The Degree of Currency Substitution and Exchange Rate Pass-Through

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15 September 2015

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December 2016

Abstract

This study investigates the effect of the degree of currency substitution on the exchange rate pass-through (ERPT) to import and domestic prices in Turkey, using monthly data between 1998 and 2013. The recursive interacted vector autoregressive (IVAR) specification of Towbin and Weber (2013) is employed, based on McCarthy's (1999) distribution chain model. Currency substitution is treated as an interaction term in the IVAR specification. The empirical evidence suggests that high currency substitution increases the effect of ERPT to import and domestic prices.

JEL Codes: C32; E31; E52; F31.

Keywords: Exchange rate pass-through; currency substitution; inflation; interacted VAR.

* I would like to thank Sebastian Weber for sharing the IPVAR MATLAB code.

1. Introduction

Many emerging countries have adopted floating exchange rate and inflation-targeting regimes during 1990s and later on. This has exposed them to the challenge of greater imported inflationary pressure due to exchange rate volatility. As a result, interest in exchange rate pass-through (ERPT) has grown (Aron, Macdonald, and Muellbauer, 2014 and Taylor, 2000a). In addition to ERPT, currency substitution is an important issue for emerging economies. There is a notion that currency substitution increases the ERPT to prices and makes monetary policy more complicated and less effective (Reinhart, Rogoff, and Savastano, 2003, 2014, Yazgan and Zer-Toker, 2010). Therefore, the investigations of the degree of ERPT and currency substitution as well as their interaction are important subjects. This paper represents an attempt to understand whether or not the degree of currency substitution has an effect on the speed and degree of ERPT to the prices. The aim of this study is to examine ERPT to prices under different levels of currency substitution in an emerging economy, Turkey, and to directly assess the evidence using the recursive interacted vector autoregressive (IVAR) model.

The term currency substitution has been used to refer different issues in the literature, such as foreign currency deposits in the domestic financial system, deposits held abroad by domestic residents, and foreign currency notes circulating within the boundaries of a country. In this study the term currency substitution is used similarly to in Calvo and Vegh, 1992. It refers to the process whereby foreign money holdings substitute for domestic money balances as a store of value, unit of account and medium of exchange. In the literature the term 'dollarization' is also used for the same purpose. Moreover, there are different approaches to modeling currency substitution in an economy (see Selçuk, 2003, and for the case of Turkey see Yazgan and Zer-Toker, 2010). In this study, the ratio of foreign exchange deposit accounts (FEDA) to M2[1] is used as a measure of currency substitution.

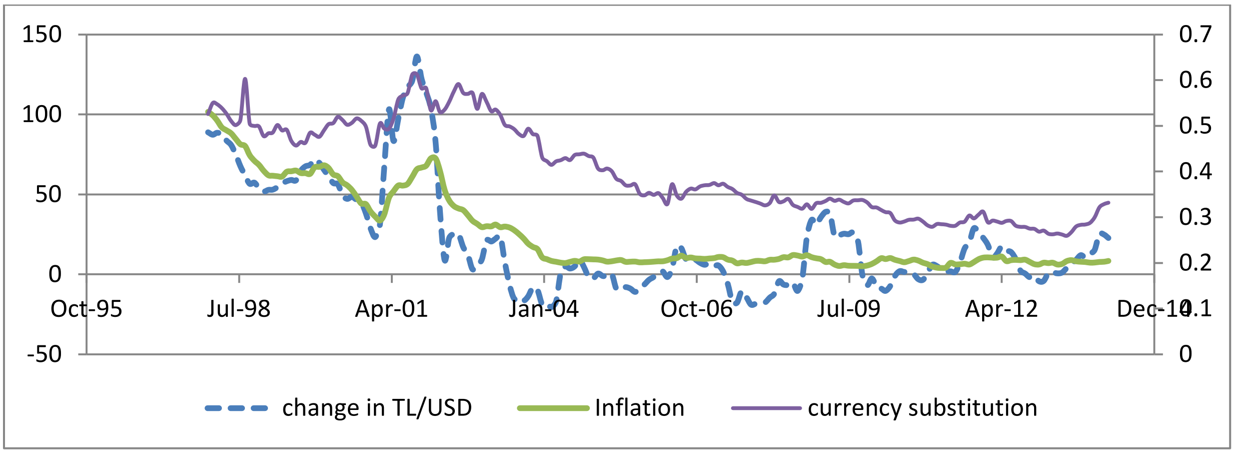
The data is gathered from Turkey, because the Turkish economy is a good context in which to test the effects of domestic exchange rate and currency substitution changes on prices. Turkey experienced financial crises and exchange rate regime changes in 1994 and 2001. The exchange rate regime was changed from crawling peg to floating in February 2001 and an implicit inflation-targeting regime was implemented between 2002 and 2005. In 2005, the Central Bank of Republic of Turkey (CBRT) announced the implementation of an

1 M2Y is used for the period between 1998 and 2012.

inflation-targeting regime to begin in 2006. The CBRT then, after the global financial crisis of 2008-2009, started to implement unconventional monetary policies (Aysan, Fendoglu, & Kilinc, 2014). In Turkey, the policy rate, which is one of the main policy tools of the CBRT, is adjusted according to currency fluctuations (see Berument, 2007 and Civcir and Akçağlayan, 2010). Exchange rate volatility and currency substitution started to increase in Turkey in May 2013 as news emerged of the U.S. Federal Reserve's tapering of its quantitative easing policy. The news caused a fall in equity markets, a depreciation of domestic exchange rates and an increase in credit default swap spreads in emerging economies (Aizenman, Binici, and Hutchison, 2014).

