rate-sensitive (such as energy) to the goods with the less sensitivity (such as manufacturing goods) (Campa & Goldberg, 2002). This result is consistent with other studies mentioning the currency of invoices will determine the level of exchange rate pass-through when prices are sticky. (Campa & Goldberg, 2005; Choudhri & Hakura, 2015; Gopinath & Itskhoki, 2010; Flodén & Wilander, 2006). They argue that exporters were facing stronger competition choosing to invoice in local currencies to keep prices stable, decreasing ERPT. Due to foreign currency pricing, prices in highly dollarized economies tend to respond more to changes in currencies when compared to other countries (Ha et al., 2020; Carranza et al., 2009; Sadeghi et al., 2015). Some retailers prefer to absorb exchange rate fluctuations to maintain stable prices and increase their market share, which decreases the ERPT to consumer prices (Devereux, Engel, & Storgaard, 2003).

Friberg (1997) also conducts his analyses on the micro-level when he tries to answer the question of which currency exporters should set their prices. He argues that

micro-level analysis is important to understand the macro issues. Friberg's idea about the importance of microeconomics to understand the dynamics of macroeconomics is supported by Campa and Goldberg (2005), arguing that stability of the macro environment and strategic pricing in segmented markets –along with the technical issues such as the composition of the imports – is crucial to understand the pass-through results. Campa and Goldberg (2005) argue that “macroeconomic variables play a significant but limited role in explaining cross-country differences in levels of pass-through elasticities.”

The substantial portion of the literature on ERPT has two conclusions. First, the “law of one price” is violated by large margins, and the ERPT is far from being complete in both developed and developing countries (Frankel et al., 2005; Velickovski & Pugh, 2011). Second, ERPT is declining over time for some countries but is increasing over time for others (Forbes et al., 2020). Assuming the validity of these conclusions, many empirical studies examine why there is substantial variation in ERPT and why it is incomplete.

ERPT has decreased in many countries in the last decades. Ihrig et al. (2006) found that ERPT is declining in import prices as well as consumer prices for all of the G-7 countries, and Marazzi et al. (2005) report that ERPT to US import prices has declined substantially during the last decade. Frankel et al. (2005) contend that the degree and the adjustment speed of ERPT in emerging countries have also declined during the last decade. Yet, Ca'Zorzi et al. (2007) of the European Central Bank, in their examination of the degree of exchange rate pass-through to prices in 12 emerging countries, including Turkey, find that the ERPT to emerging countries is always higher than the pass-through to developed countries. Velickovski and Pugh (2011) find that exchange rate pass-through to consumer prices is significantly and substantially higher in transition economies than in developed economies, comparing 23 developed and 12 transition economies. Although emerging countries experience higher and faster ERPT relative to developed countries, incomplete pass-through is no longer a luxury for industrialized countries (Frankel et al., 2005). Frankel et al. (2005) and Cheikh and Zaied (2020) also note that monetary climate affects the ERPT. They both find that pass-through coefficients are significantly higher in high inflationary environments. This is consistent with some other studies concluding that there is a positive relationship between the degree of ERPT and the inflation level in the country (Taylor, 2000; Choudri & Hakura, 2001; Ca'Zorzi et al., 2007; Darvas, 2001; Forbes et al., 2017); credible and anti-inflationary monetary policies have a tendency towards lower consumer price pass-through (Gagnon & Ihrig 2004; Ha et al., 2020); and perception of lower and persistent inflation gives rise to decline in ERPT (Taylor, 2000). Taylor (2000) explains the relationship between ERPT and prices in terms of a firm behavior based on monopolistic competition and staggered price setting. The firms' response to an increase in costs as a result of the depreciation or others is related to the cost increase. Regimes with high inflation have more persistent costs; therefore, ERPT is higher when the inflation is high (Alper, 2003),

which is in line with Campa and Goldberg (2005). According to Mann (1986), regimes with high exchange rate volatility experience lower ERPT, which contradicts Campa et al. (2005) study finding exchange rate volatility is noisy but pass-through rates to import prices are lower for countries with low exchange rate volatility analyzing 23 OECD countries. It is also highly likely that exchange rate shocks are more persistent and permanent under pegged or fixed exchange rate regimes. (Tunc & Kilinc, 2018).

McCarthy (1999, 2007) examined the impact of exchange rates and import prices on domestic PPI and CPI in selected (nine) industrialized economies. McCarthy using a VAR model to incorporate a distribution chain of pricing, finds that exchange rate pass-through has a modest effect on domestic price inflation over the post-Bretton Woods era. This is consistent with Ha et al. (2020) study, which argues the existence of a downward trend in ERPT estimates for 55 countries using a structural VAR model. In contrast, Mihaljek and Klau (2001), in their study examining the ERPT in thirteen emerging countries, including Turkey, find that ERPT has a strong effect on domestic price inflation. Mihaljek and Klau (2001), in their comments, note that the exchange rate does not only affect the prices but also affects the expectations and predictions of future inflation. Warjiyo and Hutabarat (2002, as cited in Alper, 2003), in their review of previous studies on the nexus of inflation expectations and exchange rate, note that the past inflation and exchange rate accounts for the 65 % of inflation expectation.

Devereux, Engel, and Storgaard (2003) point out the importance of the macro-level stability to have a low level of ERPT with a model of endogenous pass-through. They argue that countries with low volatility of money growth will experience low rates of ERPT, whereas countries with highly volatile money growth will have higher ERPT.

Ha et al. (2020) finds that the countries with less flexible exchange rate regimes generally have higher ERPTs. Also, countries having inflation-targeting central banks tend to have lower ERPT providing evidence that a price stability commitment by central banks weakens the responsiveness of inflation to exchange rate shocks (Gagnon & Ihrig, 2004; Ha et al., 2020).

Marazzi et al. (2005) explain the reason for the decline in ERPT in the US as the increasing presence of Chinese exporters in US imports. In fact, the increase in imports from China over the past decades shifted the composition of the importing bundle towards manufacturing products which increased the competition among exporters. This contributes to the decline in ERPT into the import prices in the US and the other OECD countries having substantial imports from China. (Marazzi et al., 2005).

