Product-level estimates of exchange rate pass-through: Evidence from Turkey

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Introduction

- Exchange rate pass-through (ERPT) is a crucial macroeconomic parameter for the role the exchange rate plays in affecting key economic variables—such as inflation and the trade balance—of a country.

- For example, it is an important parameter in the response of domestic inflation to changes in exchange rates. Central banks often need to disentangle and estimate how much of the CPI inflation is due to foreign exchange movements and how much is due to other factors such as the output gap.

- It is also relevant to how much the trade deficit responds to changes in the exchange rate. For example, if, as in the textbook formulations of the Marshall-Lerner condition, export prices in domestic currency do not respond to a depreciation while import prices do, a greater quantity response in exports and imports would be required for the trade balance to improve in response to that depreciation.

Motivation

- A sizable literature aims to estimate the ERPT magnitude. However, estimating pass-through is not necessarily straightforward. Even for a country for which the ERPT is well-examined, such as the US, the literature still offers fairly different estimates.

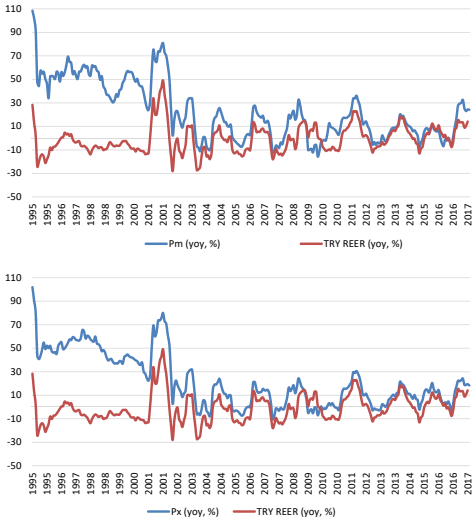
- One reason for the difficulty to obtain accurate ERPT estimates might be that most studies rely on aggregate data. Using the Turkish data, we show that ERPT estimation can be improved notably by the use of highly-detailed data at the 6-digit product level.

- Turkish ERPT behavior offers an interesting case. For example, Turkey is one of the three countries that Gopinath (2015) uses to illustrate her main points—along with the US and Japan—in her multi-country pass-through paper. Nevertheless, despite the relative clarity of Turkey's ERPT patterns, empirical estimates for the Turkish ERPT also encompass a wide range.

Contribution

- While there are studies for other countries that use detailed product-level or micro-level data to estimate pass-through rates, they do not compare those estimates to the ones obtained from aggregated data through a detailed examination of a comparable specification, as we do here.
- See, for example, Gaulier et al (2008) for a multi-country study and Berner (2011) who employs 8-digit data for Germany.
- For the Turkish pass-through, ours is the first paper, to the best of our knowledge, that employs a fine-grained product-level data set in the estimation.

Visual pass-through evidence



The monthly year-on-year (yoy) changes in the real TRY exchange rate (REER) and **import** (Pm) and **export** prices (Px) in current TRY, respectively.

Interpretation of the visual evidence

- The figures clearly suggest that the TRY exchange rate movements pass through to TRY trade prices at a high rate and without much of a lag.
- Despite the visually-evident nature of the Turkish pass-through behavior given in figures, the estimates reported in the related literature cover a wide range.
- Even if we exclude the outliers, the literature's estimates range from 9 to 100 percent. The st dev of the estimates of import price pass-through is 35 percentage points for the short run and 47 percentage points for the long run, while the standard deviation of the estimates for export prices is 24 percentage points for both the short and the long run—see the Appendix in the paper.
- In stark contrast to that wide range, the fine-grained product-level data that we use in this paper allow us to estimate the pass-through rates quite accurately and with high precision—i.e., with low standard deviations.

