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Nazire Nergiz Dinçer, Anirudh Shingal and Ayça Tekin-Koru

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TRADE AND EXCHANGE RATE EFFECTS: EVIDENCE FROM FIRM-LEVEL DATA[1]

Nazire Nergiz Dinçer[2], Anirudh Shingal[3] and Ayça Tekin-Koru[4]

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Send correspondence to:
Nazire Nergiz Dinçer
TED University
nergiz.dincer@tedu.edu.tr

[1] Note: Due to some unexpected problems that we experienced in the micro-data set-up at the outset, this version of the paper is just a documentation of the first set of results we have.

[2] Department of Economics, TED University, Ziya Gokalp Bul. No:48, Kolej, Ankara, Turkey. Phone: +90(312)585-0038.

[3] ICRIER, New Delhi; European University Institute, Florence and World Trade Institute, University of Bern. Email: ashingal@icrier.res.in.

[4] Department of Economics, TED University, Ziya Gokalp Bul. No:48, Kolej, Ankara, Turkey. Phone: +90(312)585-0034. E-mail: ayca.tekinkoru@tedu.edu.tr and Scientific Research Center, Australian College of Kuwait, West Mishref, Mubarak Al-Abdullah Al-Jaber Area, Block 5 - Al Aqsa Mosque Street, Building 4, Kuwait City.

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Abstract

We estimate an augmented gravity model using a firm-level database on Turkish firms to revisit the trade-exchange rate relationship over 2003-2015 at the intensive export margin. Besides several additional layers of analysis made possible by unique attributes of our firm-level database, we also examine exchange rate effects separately for firms engaged in manufacturing and services activities, which is a significant departure from existing literature. Our findings suggest considerable heterogeneity in the exchange rate effects on exports at the intensive margin. On the whole, for existing trade flows, more GVC-intensive production is found to attenuate the effect of an exchange change, especially for the services-intensive firms in the sample.

Keywords: International trade, exchange rates, global value chains, exchange rate pass-through.
JEL Classifications: F10, F14.

1 Introduction

There is a large existing literature examining the effects of different exchange rate dimensions on trade performance (see Auboin and Ruta, 2013 for an early review). This literature studies both exchange rate movements and volatility; considers the extensive and intensive margin of trade as well as the quality and composition of trade; and uses both disaggregated product and firm-level data.

In this paper, we use quarterly firm-level data on Turkish firms to revisit the trade-exchange rate relationship over 2003-2015. The recent sharp depreciation of the Turkish Lira (TL) raises obvious questions about the response of Turkish exports to exchange rate changes. From an economic perspective, even a temporary change in exchange rates may have a permanent effect on exports. However, a high level of integration into global value chains (GVCs) could potentially offset any positive effects of currency depreciation by simultaneously rendering the imports of intermediate inputs more expensive.

An indicator of a country's integration in GVCs is the extent to which its exports rely on the share of imported intermediate inputs in foreign value added (backward participation) and the extent to which its exports serve as inputs in value added in the exports of other countries (forward participation). In 2009, Turkey displayed a higher share of backward versus forward participation (22 versus 16%; OECD, 2013). This was especially true of manufacturing industries such as textiles, chemicals, basic metals, machinery, transport and electrical equipment. In fact, 21% of the final demand for manufactured goods and market services in Turkey in 2009 represented value added created abroad, with foreign value-added shares for transport equipment being over 90%.

The use of intermediate inputs by Turkish firms has implications for their economic resilience to short and long-term changes in macroeconomic fundamentals, in particular exchange rates. Thus, any favourable effect on Turkish exporters resulting from a depreciation of the TL is expected to be muted at both margins of trade by increasing the relative prices of imported intermediate inputs. This mechanism is referred to as "natural hedging" and depends on the extent to which exchange rate changes are transmitted to traded prices (exchange rate pass-through). The objective of this paper is to examine this pass-through in the context of Turkey using a firm-level database provided by the Turkish Statistical Institute, TurkStat, over 2003-2015.

The TurkStat database is unique as it matches monthly trade data sourced from customs declarations in Turkey at the GTIP 12-digit level (which is a variant of the Harmonized System) over 2003-2015 with TurkStat surveys covering all manufacturing and services-intensive firms with 20+ employees and sub-sample of firms employing less than 20 people. The trade data include information on value (export f.o.b./import c.i.f.), quantity of exports and imports in kilograms, the reference period, product code, partner country, nature of transaction and type of payment. The surveys provide information on a wide variety of firm characteristics such as

employment, wages, investment, value added, sales, foreign ownership and the number of domestic plants.

It turns out that the Turkish Lira has witnessed both real appreciation and depreciation against its major partner currencies (€, $, £) over the course of this period (see Figures 1-3). This enables us to examine the question of symmetry in the trade-exchange rate relationship using the same data set. Relative to existing literature, we are also better able to study the effect of exchange rate volatility on trade performance given the monthly coverage of the data set; the latter also enables us to distinguish between short- and medium-term exchange rate effects.