The Chinese domination in the global manufacturing industry has come along with two macro phenomena: cross-border manufacturing and financial integration. Cross-border production accelerates the decline in ERPT (Aksoy & Riyanto, 2000; Hegji, 2003, as cited in Ihrig et al., 2006). In addition to cross-border manufacturing, increasing financial integration involving lower trade costs is another crucial factor

in the decline in ERPT (Gust et al., 2005). However, Ca'Zorzi et al. (2007) find only weak empirical support for the presence of a positive relationship between ERPT and import openness which is an aspect of financial integration.

An emerging venue for the ERPT literature is the analysis of the underlying shocks triggering exchange rate movements (Shambaugh, 2008; Forbes et al., 2018; Ha et al., 2020). All these studies emphasize the importance of understanding the nature of the macroeconomic shocks that trigger an exchange rate movement. Forbes et al. (2018) find that ERPT is low following domestic demand shocks and relatively high following domestic monetary policy shocks in the UK. Understanding the dynamics of different ERPT responses after each macroeconomic shock is very crucial to setting up an appropriate monetary policy response (Forbes et al., 2018).

2.2. The Literature on ERPT in Turkey

Leigh and Rossi (2002) examine the effect of exchange rate movements on prices in Turkey using a Vector Autoregression model. They find that the impacts of exchange rate shocks are mostly felt in the first four months, although the impact lasts for about one year. They also find that estimated pass-through is near complete in a shorter time and larger relative to other key emerging countries (Leigh & Rossi, 2002). Leigh and Rossi (2002) estimate that the exchange rate shocks pass through to CPI and WPI by 45 % and 60 %, respectively, by the eleventh month; and Arbatli (2005) reports the ERPT to CPI and WPI at 39 % and 49 % respectively by the eight months in Turkey. Alper (2003) obtains similar results by using the Error Correction Models with data from 1987 to 2003. To Alper (2003), the main causes of the high ERPT are the past economic crises of Turkey and the high degree of openness. Arbatli's (2005) finding somewhat supports Alper's (2003) conclusion. Arbatli (2005), in her investigation of ERPT in Turkey from 1991 to 2004, finds that ERPT is lower during periods with higher exchange rate depreciation and periods with lower inflation. Yilmazkuday (2022) analyzes the drivers of Turkish inflation using a structural VAR model for 2005 to 2021. He concludes that the exchange rate pass-through into Turkish inflation is about 26% in the long run, which is the second most important shock after the oil price shocks to inflation, in line with the previous studies. Exchange rate shocks account for 17% of the variation in Turkish inflation (Yilmazkuday, 2022).

Alper (2003), Arbatli (2005), and Leigh and Rossi (2002) do not distinguish the regime shift to the floating exchange rate regime in 2001 in their study. Therefore, the validity of the findings in those three studies is highly questionable for Turkey's position after 2001, when the country's exchange rate regime was switched from a fixed to a floating one. On the other hand, the studies of Ca'Zorzi et al. (2007), Kara and Ogunc (2005), and Yilmazkuday (2022) shed some light on the most effective duration and degree of ERPT in Turkey during the floating exchange rate regime. Ca'Zorzi et al. (2007), in their aforementioned study, report that the ERPT is higher in emerging countries like Turkey than the developed countries.

Kara and Ogunc (2005) estimate the ERPT into import and domestic prices before (1995-2001) and after (2001-2004) the floating period in Turkey. Kara and Ogunc (2005) find that ERPT has weakened after the adoption of a floating exchange rate regime in 2001. More specifically, the long-term (i.e., 24 months) aggregated ERPT in the core CPI measure has declined from 46 % in the pre-float period to 30% in the floating period. In addition, it takes 4-5 months for completion of 80% of the total long-run ERPT in the pre-floating period, while it takes about 10-11 months for that in the post-floating period (Kara & Ogunc, 2005).

Kara and Ogunc's (2005) study demonstrates that the change in the Turkish exchange rate policy, along with successive disinflation implementations after May 2001, has significantly altered the behaviors of exchange rate and inflation after 2001. Employing the Granger causality test between the exchange rate and the inflation for the two periods, before and after the adoption of the floating exchange rate regime, the study finds that there is a causal relationship that runs from the exchange rate to inflation for the pre-float period, while there is no such causal relationship for the floating period. On the other hand, they argue that the exchange rate shock has a significant impact on inflation even in the floating exchange rate regime if the exchange rate shock is persistent. Kara and Ogunc (2005) observe that the exchange rate shocks were not persistent and one-sided during the floating regime period that they conducted their analyses. Kara and Ogunc's (2005) study has a limited time span after the floating period. Turkey adopted an inflation targeting regime with a two-year adjustment period after switching to floating its currency. This new dynamic needs to be analyzed with a larger time span.

Kara and Ogunc (2008) and Yunculer (2011) analyze pass-through to Turkish prices using a VAR framework during the inflation targeting period. Yunculer (2011) has found that pass-through is higher for producer prices than consumer prices. Both studies conclude that the degree of ERPT has weakened and slowed substantially after the adoption of an inflation targeting regime for their analyzed time spans (Kara & Ogunc, 2008; Yunculer, 2011).

Tunc and Kilinc (2018) demonstrate that ERPT sustained its relatively high level even after adopting inflation targeting regime. Their study includes the 2006-2015 period when Turkey actively used inflation targeting. Tunc and Kilinc (2018) use a Structural VAR analysis to include the global variables like world energy prices exogenously in their model, finding that ERPT is close to 18% in Turkey.

Butkiewicz and Ozdogan (2014) analyzed the monetary transmission mechanism in Turkey before and after the 2001 financial crisis. Using a VAR model, they confirm that the strength of the exchange rate channel has increased and exchange rate pass-through has declined after the floating of the Turkish Lira, which is consistent with the literature.

This paper contributes to the literature by analyzing the impact of exchange rate regime change on pass-through as well as the evolution of ERPT in transitioning to

more formal inflation targeting during the floating period. Also, this study sheds light on whether the ERPT dynamics have changed after Turkey started experiencing higher inflation and higher exchange rate volatility in the last four years.