Consequently, Turkey is an emerging open economy that has adopted a floating exchange rate and inflation-targeting regime. Figure 1 presents the change in exchange rate, currency substitution and consumer price inflation. It is clear that exchange rate and inflation move together up to the exchange rate regime was changed from crawling peg to floating in February 2001. Moreover, before 2003, there was high inflation, exchange rate volatility and currency substitution. After 2003, inflation and the exchange rate became stable, with a respectively low currency substitution ratio (for the sample before 2003, currency substitution is 52.1, the standard error of change in exchange rate is 32.84 and the standard error of inflation is 18.66 while, after 2003, currency substitution is 34.8, the standard error of exchange rate is 13.53 and the standard error of inflation is 5.50). Currency substitution is usually the ultimate consequence of high inflation (Lebre de Freitas, 2004; Valev, 2010). In addition to inflation, the exchange rate instability also increases the degree of currency substitution (Isaac, 1989; Akçay, Alper, and Karasulu, 1997; Prock, Soydemir, and Abugri, 2003). As shown in empirical studies, also in Turkey currency substitution is high once exchange rate and inflation as well as their volatilities are high. The above enables us to analyze the effect of ERPT under different levels of currency substitution in Turkey.

Figure 1: Currency substitution, change in exchange rate and inflation between January 1998 and March 2014



* Source: CBRT, left vertical axis annual change in the TL/USD and annual Inflation, Right vertical axis Currency Substitution

In macroeconomics, the issue of the speed and degree of pass-through has been studied for developed and developing countries through the application of single-equation models and vector autoregressive (VAR) models. The single-equation models are based on the approach pioneered by Obstfeld and Rogoff (1995, 2000) and Betts and Devereux (1996, 2000), among others, which analyzes the degree of pass-through in an environment of sticky prices and monopolistic competition. This literature has emphasized the implications of local versus producer currency pricing for the pass-through. The alternative approach utilizes a reduced-form recursive 'distribution chain' model, developed by McCarthy (1999, 2000), whereby the pass-through from the exchange rate to prices is conditioned by various supply and demand shocks, and is separately assessed for import, producer and consumer prices (Gueorguiev, 2003, and for the case of emerging economies see Aron, Macdonald, and Muellbauer, 2014). This approach provides a means to compare the reactions of prices to an exchange rate shock at different stages of the distribution process. Although the model was initially employed for developed economies[2], it is now widely applied to small economies[3].

2 Applications to developed economies can be found in McCarthy (1999; 2000; 2006; 2007) and Hahn (2003)

3 McCarthy's distribution chain model for small open economies has been applied by Rabanal and Schwartz (2001) to Brazil, by Bhundia (2002) and Ocran (2010) to South Africa, by Gueorguiev (2003) to the case of Romania, by Rowland (2003) to Colombia, by Billmeier and Bonato (2004) to Croatia, by Ito and Sato (2008) to East Asian countries, by Babecká-Kucharèuková (2009) to the Czech Republic, and by Maertens Odria, Castillo, and Rodriguez (2012) and Winkelried (2014) to the case of Peru. Applications to Turkey are given in the next footnote.

The first ERPT studies of Turkey emerged in 2002. Single-equation models[4] and VAR models are used to investigate the level of ERPT. Among these studies, the one most often preferred in the context of Turkey is that of McCarthy (1999). McCarthy's distribution chain model for Turkey has been applied by Leigh and Rossi (2002) and later by Arat (2003), Arbatli, (2003), Kara and Ogunc (2005; 2008; 2011; 2012), Ca' Zorzi, Hahn and Sánchez (2007), Yunculer (2011), Karagöz et al. (2012) and Azgün (2013).

The measurement and interpretation of ERPT measures is a very important issue for policy makers, but many published estimates are misleading. This poses challenges for the policy maker. Despite this vast amount of research on ERPT in the literature, the effect of currency substitution on ERPT is a hitherto neglected force, despite being an essential part of the analysis of ERPT. Generally, ERPT to prices and currency substitution concepts have been discussed separately. There are a few studies that deal with both ERPT to prices and currency substitution, such as Reinhart, Rogoff, and Savastano (2003; 2014) and Yazgan and Zer-Toker (2010). This study provides new empirical evidence for the measurement of ERPT in emerging economies by introducing currency substitution as an interaction variable in the distribution chain model of McCarthy (1999).

The rest of the article is structured as follows. Section 2 presents the data and provides a preliminary analysis of time-series properties. Section 3 introduces the econometric methodology. Section 4 discusses the empirical evidence from Turkey. Section 5 concludes.