Baseline model

The baseline regression model that we estimate can be expressed as follows:

$$P_{ijt} = \alpha_0 + \sum_{k=0}^{6} \beta_{1,k} E_{t-k} + \sum_{k=1}^{6} \beta_{2,k} GDP_{t-k} + \sum_{k=0}^{6} \beta_{3,k} W_{t-k} + \sum_{k=0}^{6} \beta_{4,k} P_{t-k}^{Energy} + \sum_{k=0}^{6} \beta_{5,k} P_{t-k}^{Ind} + c_j + a_i + y_t + m_t + \epsilon_{ijt},$$

where i stands for the 6-digit product, j country (trade partner), and t time. E_t is the log nominal effective TRY exchange rate and the coefficients on E_t are the main parameters of interest, giving us the baseline pass-through rates. P_{ijt} is the log of TRY import price in the regression for import pass-through, and the log of TRY export price in the regression for export pass-through, while the right-hand-side variables are the same in both regressions. We run several specifications all of them with country fixed effects, c_j, product fixed effects, a_i, year fixed effects, y_t, and month-of-year fixed effects, m_t. W_t measures foreign price levels.

Model 2

$$P_{ijt} = \alpha_0 + \sum_{k=0}^{6} \beta_{1,k} E_{t-k} + \sum_{k=1}^{6} \beta_{2,k} GDP_{t-k} + \sum_{k=0}^{6} \beta_{3,k} W_{t-k} + \sum_{k=0}^{6} \beta_{4,k} P_{t-k}^{Energy} + \sum_{k=0}^{6} \beta_{5,k} P_{t-k}^{Ind} + \sum_{k=0}^{6} \beta_{6,k} CPI_{j,t-k} + \sum_{k=0}^{6} \beta_{7,k} E_{j,t-k} + c_j + a_i + y_t + m_t + \epsilon_{ijt},$$

where $E_{j,t-k}$ is the k^{th} lag of the trade partner j's log nominal exchange rate. Note that the trade partner's CPI is also included in the regression in order to control for the possible variation in the bilateral trade partner's price level, which could cause variation in $E_{j,t-k}$ with no effect on P_{ijt}, biasing the pass-through estimate toward zero.

Pooled model

$$P_{ijt} = \alpha_0 + \sum_{k=0}^{6} \beta_{1,k}^{X} E_{t-k} X_{ijt} + \sum_{k=0}^{6} \beta_{1,k}^{M} E_{t-k}(1 - X_{ijt}) + \sum_{k=1}^{6} \beta_{2,k} GDP_{t-k} + \sum_{k=0}^{6} \beta_{3,k} W_{t-k} + \sum_{k=0}^{6} \beta_{4,k} P_{t-k}^{Energy} + \sum_{k=0}^{6} \beta_{5,k} P_{t-k}^{Ind} + c_j + a_i + y_t + m_t + \epsilon_{ijt},$$

where X_{ijt} is an indicator variable that takes the value of 0 if the observation in question is for imports and 1 for exports.

$$\hat{p}_t = \alpha_0 + \sum_{k=0}^{6} \beta_{1,k} \hat{e}_{t-k} + \sum_{k=1}^{6} \beta_{2,k} \hat{GDP}_{t-k} + \sum_{k=0}^{6} \beta_{3,k} \hat{W}_{t-k} + \sum_{k=0}^{6} \beta_{4,k} \hat{P}^{Energy}_{t-k} + \sum_{k=0}^{6} \beta_{5,k} \hat{P}^{Ind}_{t-k} + \epsilon_t,$$

where, as in the panel estimation, p_t is import price in the import pass-through regression and export price in the export pass-through regression.

Data I

- Monthly import and export quantities as well as import and export prices are obtained from TurkStat at 6-digit industry detail. The dataset covers 5,565 different 6-digit sectors, and details Turkey's bilateral trade with more than 200 countries at monthly frequency. Original data are in US dollars, which we convert to TRY terms by using the monthly exchange rate data published by the Central Bank of the Republic of Turkey.

- The effective exchange rates are from the BIS data set—the "broad indices" are used.

- W_t, as noted, is borrowed from Campa and Goldberg (2005) and is calculated using the formula $W_t \equiv \ln(NEE_t \cdot CPI_t / REE_t)$, where NEE_t and REE_t correspond to the nominal effective exchange rate and the real effective exchange rate, respectively. W_t can be interpreted as a trade-weighted average of foreign price levels.