ERPT is still relatively high in Turkey compared to developed countries. It needs to be analyzed whether ERPT dynamics have changed with very volatile exchange rates in the last four years, including the COVID recession period. In order to offer an effective monetary policy response to achieve price stability, policymakers must have a good understanding of the dynamics of the exchange rate pass-through mechanism in Turkey.

3. Data and Descriptive Observations

To study exchange rate pass-through to Turkey's consumer prices, Consumer Price Index (CPI), nominal US \$/TL exchange rate, import price index, and the output gap are used on a monthly basis based on the considerations regarding the pricing along with a distribution chain model of McCarthy (1999). Table 1 presents the summary of variables, acronyms used in the model, measurement, and sources of the variables. The exchange rate is the nominal monthly average Turkish Lira value of the US dollar. A recent study shows that 60% of Turkish imports are invoiced in US dollars, although only an average of 6% of its imports are from the US (Gopinath, 2015). Based on this information, a change in the import price index in US Dollars is used to capture the import price shocks on a global scale, as in Yunculer (2011). Change in CPI price index is used to represent the price change in imported and domestically produced final goods and services in the economy to capture direct and indirect effects of shocks. The output gap is used to capture demand shocks in the economy. The output gap is produced with HP-filter on the seasonally adjusted Industrial Production Index as in Yunculer (2011).

Table 1. Variables in the VAR model

Variable	Acronym	Measurement	Source
Output Gap	gap	Cyclical component of Industrial Production Index	OECD database, manual calculation
Import Price Index	π^{imp}	Index	Turkish Statistical Institute
Nominal Exchange Rate	exc	US \$/TL	IMF Financial Statistics
Consumer Price Index	π^{cpi}	Index	IMF Financial Statistics

The analysis covers monthly data from the beginning of 1997 until January 2022 since the import price index data series started in January 1997. Data is divided into two sub-samples for VAR analysis to capture the exchange rate regime change in 2001. The first sample consists of pre-float years between January 1997 to January 2001. The second sample includes the years of the floating exchange rate regime from

January 2002 to January 2022. 2001 data is not included because of a deep financial crisis in Turkey to decrease the noise in the estimations.

The stationarity of the time series variables is checked with unit root tests. It is found that the CPI index, import price index, and exchange rate are not stationary. First, differences in the log of CPI index, import price index, and the exchange rate is used to solve the unit root problem. Output gap series is found to be stationary and used in levels.

Looking at the historical change of the monthly inflation in Turkey since the early 1990s (Figure 1), one can observe persistently high inflation rates throughout the 90s. Turkey experienced a large financial crisis in 2001. The inflation rates had consistently declined since 2001 when Turkey adopted an IMF-backed economic program with increased central bank independence and targeted an inflation level. The inflation rate in May 2004, for instance, dropped below the 10% level for the first time relative to the past several decades. But, after 2017, the Turkish Lira experienced large depreciation against US dollars and lost its value by 44% only in 2021 (Turak, 2022). The inflation rate started increasing again. January 2022 annualized inflation rate increased to 48%, which is the highest level after the 2001 financial crisis.

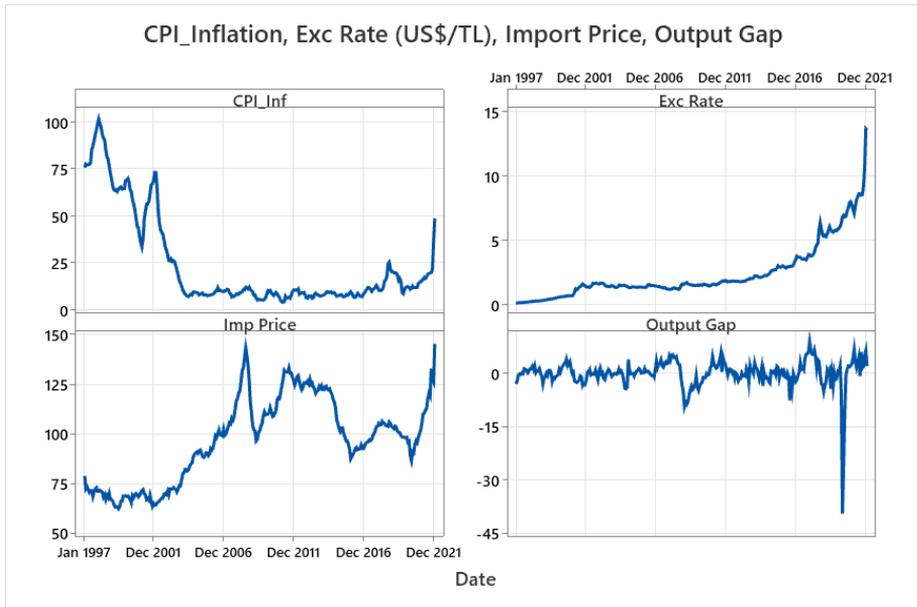


Figure 1. Time series plot of %change in CPI index, \$/TL nominal exchange rate, Import Price Index, and Output gap between 1997 and 2022.

The evolution of the monthly \$/TL exchange rate shows big depreciation. The volatility of the Turkish Lira has increased dramatically after May 2001 with the

floatation of the currency against other currencies (see Figure 2). The Turkish Lira has experienced large depreciation against the US dollar in 2018 and 2021. The volatility of the Turkish Lira even doubled when the data were analyzed separately for 2002-2017 and 2018-2022. In fact, the standard deviation of the average monthly nominal exchange rate increased to 2.07 from 0.84 in the 2018-2022 period.

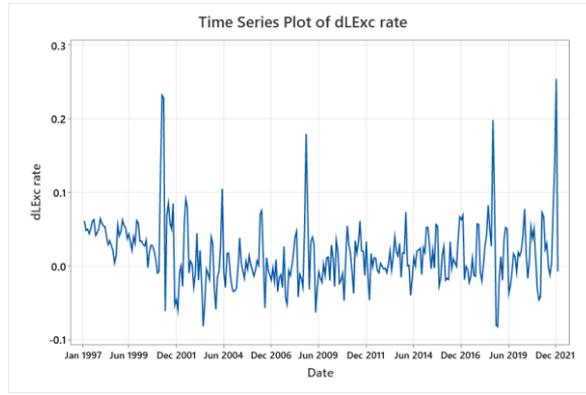


Figure 2. Monthly change in the log of the nominal exchange rate (\$/TL)

4. Method and Model

In this study, a reduced form Vector Auto Regression model (VAR) is used a la McCarthy’s (1999; Campa & Goldberg, 2005,2010) and Ca’Zorzi’s (2007) set up to measure ERPT. VAR allows measuring ERPT not only within a specific time period but also in a dynamic manner. VAR is the most commonly used method for estimating ERPT because it removes the issue of endogeneity between inflation and exchange rate by allowing dynamic feedback between them. It also allows for monitoring the evolution of the pass-through over time. It is particularly important because the speed and duration of pass-through are closely linked to short- and medium-term inflation forecasting.