2. Data

To investigate the pass-through of exchange rates to import price and domestic price inflation under different currency substitution levels, monthly data from January 1998 to December 2013 were gathered. The endogenous variables of the model are the output gap, the exchange rate, import prices and price inflation. The first variable used in the specification is the domestic output gap ($Y - \bar{Y}$), estimated from real GDP using the Hodrick-Prescott filter[5]. It controls for the effects of excess demand on inflation. The exchange rate is domestic currency value of one U.S. dollar. Import prices are given by the import unit value index, denominated in Turkish Lira (TL). Price inflation is given by the consumer price index (CPI).

4 Single-equation ERPT estimation models for Turkey have been applied by Guncavdi and Orbay (2004), Kara et al. (2005), Kara, Kucuk-Tuger, Ozlale, Tuger, and Yucel (2007), Özçiçek (2010), María-Dolores (2010), Toraganli (2010), Brun-Aguerre, Fuertes, and Phylaktis (2012), Çiçek and Boz (2013) and Doğan (2013).

5 The output gap is estimated as the difference between real GDP and potential GDP (Hodrick-Prescott filtered trend). The monthly real GDP series is constructed from quarterly data using the interpolation method, by applying the low frequency to high frequency quadratic match sum conversion option. Then, to account for seasonality, Census X12 is applied.

The ratio of FEDA to M2 is used as a measure of currency substitution. All these variables, except for the output gap and currency substitution, are introduced into the model as logarithms and first differences. All Turkish data were gathered from the CBRT's electronic data delivery system (EDDS) except for the import unit value index, which was obtained from the Turkish Statistical Institute (TurkStat). Table A.1 in the appendix provides the definitions and sources of the variables.

The Augmented Dickey-Fuller and Phillips-Perron unit root tests show that all series except for the output gap series are nonstationary in levels and stationary in first differences at the 1 percent significance level[6]. The series are transformed into their first differences to make them stationary and so that the IVAR model can be employed satisfactorily. Table 1 reports the correlations of the transformed series. There is a high positive correlation between the exchange rate and import prices and between currency substitution as well as price inflation.

Table 1: Correlation of Variables

	Output Gap	Exc. Rate	Imported Inf.	Price Inflation	Cur. Sub.
Output Gap	1				
Exc. Rate	-0.0453	1			
Import Prices	0.1105	0.8097	1		
Price Inflation	-0.0644	0.3626	0.3304	1	
Cur. Sub.	-0.08439	0.1986	0.1733	0.6055	1

3. Methodology

This section discusses the model and methodology to investigate the ERPT to prices under different currency substitution levels. I employ the IVAR specification of Towbin and Weber (2013)[7] based on McCarthy's (1999) model. The recursive IVAR(p) model can be represented as follows:

$$A_0 Y_t = C + \sum_{k=1}^{p} A_k Y_{t-k} + DX_t + \sum_{k=1}^{p} B_k X_t Y_{t-k} + u_t \text{ , where t = 1, 2,...,T.} \quad (1)$$

where Y_t is a q-vector of the explanatory variables and is composed of the output gap (aggregate demand), the exchange rate change, the import unit value index denominated in TL (import prices) and the CPI (domestic price inflation). X_t is the interaction term, which is considered to influence the dynamic relationship among the endogenous variables, here

6 See appendix Table A.2 for the level and Table A.3 for the first difference unit root test results.

7 The estimation is performed using Towbin and Weber's IPVAR MATLAB toolbox. For further explanation, see Towbin & Weber (2011, 2013).

currency substitution. C is the q-vector of the intercept. A_k and B_k are qxq matrices of autoregressive coefficients. D is the qxq matrix of coefficients of interacted variables. u_t stands for the q-vector of structural errors. p is the lag order. A_0 is recursive IVAR coefficient which is a lower triangular qxq matrix with ones on the main diagonal. The reduced form of model can be shown as follows:

$$Y_t = \tilde{C} + \sum_{k=1}^{p} \tilde{A}_k Y_{t-k} + \tilde{D} X_t + \sum_{k=1}^{p} \tilde{B}_k X_t Y_{t-k} + \varepsilon_t \qquad \text{, where t = 1, 2,...,T .} \tag{2}$$

here the values of ε_t are not the standard structural shocks. The relationship between the reduced-form IVAR disturbances ε_t and the fundamental economic shocks u_t is given by $u_t = A_0 \varepsilon_t$. The recursive IVAR coefficient A_0 and the structural error terms for the impulse response functions (IRF) are obtained by the Cholesky decomposition. Therefore, there are restrictions on the contemporaneous correlations between the variables. The order of the variables is important: The first variable cannot respond to contemporaneous shocks (within the month) in any other variables, and the second one can respond to contemporaneous shocks affecting the first variable but not to any others. Based on these considerations, the model can be written as

$$y_t^{gap} = E_{t-1}(y_t^{gap}) + u_t^d \tag{3}$$

$$\Delta e_t = E_{t-1}(\Delta e_t) + \alpha_{21} u_t^d + u_t^{\Delta e} \tag{4}$$

$$\pi_t^{impi} = E_{t-1}(\pi_t^{impi}) + \alpha_{31} u_t^d + \alpha_{32} u_t^{\Delta e} + u_t^{impi} \tag{5}$$

$$\pi_t^{cpi} = E_{t-1}(\pi_t^{cpi}) + \alpha_{41} u_t^d + \alpha_{42} u_t^{\Delta e} + \alpha_{43} u_t^{impi} + u_t^{cpi} \tag{6}$$