Finally, the richness of our data set enables us to compare the exchange rate effects of trade for manufacturing vs services-intensive firms; public vs private sector firms; by domestic vs foreign ownership and for small vs large firms. These additional layers of analysis add another dimension to the contribution of this research relative to existing literature.

Our findings suggest considerable heterogeneity in the exchange rate effects on exports at the intensive margin. On the whole, for existing trade flows, more GVC-intensive production is found to attenuate the effect of an exchange change, especially for the services-intensive firms in the sample.

The remainder of the paper is structured as follows. We provide a brief review of relevant literature in Section 2. Section 3 outlines the conceptual framework underlying our empirical analyses. Section 4 discusses the empirical strategy and estimation issues. Section 5 describes the firm-level database, while Section 6 discusses the estimation results.

2 Literature review

The purpose of this section is to describe the main studies and results related to our paper. We do not aim at giving a complete overview of the rich exchange rate literature. Auboin and Ruta (2013) provide a good survey of the relationship between exchange rates and international trade.

Greenaway et al. (2010) is one study closely related to this paper. The authors examine a panel of UK manufacturing firms and show that the negative effect of an exchange rate appreciation on the probability to export is lower in industries that import a greater share of inputs. Interestingly, a similar cushioning effect of imported inputs on the adverse effect of a currency appreciation is not found in export sales regressions (the intensive export margin). In contrast, Berman et al. (2012) show using French firm-level data that the export volume reacts less to exchange rate movements for firms that employ a larger fraction of imported inputs. Similarly, Amiti et al. (2014) find that French firms that source more foreign inputs display a lower exchange rate pass-through rate, which implies a lower sensitivity of export volume to currency fluctuations.

Our paper is also related to the literature examining export hysteresis, namely the persistence in exporting depending on export history. This matters from a policy perspective because, as shown theoretically by Baldwin and Krugman (1989), a large exchange rate shock can lead to exporters' exit decisions that are not reversed after the currency approaches its pre-crisis level. Their theoretical result relies on the existence of entry sunk costs into export markets. Empirically, the existence of sunk costs is well supported (see Roberts and Tybout, 1997; Bernard and Wagner, 2001; Bernard and Jensen, 2004; Das et al. 2007). For instance, the results by Bernard and Wagner (2001) and Bernard and Jensen (2004) for Germany and the US, respectively, imply a large increase in export probability of about 30 to 60 percentage points.

In addition, these studies reveal that the sunk cost of investment related to foreign market entry depreciates quickly over time: the effect of having exported in the previous two years is usually much smaller than having exported in the previous year. Roberts and Tybout (1997) also show that the impact of an exchange rate shock on predicted export probabilities is larger for firms that are already exporting. As a result, an average non-exporter requires a greater currency depreciation than an average exporter to generate positive export profits. These results are in line with the export hysteresis theory outlined in Baldwin and Krugman (1989). Campa (2004) confirms the importance of sunk exporting costs for the extensive export margin using Spanish firm-level data. However, he also finds that the aggregate response of export volume to exchange rate changes is mainly driven by quantity adjustments (the intensive export margin) and not by entry and exit decisions of firms.

More recently, Fauceglia et al. (2018) find evidence for both natural hedging and export hysteresis in the context of the appreciation of the Swiss Franc in complementary analyses using disaggregated product-level data from Swiss Customs and a panel data set of manufacturing firms from the KOF innovation survey.

3 Conceptual framework

A formal theoretical framework laying out the implications of exchange rate changes on export quantities, revenues and probability of exporting in the presence of backward participation in global value chains is detailed in Fauceglia et al. (2018) and emphasizes factors affecting exchange rate pass through (ERPT).

Essentially, a firm supplying a destination market charges an optimal export price that is the sum of the log marginal cost and a mark-up. The marginal cost in the destination's currency is depends on the produced quantity, factors (such as wages) that affect costs denominated in the home currency and the exchange rate. Importantly, a higher expenditure share of imported inputs priced in the destination's currency reduces the sensitivity of marginal costs to exchange rate fluctuations.

A change in the export quantity consequent upon a change in the exchange rate equals ERPT times the foreign demand elasticity. With constant mark-up pricing, CRS production

technology and no imported inputs, ERPT is complete. In contrast, when some inputs are sourced internationally and priced in the export price currency, it follows that ERPT is incomplete because marginal costs in this case are less affected by exchange rate movements ("natural hedging"). Therefore, a higher share of imported inputs reduces the need to adjust export prices ("natural hedging") and weakens quantity responses to exchange rate fluctuations.