The baseline VAR model used to analyze the ERPT is:

$$Y_t = C + \sum_{i=1}^p \Phi_i Y_{t-i} + \varepsilon_t \tag{1}$$

Where Y_t represents the vector of endogenous variables, C is a vector of constants, Φ_i is the matrices of autoregressive coefficients, and ε_t is a vector of white noise processes. The error terms are assumed to be serially uncorrelated with zero mean and constant variance with a variance-covariance matrix of $E(\varepsilon_t \varepsilon_t') = \Sigma_\varepsilon$. The constants and the autoregressive coefficients (i.e., C and $\Phi_1, \Phi_2, \dots, \Phi_p$) are estimated by Ordinary Least Squares (OLS) for each part of the equation (1) separately. The sample covariance matrix of the OLS residuals is used to estimate Σ_ε .

VAR model includes stationary endogenous variables; $dlexc$, which is *the* first difference of log of exchange rate; $d\pi^{imp}$, which is *the* first difference of log of import price index; a gap which is *the* output gap in levels; and $d\pi^{cpi}$ which is *the* first difference of log of consumer price index with the same order in the model. The model can be represented as follows as in Yunculer (2011) and Kara and Ogunc (2008):

$$dlexc_t = E_{t-1}(dlexc_t) + \varepsilon_t^{dlexc} \quad (2)$$

$$d\pi_t^{imp} = E_{t-1}(d\pi_t^{imp}) + \alpha_1 \varepsilon_t^{dlexc} + \varepsilon_t^{imp} \quad (3)$$

$$gap_t = E_{t-1}(gap_t) + \beta_1 \varepsilon_t^{dlexc} + \beta_2 \varepsilon_t^{imp} + \varepsilon_t^{gap} \quad (4)$$

$$d\pi_t^{cpi} = E_{t-1}(d\pi_t^{cpi}) + \delta_1 \varepsilon_t^{dlexc} + \delta_2 \varepsilon_t^{imp} + \delta_3 \varepsilon_t^{gap} + \varepsilon_t^{cpi} \quad (5)$$

ε_t^{dlexc} represents nominal exchange rate shock, ε_t^{gap} represents demand shock, and ε_t^{imp} and ε_t^{cpi} represent shocks to import and consumer prices, respectively. $E_{t-1}(\cdot)$ represents the expectation of the variable based on the information set available at the end of period $t-1$. Given the structure of the recursive VAR, conditional expectations in equations 2-5 are replaced by linear projections of the lags of the four endogenous variables in the system, which make the model a simple VAR estimation (Yunculer, 2011).

The ordering of the variables is the exchange rate, import prices, output gap, and consumer prices, in line with Kara and Ogunc (2008) and Yunculer (2011). The exchange rate is ordered first since exchange rate shocks are considered exogenous, and other variables can only affect it by future expectations. The consumer price index is ordered last because the pricing chain goes from import prices to consumer prices.

The lag lengths are selected by making use of the VAR system that includes a constant term. According to the Schwarz Information criterion and Akaike Information criterion, the most appropriate lag length is found to be one for both sub-periods.

A separate equation for oil price denominated in the local currency has not been included in the model as in the McCarthy's (1999) study because "the oil-based prices are administered prices in Turkey, and for some products, private consumption tax compromises over 80% of the price and therefore the impact of international oil price developments can often be distorted by the changes in special consumption taxes" (Kara & Ogunc, 2005). Turkey imports oil from the exporter countries, which is implicitly included in the import price index.

4.1. Estimation of Pass-through Coefficients

The impulse response function enables us to observe the dynamic effects of exchange rate shocks on consumer prices over time. Therefore, in the analysis, impulse response functions of CPI inflation to a one-unit innovation to the exchange

rate (a depreciation of the Turkish Lira) are used to assess the degree of ERPT in domestic prices in Turkey. Following Leigh and Rossi (2002), Shambaugh (2008), and Yilmazkuday (2022), ERPT is estimated as the ratio between the two-year cumulative impulse response of consumer prices and the two-year cumulative impulse response of the exchange rate, both following a specific shock. Specifically, I specify the pass-through coefficient for j periods after a shock taking place at time t as follows as in Yilmazkuday (2022):

$$ERPT_j = \frac{\sum_{i=t}^{t+j} dlcpi_i}{\sum_{i=t}^{t+j} dlexrate_i} = \frac{CIR\ of\ CPI\ to\ an\ Exchange\ Rate\ Shock}{CIR\ of\ Exchange\ Rate\ to\ an\ Exchange\ Rate\ Shock} \quad (6)$$

5. Empirical Findings

A reduced-form VAR model for the two sample periods is estimated separately, and the impulse responses over a one-year horizon for these two periods are analyzed. Figure 3 shows the impulse response of CPI inflation to one unit (percent) exchange rate shock for both sub-samples, which include data from January 1997 to January 2001(pre-float period) and January 2002 to January 2022 (floating period).