where y_t^{gap} is the output gap (aggregate demand), Δe_t is the first difference of the logarithm of the exchange rate, π_t^{impi} is the first difference of the logarithm of the import unit value index denominated in TL (import prices), π_t^{cpi} is the first difference of the logarithm of the CPI (price inflation) and $u_t^d, u_t^{\Delta e}, u_t^{impi}, u_t^{cpi}$ are the demand, exchange rate, import prices and price inflation shocks. $E_{t-1}(\cdot)$ represents the unconditional expectation of a variable based on the information set available. The shocks are assumed to be serially uncorrelated and orthogonal across equations. Expectations are introduced into the model through linear projections of the lags of the variables in the system. The endogenous variables are organized according to Kara and Ogunc (2008); moreover, currency substitution is introduced as the interaction variable, which is the main distinction and contribution of the model. Thus, the effect of currency substitution on ERPT is examined.

One may argue that interest rate should be in the model to control central bank action. A large rise in import prices is likely ultimately to increase inflation and the domestic country's central bank may react to this change; the monetary policy action may potentially affect the exchange rate. I repeated exercise with interest rate, whereas the results didn't change. Therefore, interest rate is not included the model.

Even though, McCarthy (1999) uses oil price as supply shock. I omitted oil price in a similar way to in Kara and Ogunc (2008; 2012), because of two reasons, Firstly, private consumption and value-added taxes together comprise over 70 percent of the oil price in Turkey and the effect of international oil price fluctuation can often be adjusted by changes in taxes by government. Secondly, Turkey imports more than 90 percent of crude oil consumption and significant quantities of petroleum products[8] and the import prices are denominated in TL in my model. In this way, the impact of import prices (including oil prices) and the depreciation of the domestic currency are considered together.

Before performing inference from IRF graphs, I test the presence of statistically significant difference between low and high currency substitution cumulative IRF curves. I employ impulse response based test according to Kilian and Vigfusson (2011). Based on the gathered impulse responses, both the impacts of exchange rate shocks at low and high currency substitution levels are estimated. The differences between low and high currency substitution condition for the same periods are compared and tested statistically whether they are same or not. In which the null hypothesis in particular is

$$H_0 : \mathrm{I}_y(h, low) = \mathrm{I}_y(h, high) \text{ or } H_0 : \mathrm{I}_y(h, low) - \mathrm{I}_y(h, -high) = 0 \quad (7)$$

Ha: not Ho

Where $I_y(h,low)$ and $I_y(h,high)$ are responses of Y_t to exchange rate shock at low and high currency substitution conditions for the period $h=1,2\ldots.H$. This test has a t-distribution and it depends on the impact of shock and interaction variable. Table 2 suggests that the effects of exchange rate on prices at low and high currency substitution are different and statistically significant. Therefore, I can interpret the effect of different currency substitution level on ERPT.

8 See U.S. Energy Information Administration: http://www.eia.gov/countries/cab.cfm?fips=tu.

Table 2: Impulse Response Based Difference test

Output Gap				
Perd.	**High**	**Low**	**Dif.**	***p*-value**
1	0.000	0.000	0.000	NaN
2	-0.030	-0.050	0.021***	$2{,}08\text{x}10^{-108}$
3	-0.071	-0.117	0.046***	$3{,}96\text{x}10^{-93}$
4	-0.115	-0.187	0.072***	$1{,}01\text{x}10^{-85}$
5	-0.156	-0.255	0.099***	$2{,}03\text{x}10^{-83}$
6	-0.193	-0.319	0.126***	$8{,}34\text{x}10^{-84}$
7	-0.226	-0.379	0.153***	$1{,}95\text{x}10^{-85}$
8	-0.254	-0.434	0.180***	$1{,}64\text{x}10^{-87}$
9	-0.279	-0.486	0.207***	$1{,}27\text{x}10^{-89}$
10	-0.301	-0.534	0.232***	$1{,}39\text{x}10^{-91}$
11	-0.321	-0.578	0.257***	$2{,}61\text{x}10^{-93}$
12	-0.338	-0.619	0.281***	$8{,}52\text{x}10^{-95}$

Exchange Rate				
Perd.	**High**	**Low**	**Dif.**	***p*-value**
1	0.676	0.708	-0.033	NaN
2	0.967	0.965	0.002***	1,8x10-18
3	1.069	1.054	0.014***	1,10x10-11
4	1.087	1.079	0.008***	0,0001
5	1.076	1.079	-0.003*	0,0711
6	1.059	1.070	-0.011	0,4617
7	1.043	1.058	-0.015	0,6338
8	1.030	1.045	-0.015	0,4676
9	1.020	1.033	-0.013	0,2148
10	1.012	1.021	-0.009*	0,0641
11	1.005	1.010	-0.005***	0,0136
12	1.000	1.000	0.000***	0,002