Data II

- Oil price and non-oil industrial commodity price indices that we use as controls in the regressions are from the IMF.
- The Fuel (Energy) Index, coded PNGR in the IMF database, includes prices of crude oil, coal, natural gas, and propane, while the Industrial Inputs Price Index, coded PINDU in the IMF database, includes prices of agricultural raw materials and metals.
- The bilateral foreign exchange rate data are taken from the International Financial Statistics database (exchange rate section) of the IMF.

Results I

Import pass-through estimates using bilateral FX rates

Exchange rate$_t$	t	0.9037***	0.8956***	0.8783***
		(0.0572)	(0.0411)	(0.0347)
	t-1	-0.0109	-0.0079	0.0345
		(0.0984)	(0.0657)	(0.0407)
	t-2	0.0247	-0.0004	-0.0018
		(0.1029)	(0.0703)	(0.0473)
	t-3	0.1017	0.0719	0.0416
		(0.1173)	(0.0781)	(0.0522)
	t-4	-0.0876	-0.0846	-0.0527
		(0.0859)	(0.0596)	(0.0465)
	t-5	0.0563	0.0587	0.0396
		(0.0789)	(0.0548)	(0.0488)
	t-6	-0.1080	-0.0674	-0.0356
		(0.0714)	(0.0493)	(0.0382)
Country $\times$ product		-	+	+
Country $\times$ year		-	+	+
Product $\times$ month		-	-	+
Exchange rate$_t$	ST	0.9037	0.8956	0.8783
	LT	0.8799	0.8659	0.9039
Exchange rate$_{j,t}$	ST	-0.4763	-0.2514	-0.2477
	LT	-0.4210	-0.2015	-0.1738
N		6,222,699	6,190,900	6,188,171

Results II

Export pass-through estimates using bilateral FX rates

Exchange rate$_t$	t	0.8478***	0.8378***	0.8484***
		(0.0504)	(0.0489)	(0.0453)
	t-1	0.0214	-0.0015	0.0169
		(0.0544)	(0.0603)	(0.0502)
	t-2	-0.0473	-0.0367	-0.0602
		(0.0751)	(0.0772)	(0.0747)
	t-3	0.0008	-0.003	0.0107
		(0.0548)	(0.0499)	(0.0535)
	t-4	0.0224	0.0456	0.0738**
		(0.0615)	(0.0362)	(0.0356)
	t-5	0.0818	0.0168	-0.0253
		(0.0733)	(0.0489)	(0.0396)
	t-6	-0.0855*	-0.0463*	-0.0377
		(0.0494)	(0.0280)	(0.0237)
Country $\times$ product		-	+	+
Country $\times$ year		-	+	+
Product $\times$ month		-	-	+
Exchange rate$_t$	ST	0.8478	0.8378	0.8484
	LT	0.8414	0.8127	0.8266
Exchange rate$_{j,t}$	ST	-0.2735	-0.1993	-0.3009
	LT	-0.0171	-0.0245	-0.0124
N		7,414,677	7,373,725	7,369,410

Results III

Comparison of pass-through estimates from micro and macro estimations

		1	2	3	Macro
Import pass-through					
	ST	0.92	0.89	0.88	0.98
		(0.050)	(0.038)	(0.032)	(0.073)
	LT	0.87	0.86	0.89	0.90
		(0.040)	(0.031)	(0.028)	(0.050)
Export pass-through					
	ST	0.81	0.83	0.84	0.90
		(0.053)	(0.042)	(0.039)	(0.060)
	LT	0.83	0.81	0.82	0.82
		(0.046)	(0.030)	(0.028)	(0.044)

The standard errors are reported in parentheses. They are clustered at the product level for the micro estimates and obtained by HAC for the macro estimates. All the estimates are significantly different from zero with $p<0.01$. Note that this table shows the response of Turkish export and import prices as measured in TRY. The conventional definition of pass-through would look at the response of prices measured in importers' currency, which, for exports (in the bottom half of the table), would correspond to 100 minus the shown value.