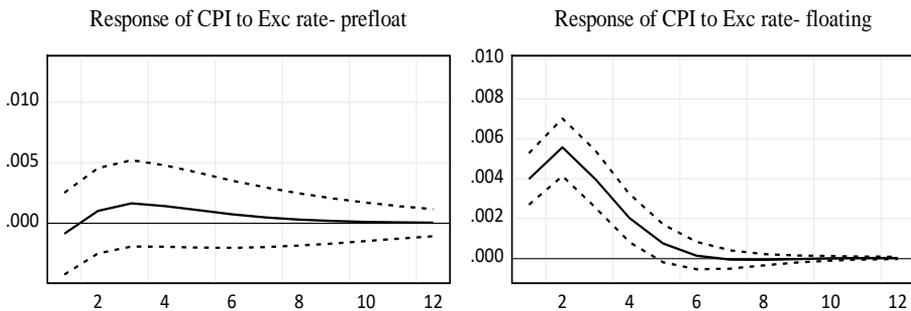


Figure 3: Impulse response of CPI to one unit exchange rate shock (1 percent depreciation to Turkish Lira) at pre-float and floating periods (Cholesky decomposition)

As shown in Figure 3, the response of inflation is more in the second period. Inflation increases about 0.2% as a response to an exchange rate depreciation within three months during the pre-floating period, then the effect declines. The response stabilizes after nine months. However, inflation rises about 0.5% as a result of an exchange rate depreciation within two months during the floating period. The response stabilizes more quickly after six months. This behavior is in line with economic theory stating that a depreciation of the currency increases the net exports, and increases the GDP, eventually passing through to consumers with higher prices.

As shown in Figure 4, the Import price decreases initially after the depreciation of the Turkish Lira during the pre-float period. This is in line with the model since the

import price index is in US dollars. That means a depreciation of the Turkish Lira creates a decrease in dollar denominated prices and can be interpreted as an increase in Lira-denominated prices. Output responds positively to a currency depreciation which is consistent with the economic theory.

Import prices give a similar negative response to a one percent exchange rate depreciation at the floating period, too. However, it takes a longer time for import prices to stabilize during the floating period. Output increases initially but decreases after the second period.

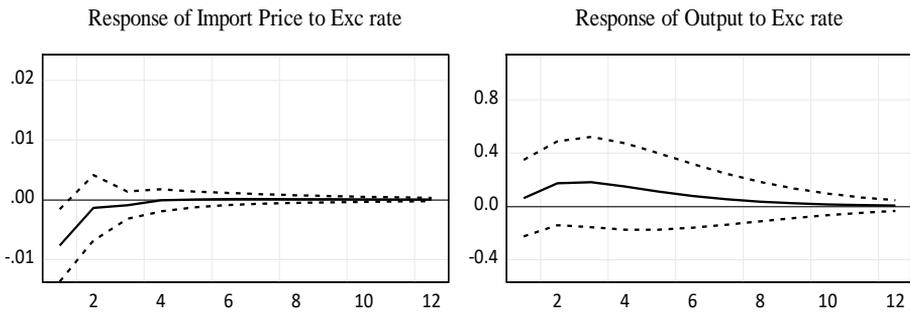


Figure 4. Impulse response to one unit exchange rate shock at pre-float period (Cholesky decomposition)

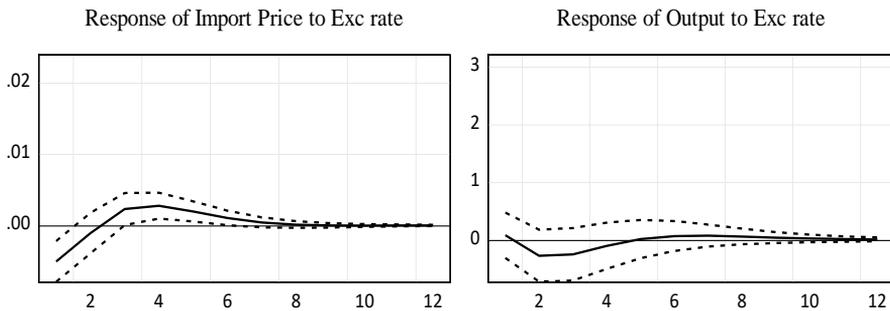


Figure 5. Impulse response to one unit exchange rate shock at floating period (Cholesky decomposition)

Figure 6 shows the estimated cumulative exchange rate pass-through for CPI inflation for two sub-samples following a one-unit innovation in the exchange rate. ERPT on consumer prices in Turkey is incomplete, and it is lower during the pre-floating exchange rate period (i.e., before 2001) than that during the floating exchange rate period. During the floating exchange rate period, the impacts of exchange rate movements on inflation have changed in terms of magnitude and duration. For instance, while 22 % of the movement in the exchange rate passed through to inflation by the eighth month during the pre-floating period, it is 35 % by the sixth month during the floating period.

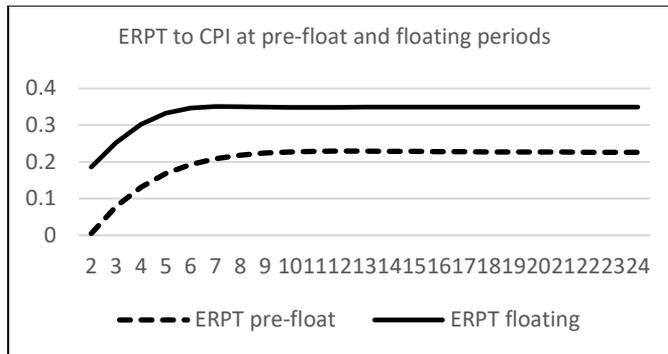


Figure 6. Cumulative Pass-through to Inflation (Before and After the Floating Exchange Rate Regime)

These figures demonstrate that the ERPT has increased after Turkey adopted the floating exchange rate regime. This is somewhat puzzling but consistent with the increase in the volatility of the exchange rate. ERPT literature states that an increase in exchange rate volatility is associated with higher ERPT (Campa & Goldberg, 2005). Turkish Lira has experienced almost 50% depreciation against the US dollar in 2021 (Kubilay, 2021) as well as similar episodes in July 2018 and October 2020, mostly due to unorthodox monetary policy practices by the Turkish government. Turkish central bank is losing its independence (Ahmadi & Prakash, 2022), and the confidence of the public is declining due to more autocratic policies by the government (Ozdogan, 2020), especially in the last four years. This might explain the unconventional results presented here for the floating period. To further analyze the floating period (i.e., 2002-2022) and specifically test whether the increase in exchange rate volatility in the last four years increased the ERPT, robustness tests are conducted. The results are presented in the section on robustness tests.