Imported Inflation				
Perd.	**High**	**Low**	**Dif.**	***p*-value**
1	0.664	0.523	0.140	NaN
2	0.944	0.680	0.264***	0
3	1.012	0.718	0.294***	0
4	1.008	0.711	0.297***	$1{,}05\text{x}10^{-270}$
5	0.983	0.689	0.294***	$1{,}40\text{x}10^{-234}$
6	0.957	0.662	0.295***	$9{,}72\text{x}10^{-222}$
7	0.936	0.634	0.302***	$8{,}11\text{x}10^{-221}$
8	0.921	0.608	0.313***	$2{,}43\text{x}10^{-225}$
9	0.909	0.583	0.326***	$4{,}15\text{x}^{-231}$
10	0.900	0.560	0.341***	$2{,}13\text{x}10^{-236}$
11	0.893	0.538	0.355***	$1{,}31\text{x}^{-240}$
12	0.887	0.518	0.369***	$9{,}07\text{x}10^{-244}$

Price Inflation				
Perd.	**High**	**Low**	**Dif.**	***p*-value**
1	0.069	0.041	0.028	NaN
2	0.172	0.064	0.108***	0
3	0.253	0.071	0.182***	0
4	0.300	0.073	0.227***	0
5	0.324	0.072	0.251***	0
6	0.333	0.071	0.262***	0
7	0.335	0.069	0.266***	0
8	0.334	0.068	0.267***	0
9	0.333	0.066	0.267***	0
10	0.331	0.065	0.267***	0
11	0.330	0.063	0.266***	0
12	0.328	0.062	0.266***	0

Based on 1.000 replications of model t-values
indicates the level of significance at 1%
** indicates the level of significance at 5%
* indicates the level of significance at 10%

4. Empirical Results

According to economic theory, it is expected that degree of ERPT to import prices and that to domestic prices are proportional to each other. A lower value of the domestic currency is likely to raise the cost of imports, which can feed into higher consumer prices (Mishkin, 2008). In addition to this, greater currency substitution triggers domestic currency depreciation (McKinnon, 1982), increases consumer prices (Lebre de Freitas, 2004) and increases the degree of ERPT (Reinhart et al., 2003; 2014).

The analyses begin with a unit root test, which is a preliminary step for IVAR analyses. The Augmented Dickey-Fuller and Phillips-Perron unit root tests present that all series except for the output gap series are nonstationary in levels and stationary in first differences at the 1 percent significance level. Another important preliminary step for IVAR is the selection of the lag order. Moreover, based on the Schwarz information criterion, the lag order is set to 1. The Wald test implies that the first lags in the model are jointly significant.

Figure 2: Cumulative impulse responses for one-standard-deviation exchange rate shock under high and low currency substitution (FEDA to M2 ratio) with 95% confidence band for whole sample from 1998 to 2013

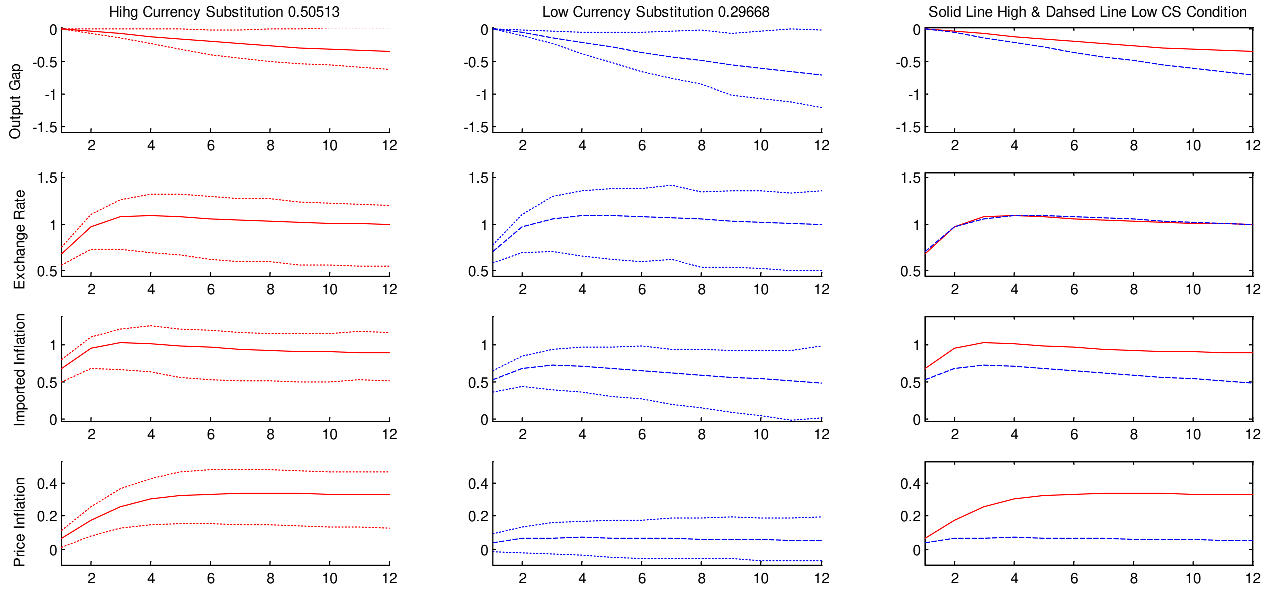


Figure 2 reports the cumulative impulse responses for aggregate demand, exchange rate changes, import prices and price inflation when a one-standard-deviation shock is applied to the exchange rate and currency substitution is treated as the interaction term. When the response value is one, it indicates complete ERPT, that is, prices are constant in the foreign currency. If the response is zero, it indicates that the impact of ERPT is zero, that is, prices are constant in the domestic currency. Concretely, the level of ERPT to price inflation is presented by the degree of response to an exchange rate shock. The period is set as 12 months.