Results IV

Import pass-through estimates by sector

		Food and agricultural products	Chemicals and plastic	Leathers and textiles	Unprocessed materials	Processed goods
Exchange rate						
	t	0.6932***	0.8921***	0.9425***	0.8443***	0.9793***
		(0.0441)	(0.0449)	(0.0236)	(0.0640)	(0.0474)
	t-1	0.0721	0.0366	-0.0161	-0.0359	0.1005
		(0.0680)	(0.0560)	(0.0287)	(0.0466)	(0.0854)
	t-2	-0.0568	0.0144	-0.0294	-0.0089	-0.0354
		(0.0733)	(0.0514)	(0.0243)	(0.0384)	(0.0949)
	t-3	0.0324	0.0567	0.0196	0.0614	0.0130
		(0.0481)	(0.0680)	(0.0315)	(0.0659)	(0.1028)
	t-4	0.1117*	-0.1406*	-0.0433**	-0.0086	-0.1008
		(0.0589)	(0.0839)	(0.0220)	(0.0413)	(0.1032)
	t-5	-0.2056**	-0.0944	0.0430	-0.0361	0.1667**
		(0.0806)	(0.0724)	(0.0309)	(0.0744)	(0.0831)
	t-6	-0.0250	0.0871	-0.0765***	0.0548	-0.1605**
		(0.0604)	(0.0672)	(0.0254)	(0.0508)	(0.0701)
Short-run		0.6932***	0.8921***	0.9425***	0.8443***	0.9793***
		(0.0441)	(0.0449)	(0.0236)	(0.0640)	(0.0474)
Long-run		0.6220***	0.8519***	0.8398***	0.8710***	0.9628***
		(0.0706)	(0.0291)	(0.0536)	(0.0386)	(0.0434)
N		242,100	1,381,780	1,255,156	1,439,841	2,219,190

Results V

Export pass-through estimates by sector

		Food and agricultural products	Chemicals and plastic	Leathers and textiles	Unprocessed materials	Processed goods
Exchange rate						
	t	0.7119***	0.8257***	0.9450***	0.7738***	0.9178***
		(0.0508)	(0.0376)	(0.0158)	(0.0658)	(0.0822)
	t-1	0.0414	0.0942**	-0.0345***	-0.0756	0.0637
		(0.0435)	(0.0406)	(0.0126)	(0.0471)	(0.1474)
	t-2	-0.1449***	-0.0266	-0.0012	0.1102*	-0.1573
		(0.0465)	(0.0538)	(0.0188)	(0.0582)	(0.1993)
	t-3	-0.1192	-0.0035	-0.0211	0.0342	0.0379
		(0.0724)	(0.0556)	(0.0162)	(0.0510)	(0.1236)
	t-4	0.1669***	-0.0217	0.0314*	0.0666	0.0360
		(0.0475)	(0.0535)	(0.0164)	(0.0412)	(0.0531)
	t-5	-0.2584***	-0.0557	-0.0607***	0.0428	0.0543
		(0.0422)	(0.0467)	(0.0178)	(0.0781)	(0.0610)
	t-6	0.1362***	0.0156	-0.0515***	-0.0420	-0.1481**
		(0.0432)	(0.0342)	(0.0151)	(0.0464)	(0.0606)
Short-run		0.7119***	0.8257***	0.9450***	0.7738***	0.9178***
		(0.0508)	(0.0376)	(0.0158)	(0.0658)	(0.0822)
Long-run		0.5339***	0.8280***	0.8074***	0.9100***	0.8043***
		(0.0716)	(0.0292)	(0.0159)	(0.0434)	(0.0476)
N		896,766	1,674,631	3,055,835	2,641,773	3,032,064

Concluding remarks

- Using highly-detailed (6-digit product-level) bilateral monthly import and export data, we estimate that the exchange rate pass-through rates in Turkey from the TRY exchange rate to TRY-denominated import and export prices are 89 percent and 82 percent, respectively.
- Central to the Marshall-Lerner condition is the assumption that the difference in question is unity (i.e., 100 percentage points), which proves to be very inaccurate in the Turkish case, as our estimates are in the range of only 5 to 9 percentage points, with the baseline preferred value of 8 percentage points.
- We find that the pass-through rates are substantially lower in the *food and agricultural products* category, for both imports and exports, which are estimated at around 70 percent in the short run and around 60 percent or less in the long run. Pass-through rates are the highest in the *processed goods* and *leathers and textiles* categories for both imports and exports, staying above 90 percent in the short-run and above 80 percent in the long run.