Forecast error variance decomposition gives insight into the various shocks affecting the CPI inflation by decomposing the variation in CPI inflation into shocks to endogenous variables. Forecast error variance decomposition of Turkish inflation is presented in Table 2 for different horizons. As is evident, import prices and exchange rate contributed the most volatility of inflation in pre-float and floating periods, respectively. Specifically, during the pre-float period, 17% of the variation in inflation is explained by import prices, whereas only 3% of the variation is explained by the exchange rate after one year. The smaller impact of exchange rates can be explained by the fixed exchange rate regime utilized in Turkey during the pre-float period. This picture changes dramatically for the floating period. In this period, 35% of the variance in inflation is explained by the exchange rate, whereas only 7% of the variation is explained by import price after one year. Forecast error variance decomposition analyses suggest that inflation is mostly driven by the exchange rate following its own shock at the floating period.

Table 2. Forecast Error Variance Decomposition of CPI inflation.

Contribution of endogenous variables	Pre-Floating Period			Floating Period		
	After one Month	After one Quarter	After one Year	After one Month	After one Quarter	After one Year
Exchange Rate	0.6%	2%	2.9%	14.6%	34.4%	35.2%
Output	0.0%	1.2%	7.6%	0.0%	0.85%	2.4%
Import Price	2.7%	13.7%	16.7%	5.6%	6.2%	6.6%
CPI Inflation	96.7%	83.1%	72.8%	79.7%	58.5%	55.8%

6. Robustness Checks

Several robustness checks are administered to confirm the validity of the results. The order of the endogenous variables is changed, and VAR is re-estimated. Impulse responses and ERPT coefficient were found to be the same with different ordering of the endogenous variables for both sub-samples.

The second sub-sample includes episodes of large currency depreciation and a decrease in central bank independence in Turkey, especially after 2017. To analyze whether the ERPT dynamics have changed after 2017, the sub-sample was divided into two groups to do some robustness checks. It is evident that the 2018-2022 impulse response of CPI to an exchange rate shock is dramatically different than that in 2002-2017 (See Figures A1 and A2 in Appendix A). CPI inflation increases about 0.1% as a response to an exchange rate depreciation within the first month, and the effect declines in four months in the 2002-2017 period. However, inflation rises about 1.5 % as a result of an exchange rate depreciation in the first two months before it starts to decline for the next two months in the 2018-2022 period.

ERPT has also changed after 2017. It seems ERPT was low before 2018, around 5% after 24 months; however, it is very high, around 60 % in the 2018-2022 period after stabilizing in 18 months (see Figures A3 and A4 in Appendix B). This result is in line with the literature stating that high inflation and high volatility of exchange rate are correlated with higher exchange rate pass-through (Taylor, 2000; Campa & Goldberg, 2005). This result is also in line with the literature regarding the slowing down of the ERPT with inflation targeting for the second period if the latest episodes of high inflation and the highly volatile exchange rate have not been included.

7. Conclusion

This paper provides empirical evidence on the incompleteness and the pattern of ERPT on Turkey's CPI inflation based on a reduced form VAR Model for two sub-periods: before and after Turkey's adoption of the floating exchange rate regime in 2001. Results demonstrate that ERPT is not only incomplete but also has a different pattern before and after the floating exchange rate regime. The pass-through has increased in Turkey after the adoption of the floating regime. Specifically, it increased to 35% from 22% after the regime change. Most of the pass-through for

the pre-float period is completed within nine months. However, completion of pass-through takes less time –about six months- after the adoption of the floating exchange rate regime. Robustness tests reveal that the floating period needs to be analyzed deeply since Turkey has experienced large exchange rate depreciation in the last four years. When the floating period is divided into two subsamples before and after 2017, the results show a very clear conclusion. ERPT was low, even lower than the pre-float period between 2002-2017, which is in line with the literature. Turkey had stable inflation with a less volatile exchange rate with a more credible central bank during in 2002-2017 period. Following 2017, ERPT increased very dramatically with a higher inflation rate and a more volatile exchange rate.

The findings have some policy implications. First, policy measures designed to limit exchange rate volatility and reduce the pass-through rate would greatly contribute to price stability, given that a credible commitment to maintain low and stable inflation is a key factor in weakening the ERPT even in sizable depreciation of the currency (Ha et al., 2020). On the other hand, this policy is hard to achieve in uncertain global financial markets, particularly in the post-COVID era. The second policy implication would be improving the central bank independence, which could potentially decrease ERPT to domestic prices because a central bank free from political and other pressures has a better position to make concrete policies to stabilize the prices and anchor inflation expectations.

The policy implications presented are explicit by not precise because of the limitations of this study. This study does not specifically consider the impacts of the COVID 19 recession and supply chain problems. Moreover, this study does not consider the frequencies of the exchange rate shocks before and during the floating exchange rate regime. Future research can investigate the shocks causing exchange rate fluctuations. It would be interesting to test whether exchange rate shocks due to different underlying reasons pass-through to the prices differently. In addition, future research could use dynamic stochastic general equilibrium models where the pricing behavior is modeled explicitly.

References

- Ahmadi, S., & Prakash A. (2022, January, 10). Autocrats Are Exploiting COVID-19 to Weaken Central Bank Independence. *Foreign Policy*. <https://foreignpolicy.com/2022/01/10/covid-19-pandemic-economy-central-bank-independence-turkey-china-monetary-policy/>
- Aksoy, Y., & Riyanto Y. (2000). Exchange Rate Pass-Through in Vertically Related Markets. *Review of International Economics*, 8(2), 235-51. <https://doi.org/10.1111/1467-9396.00218>
- Alper, K. (2003). Exchange Rate Pass-Through to Domestic Prices in Turkish Economy. MSc Thesis. Middle East Technical University. Ankara, Turkey.
- Arbatli, E. (2005). Exchange Rate Pass-Through in Turkey: Looking for Asymmetries. *Central Bank Review*, 2, 85-124.
- Burstein, A., & Gopinath G. (2014). International prices and exchange rates. *Handbook of International Economics*. 4th ed, 391-451. <https://doi.org/10.1016/B978-0-444-54314-1.00007-0>