In the first two columns of Figure 2, the high and low currency substitution conditions are shown. The middle line shows the estimates and the other two lines show the bootstrapped confidence intervals at the 95 percent level, which are computed using 1000 replications. The third column shows the estimates of these two different conditions together for each variable, providing a clear comparison. In the first column (high currency substitution), currency substitution is equal to the 80th percentile of the series, with a value of 0.50513, which means that 50 percent of broad money is composed of foreign currency deposits. In the second column (low currency substitution), currency substitution is equal to the 20th percentile of the series, with a value of 0.29668, which means that 29 percent of broad money is made up of foreign currency deposits (the responses of the import prices and price inflation to one-standard-deviation shocks in the exchange rate are given as bar graphs in appendix Figure A.1 and Figure A.2).

During high currency substitution, there is complete ERPT to import prices with an impact elasticity of 1. Furthermore, during low currency substitution, there is partial ERPT to import prices with an impact elasticity of 0.73. The correlation test results (See Table 1: Correlation of Variables) also show that there is a high positive correlation between the exchange rate and import prices. Around 80 percent of the exchange rate series corresponded to the import price series. For that reason, the import price behavior depends highly on movements in the exchange rate in Turkey. The pass-through to import prices is higher under high currency substitution than under low currency substitution in all periods. The speed of the ERPT to import prices can be observed as well as its level (degree). The response of import prices is the greatest in the third period under both the high and low currency substitution conditions. Consequently, low currency substitution weakens, but does not change the speed of, the ERPT effect on import prices.

Consumer prices, on the other hand, contain nontradable goods, which should not be particularly sensitive to import price developments. The IRFs show the response of price inflation to ERPT to be less than half the responses of import prices to ERPT. Moreover, a salient difference can be seen between the high and low currency substitution conditions. The total pass-through of 33.5 percent of exchange rate changes is passed through to price inflation within seven months under high currency substitution, while for the low condition the corresponding figure is 7 percent in the seven months after the shock. Thus, low currency substitution seems to dramatically weaken the ERPT effect. Furthermore, the level of currency substitution does not affect the time it takes for ERPT to be completed. In addition to this, the estimation results present that there is high positive correlation between currency substitution and inflation in Turkey. The pass-through effect is powerful during high currency substitution (when 50 percent of broad money is made up of foreign currency deposits) a 10 percent persistent appreciation of the U.S. dollar (depreciation of TL) increases prices by 3.3 percent in seven months. On the other hand, the low currency substitution condition (29 percent of broad money made up of foreign currency deposits) weakens the pass-through effect. A 10 percent persistent appreciation of the U.S. dollar (depreciation of TL) increases prices by 0.7 percent in seven months.

Robustness Check

For robustness, in addition to measuring the ERPT to price inflation through direct exchange rate shocks, the approach of Rabanal and Schwartz (2001) is used. The pass-through coefficient is computed as the ratio of the j-month cumulative response of price inflation to the j-month cumulative response of the exchange rate to an exchange rate shock[9]. The coefficients support the direct cumulative response of price inflation to exchange rate shocks. It gives the same results.

Furthermore, I repeat the exercise by simple VAR estimation and impulse response analysis with Cholesky decomposition where currency substitution also considered as an endogenous variable. The simple VAR (p) model can be represented as follows:

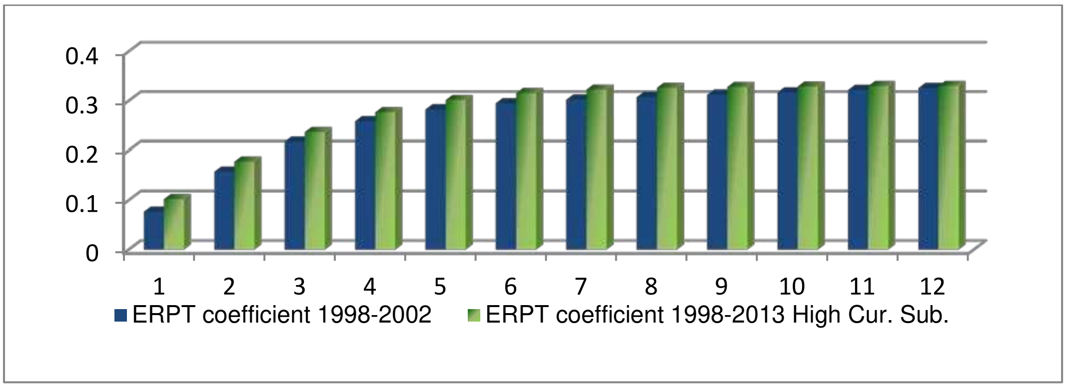
$$Y_t = \beta_0 + \sum_{k=1}^{p} \beta_{1,k} Y_{t-k} + u_t \text{ , where t = 1, 2,...,T.} \tag{7}$$

where vector Y_t is composed of endogenous variables which are the output gap, the exchange rate change, import price inflation, price inflation and currency substitution. β_0 is the q-vector of the intercept. u_t stands for the q-vector of residuals.

Here, the data sets are split into two periods: before and after 2003. There was high uncertainty between January 1998 and December 2002 and the average currency substitution was 52.1 percent (52.1 percent of broad money consisted of foreign currency deposits), which is very close to the 80th percentile of the entire currency substitution series (0.50513). Moreover, the average currency substitution between January 2003 and December 2013 was 34.8 percent (34.8 percent of broad money is foreign currency deposits), which is very close to the 20th percentile of the entire currency substitution series (0.29668).

9 The Rabanal and Schwartz (2001) specification is given by the following ratio: $PT_{t,t+j} = P_{t,t+j} / E_{t,t+j}$ where Pt,t+j is the cumulative change in the price inflation and Et,t+j is the cumulative change in the exchange rate between months t and t+j.

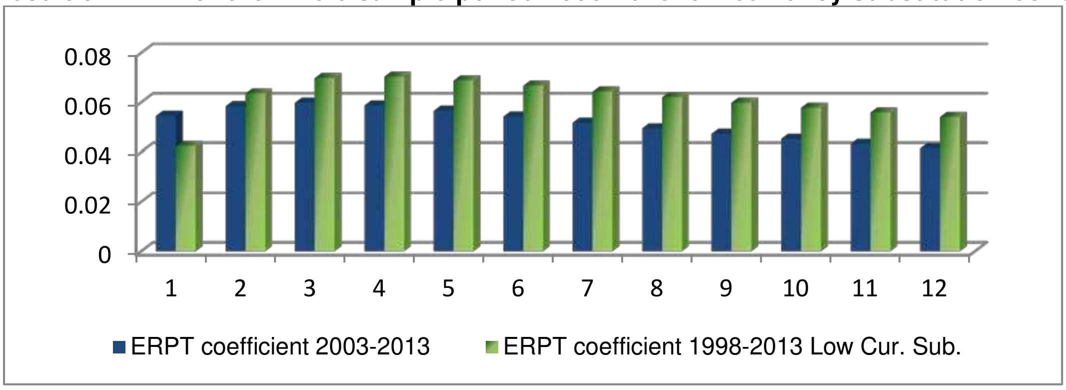
Figure 3: Comparing ERPT coefficient results of simple VAR for the period 1998-2002 and the result of IVAR for the whole sample period 1998-2013 under high currency substitution conditions



The response of price inflation to an exchange rate shock over the period from January 1998 to December 2002 and January 1998 and December, 2013 period

When currency substitution is considered an endogenous variable, Figure 3 shows the comparison of the IRFs results by simple VAR for the period 1998-2002 and the IVAR results for the period 1998-2013 under the high currency substitution condition. It is clear that they are almost the same[10].

Figure 4: Comparing ERPT coefficient results of simple VAR for the period 2003-2013 and the result of IVAR for the whole sample period 1998-2013 low currency substitution condition



The response of price inflation to exchange rate shock January 1998 and December, 2002 period and IVAR high currency substitution January 1998 and December, 2013 period

Figure 4 shows the comparison of the IRFs results by simple VAR for the period 2003-2013 and the IVAR results for the period 1998-2013 under the low currency substitution condition. These results indicate that the IVAR results are largely robust. When the data sets are split into two periods: before and after 2003, it also presents that during inflation-targeting regimes currency substitution and ERPT to prices decreases. For Turkey case, this reduction can be also explained by switching main anchor from exchange rates to inflation targets. In other words, the inflation expectation triggers currency substitution and a higher ERPT to prices. The inflation-targeting regime has a positive effect on expectation so on currency

10 See standard IRF graphs of subperiods when currency substitution is exogenous in appendix Figures A.4 and A.5.

substitution and ERPT. Consequently, the findings of this study present following results: First, ERPT to import prices is higher than consumer prices which is convenient with theory. Second, currency substitution increases the effect of ERPT to prices which support economic theory and thus Reinhart, Rogoff, and Savastano (2014). Third, currency substitution does not change speed of ERPT to prices.

5. Conclusion

The empirical results of this study indicate that ERPT to import prices and domestic prices is higher during the high currency substitution condition than during low currency substitution. Additionally, they indicate that the level of currency substitution does not affect the speed of ERPT. In particular, it is shown that there is a strong relation between currency substitution and degree of ERPT. The IVAR analysis results show that a 10 percent persistent appreciation of the U.S. dollar (depreciation of the TL) increases domestic prices over seven months by 3.36 percent during high currency substitution and 0.7 percent during low currency substitution. Even though the ERPT is lower under low currency substitution, it is still significantly high. Therefore, currency substitution and ERPT are still important in the Turkish economy.