- Butkiewicz, J.L., & Ozdogan Z. (2014). Financial Crises, Monetary Policy Reform and Monetary Transmission Mechanism in Turkey. *Middle East Developmental Journal*. 6(1), 66-83. <https://doi.org/10.1080/17938120.2014.885484>
- Ca'Zorzi, M., Hahn, E., & Sanchez, M. (2007). Exchange Rate Pass-through in Emerging Markets. *European Central bank Working Papers*. 739
- Campa, J., & Goldberg L. (2002) Exchange Rate Pass-through into Import Prices: A Macro or Micro Phenomenon? *NBER Working Paper* 8934 <https://doi.org/10.3386/w8934>
- Campa, J., & Goldberg L. (2005). Exchange Rate Pass-through into Import Prices. *The Review of Economics and Statistics*, 87(4), 679-690. <https://doi.org/10.1162/003465305775098189>
- Campa, J., & Goldberg L. (2010). The sensitivity of CPI to exchange rates: distribution margins, imported inputs and trade exposure. *The Review of Economics and Statistics*, 92(2), 392-407. <https://doi.org/10.1162/rest.2010.11459>
- Carranza, L., Galdon-Sanchez J.E., & Gomez-Biscarri J. (2009). Exchange rate and inflation dynamics in dollarized economies. *Journal of Development Economics* 89(1), 98–108 <https://doi.org/10.1016/j.jdeveco.2008.06.007>
- Cheikh, N. B., & Zaied, Y.B. (2020). Revisiting the pass-through of exchange rate in the transition economies: new evidence from new EU member states. *Journal of International Money and Finance*. 100. <https://doi.org/10.1016/j.jimonfin.2019.102093>
- Choudri, E., & S. Hakura. (2001). Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter? *IMF Working Paper*, No: WP/01/194. <https://doi.org/10.5089/9781451859867.001>
- Choudhri, E.U., & Hakura, D.S. (2015). The exchange rate pass-through to import and export prices: The role of nominal rigidities and currency choice. *Journal of International Money and Finance*. 51, 1–25. <https://doi.org/10.1016/j.jimonfin.2014.09.006>
- Darvas, Z. (2001). Exchange Rate Pass-Through and Real Exchange Rate in EU Candidate Countries. *Economic Research of the Deutsche Bundesbank, Discussion Paper* 10/01. <https://doi.org/10.2139/ssrn.2785126>
- Devereux, M., Engel C., & Storgaard P. (2003). Endogenous Exchange Rate pass-through When Nominal Prices Set in Advance. *NBER Working Paper* No. 9543 <https://doi.org/10.3386/w9543>
- Devereux, M., Engel C., & Tille C. (2003). Exchange Rate pass-through and the Welfare Effect on the Euro. *International Economic Review*. 44(1), 223-242 <https://doi.org/10.1111/1468-2354.t01-1-00068>
- Dornbusch, R. (1987). Exchange Rate and Prices. *American Economic Review* 77, 93-106.
- Flodén, M., & Wilander, F. (2006). State dependent pricing, invoicing currency, and exchange rate pass-through. *Journal of International Economics* 70(1), 178–196. <https://doi.org/10.1016/j.jinteco.2005.08.002>
- Forbes, K., Hjortsoe, I., & Nenova, T. (2017). Shocks versus structure: explaining differences in exchange rate pass-through across countries and time. *Bank of England Discussion Papers* 50. <https://doi.org/10.2139/ssrn.2999637>
- Forbes, K., Hjortsoe, I., & Nenova, T. (2018). The shocks matter: improving our estimates of exchange rate pass-through. *Journal of International Economics*. 114, 255-275. <https://doi.org/10.1016/j.jinteco.2018.07.005>

- Forbes, K., Hjortsoe, I., & Nenova, T. (2020). International evidence on shock-dependent exchange rate pass-through. *IMF Economic Review*, 68, 721-763. <https://doi.org/10.1057/s41308-020-00124-2>
- Frankel A., Jeffrey, D., Parsley C., & Shang-Jin W. (2005). Slow Pass-through around the world: A new import for developing countries? *NBER Working Paper* No. 11199 <https://doi.org/10.3386/w11199>
- Friberg, R. (1997). In which currency should Exporters Set Their Prices? *Journal of International Economics*, 45, 59-76. [https://doi.org/10.1016/S0022-1996\(97\)00035-4](https://doi.org/10.1016/S0022-1996(97)00035-4)
- Gagnon, J., & Ihrig J. (2004). Monetary Policy and Exchange rate Pass-through. *International Journal of Finance and Economics*, 9, 315-338. <https://doi.org/10.1002/ijfe.253>
- Gopinath, G., & Itskhoki, O. (2010). Frequency of price adjustment and pass-through. *Quarterly Journal of Economics*, 125 (2), 675-727. <https://doi.org/10.1162/qjec.2010.125.2.675>
- Gopinath, G. (2015). The International Price System *NBER Working Paper Series*. No: 21646 <https://doi.org/10.3386/w21646>
- Gust C., Leduc, S., & Vigfusson R. (2010). Trade Integration, Competition, and the Decline in Exchange Rate Pass-Through. *Journal of Monetary Economics*, 57(3), 309-324 <https://doi.org/10.1016/j.jmoneco.2010.02.001>
- Ha, J., Stocker, M. M., & Yilmazkuday, H. (2020). Inflation and Exchange Rate Pass-through. *Journal of International Money and Finance*, 105, Article 102187. <https://doi.org/10.1016/j.jimonfin.2020.102187>
- Hegji, C. (2003). A Note on Transfer Prices and Exchange Rate Pass-Through. *Journal of Economics and Finance* 27(3), 396-403. <https://doi.org/10.1007/BF02761573>
- Ihrig J., Marazzi M., & Rothenberg A. (2006). Exchange rate pass-through in the G-7 countries. *International Finance Discussion Papers*. Paper No. 851 <https://doi.org/10.17016/IFDP.2006.851>
- Kara H., & Ogunc F. (2005). Exchange rate Pass-through in Turkey: It is slow, but is it really low? *The Central Bank of Republic of Turkey Working Papers*. No: 05/10
- Kara H., & Ogunc F. (2008). Inflation Targeting and Exchange Rate Pass-through: Evidence from the Turkish Economy. *Emerging Markets Finance and Trade*, 44, 52-66. <https://doi.org/10.2753/REE1540-496X440604>
- Knetter M. M. (1997). Goods prices and Exchange rates: What have we learned. *Journal of Economic Literature* 35(3), 1243-1272.
- Krugman P. (1987). Pricing to Market When the Exchange Rate Changes, in *Real-financial linkages among open economies*, Eds. S.W. Arndt and J. David Richardson. Cambridge, MA: MIT Press, 49-70.
- Kubilay, M. (2021). *Turkey's self-made currency crisis* <https://www.mei.edu/publications/turkeys-self-made-currency-crisis>
- Leigh, D., & Rossi M. (2002). Exchange Rate Pass-Through in Turkey. *IMF Working Paper*. WP/02/204. <https://doi.org/10.2139/ssrn.880852>
- Mann C. (1996). Prices, Profit Margins, and Exchange Rates. *Fed. Reserve Bulletin*, 72,366-79.
- Marazzi M., Sheets N., & Vigfusson R. (2005). Exchange rate pass-through to US import prices: Some new evidence. *International Finance Discussion Papers*. Paper No. 833. <https://doi.org/10.17016/IFDP.2005.833>