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Appendix

Table A.1: Data Sources

Variable	Definition	Code	Source
Output gap (aggregate demand)	$Y - \bar{Y}$ the difference between actual and potential output.		Author's calculation
Exchange rate change	USD/TRY exchange rate, selling prices	TP.DK.USD.S.YTL.1	CBRT, EDDS
Import prices	Import unit value index denominated in Turkish Lira		TurkStat
CPI (domestic price inflation)	General Index, Consumer (1987=100, General Price Index (Consumer Price) (2003=100)	TP.FG.A01 TP.FG.J0: 0	CBRT, EDDS
Currency substitution	FEDA/M2		Author's calculation
Foreign Exchange Deposit Accounts (FEDA)	Foreign Exchange Deposit Accounts Deposit Money Banks-Deposits-Deposit Types (Monthly, Thousand TL)	TP.KM.F19	CBRT, EDDS
M2	Money supply and counterpart items (monthly, thousand TL) 1998-2011 M2Y 2012-2013 M2	TP.PG.P16 TP.PR.ARZ13.1	CBRT, EDDS
Real GDP	Gross domestic product (fixed) GDP-expenditure based (at current and fixed (1998) prices) (TURKSTAT) (New Series)(Quarterly, TRY Thousand)	TP.UR.GG01.S	CBRT, EDDS

Table A.2: Unit Root Tests in the Level

	A: Intercept		B: Intercept with Trend	
	ADF	PP	ADF	PP
Output Gap	-4.197	-3.49	-4.155	-3.485**
Exchange Rate	-1.715	-1.700	-2.278	-2.037
Import Prices	-0.457	-0.394	-3.141*	-2.770
Price Inflation	-0.183	-0.083	-1.862	-1.541
Currency Sub.	-1.225	-1.073	-2.674	-2.493

Table A.3: Unit Root Tests in the First Difference

	A: Intercept		B: Intercept with Trend	
	ADF	PP	ADF	PP
Output Gap	-7.909	-8.613	-3.677**	-8.588
Exchange Rate	-9.370	-9.588	-9.376	-9.581
Import Prices	-11.528	-11.430	-11.500	-11.400
Price Inflation	-9.896	-9.659	-9.869	-9.631
Currency Sub.	-16.433	-16.505	-16.396	-16.470

* indicates the level of significance at 10%
** indicates the level of significance at 5%.
indicates the level of significance at 1%.
The critical values are gathered from MacKinnon (1996) and are one-sided p-values.

Figure A.1: The response of import prices to an exchange rate shock under high and low currency substitution conditions for whole sample from 1998 to 2013

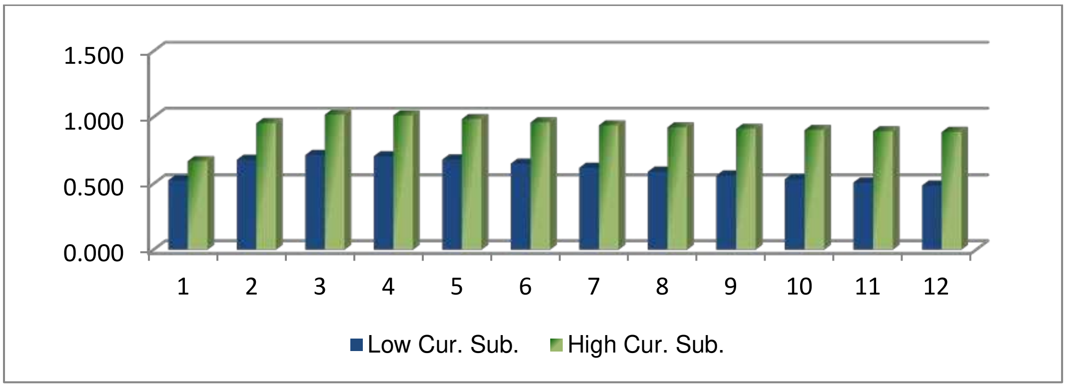

Figure A.2: The response of price inflation to an exchange rate shock under high and low currency substitution conditions for whole sample from 1998 to 2013

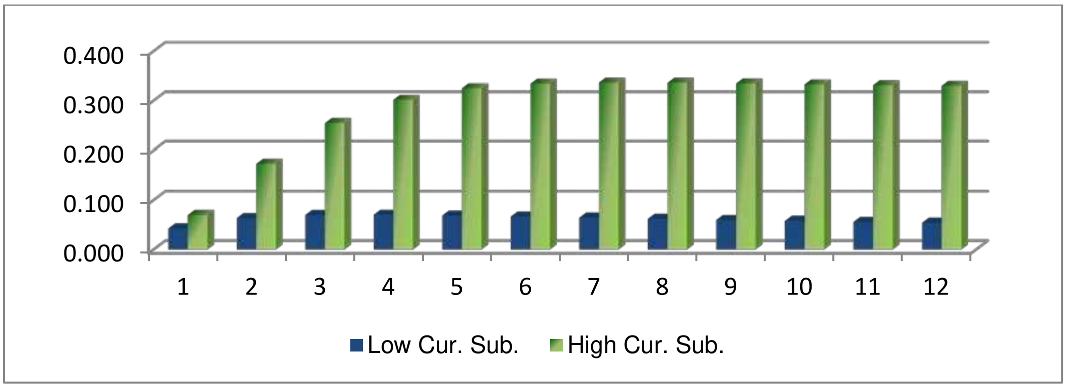

Figure A.3: ERPT coefficient results according to the response of price inflation to exchange rate shocks under high and low currency substitution conditions for whole sample from 1998 to 2013 by Rabanal and Schwartz (2001)