McCarthy, J. (1999). Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. *BIS Working Paper*. 79. <https://doi.org/10.2139/ssrn.856284>

McCarthy, J. (2007). Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. *Eastern Economic Journal*. 33(4), 511-537. <https://doi.org/10.1057/ej.2007.38>

Mihaljek, M., & Klau M. (2001). A note on the Pass-through from Exchange Rate and Foreign Price Changes to Inflation in Selected Emerging Market Economies. *Bank for International Settlements Papers* No:8.

Ozdogan, Z. (2021). The Effects of Democratic Regression on Turkish Economy and the Brain Drain. In *Human Rights in Turkey*. 365-382. Springer, Cham. https://doi.org/10.1007/978-3-030-57476-5_16

Sadeghi, S.K., Feshari, M., Marvasti, M.B., & Ghanbari, Z. (2015). Exchange rate pass-through and inflation in dollarized economies: evidence from the Middle Eastern and North African countries. *Iranian Economic Review* 19(2), 139–147.

Taylor J.B. (2000). Low inflation, pass-through, and the pricing power of firms. *European Economic Review* 44, 1389–1408. [https://doi.org/10.1016/S0014-2921\(00\)00037-4](https://doi.org/10.1016/S0014-2921(00)00037-4)

Tunc, C., & Kilinc M. (2018). Exchange Rate Pass-through in a Small Open Economy: A Structural VAR Approach. *Bulletin of Economic Research*. 70(4), 307-378. <https://10.1111/boer.12162>

Turak N. (2022). *Erdogan blames Turkey's currency problems on 'foreign financial tools' as central bank reserves fall* <https://www.cnbc.com/2022/01/13/erdogan-blames-turkeys-currency-woes-on-foreign-financial-tools-as-central-bank-reserves-fall.html>

Velickovski I., & Pugh G. T. (2011). Constraints on exchange rate flexibility in transition economies: a meta regression analysis of exchange rate pass through. *Applied Economics*, 43, 4111-4125. <https://10.1080/00036846.2010.485927>

Yilmazkuday, H. (2022). Drivers of Turkish Inflation. *Quarterly Review of Economics and Finance*. 84, 315-323. <https://doi.org/10.1016/j.qref.2022.03.005>.

Yunculer, C. (2011). Pass-through of External Factors into Price Indicators in Turkey. *Central Bank Review*. 11, 71-84.

Appendix A. The impulse responses of CPI inflation

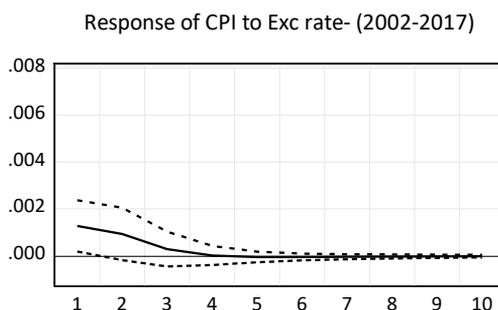


Figure A1. The impulse response of CPI inflation to one unit exchange rate shock in the period of 2002-2018

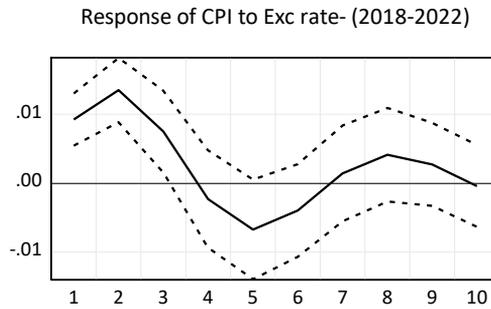


Figure A2. The impulse response of CPI inflation to one unit exchange rate shock in the period of 2018-2022

Appendix B. Cumulative Exchange rates pass-through to Inflation

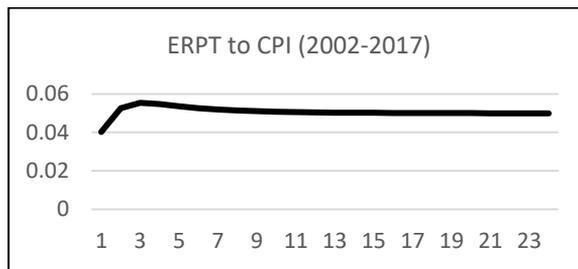


Figure A3. Cumulative Exchange rate pass-through to Inflation (2002-2017 period)

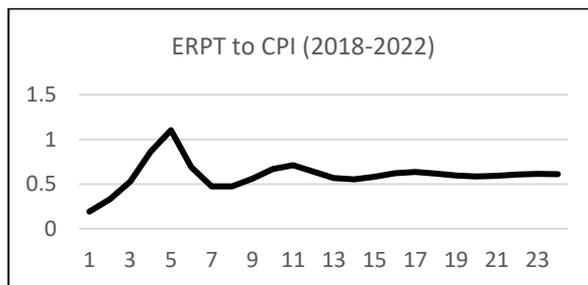


Figure A4. Cumulative exchange rate pass-through to Inflation (2018-2022 period)