Thus, the higher the share of imported inputs in total cost, the less export quantities react to exchange rate fluctuations. Specifically, a higher share dampens the positive (negative) quantity response to currency depreciations (appreciations), all else equal.

Given that firms with market power set prices in the elastic part of the demand curve and assuming that ERPT ranges realistically between zero and one, the reactions of export revenues to exchange rate movements are qualitatively the same as in the case of export quantities. Thus, revenues also increase after a depreciation because of a positive export valuation effect even in the absence of a quantity response resulting from local currency pricing.

Thus, a currency depreciation (appreciation) increases (reduces) export revenues. The response of export revenues to exchange rate fluctuations becomes smaller, the higher is the cost share of imported inputs.

4 Empirical methodology

We examine the trade effects of exchange rate changes at the intensive margin using the Poisson Pseudo-Maximum Likelihood (PPML; Silva and Tenreyro, 2006) to address heteroskedasticity-related concerns and problems of zero trade. This estimation takes the following form:

$$X_{fjt} = \exp\left(\beta_1 \ln(E_{jt-1}) + \beta_2 \alpha_{ft-1} + \beta_3 \ln(E_{jt-1}) \times \alpha_{ft-1} + \beta_4 Evol_{jt-1} + \beta_5 Evol_{jt-1} \times \alpha_{ft-1} + \gamma_1 ln(y_{jt-1}) + \mu_1 \chi_{ft-1} + \mu_2 \emptyset_{ft} + \lambda_{fj} + \lambda_t\right) + \varepsilon_{fjt} \quad (1)$$

where the dependent variable in equation (1) is the quantity of firm f exports to destination j at time t.

Amongst control variables, y_{jt} is the real GDP across Turkey's export destinations at time *t*; χ_{ft} and $\emptyset_{ft}$ are vectors of firm-specific controls – employment, capital intensity, foreign share; and labour productivity (share of value added in labour), TFP (calculated following Ackerberg et al. 2015), respectively. λ_{fj} and λ_t are firm-destination specific and time-specific fixed effects, respectively. We also experiment with alternative fixed effects in our specifications to account more fully for unobserved time-varying firm and destination factors that may have a bearing on firm-level export quantities.

Our main explanatory variables of interest are the log bilateral real exchange rate between Turkey and the destination country *j* at time *t-1* (E_{jt-1}) and the volatility of this exchange rate ($Evol_{jt-1}$). These variables are lagged[1] by one time period to mitigate endogeneity-related concerns in estimation. We expect a depreciation of the Turkish Lira to increase the quantity of exports of firm *f* i.e. $\beta_1 > 0$, while we expect exchange rate volatility to have an adverse effect at the intensive margin i.e. $\beta_4 < 0$. However, we also propose to examine the extent to which the relationship between exchange rates and export quantity is altered by the degree of backward participation, using the interaction term $\ln(E_{jt-1}) \times \alpha_{ft-1}$ and $Evol_{jt-1} \times \alpha_{ft-1}$. The α_{ft-1} term captures the use of imported intermediate inputs by firm *f* across destinations at time *t-1* and can be directly measured in the firm-level database as the latter also reports the BEC classification of the products exported and imported at the firm-level.

5 Data

We focus on the 2003-2015 period and use two different micro datasets: The Foreign Trade Statistics database (FTS) of Turkey and the Annual Industry and Service Statistics database (AISS).

5.1 Foreign Trade Statistics Database

The FTS covers the entire universe of goods traders in Turkey as the source of the data is customs declarations. The data are available for the period between 2002-2018 on a monthly basis and supplied to the final-user by TurkStat, which uses the administrative records of the Ministry of Trade to compile the data. The database covers cross border trade in goods between Turkey and other countries. International trade in services is not covered. Among a wealth of information in this database, we particularly use quantity and value (export f.o.b./import c.i.f.) of goods flows, the reference period, product code, partner country, nature of transaction and type of payment in this paper. For currency conversion, daily exchange rates of the Central Bank of Turkey are used by the TurkStat.

One of the differentiating features of our database is the level of detail available to us. The classification used for compiling Turkey's foreign trade statistics is Gümrük Tarife İstatistik Pozisyonu (GTİP) at 12-digit detail. The definition of traded goods in Turkey is made by the World Customs Organization (WCO) in 1988 according to the "Harmonized System". The first 2 digits of these codes are called chapters, the first 4 digits are called headings and the first 6 digits are sub-headings (HS code). With the addition of digits 7th and 8th, the CN codes used in the EU countries are formed. The last 4 digits are the national codes added by Turkey. Our export and import measures are therefore at 12-digit (from now we call it HS12) and contain a wealth of detail that is very rare in the literature.

Another strength of the database is its standardized quantity measure, Normally, different measurement units are used according to properties of goods. With a system established in

1 We also experiment with alternative lag structures in sensitivity analysis.

1996 in Turkey, the net weights of the goods subject to external trade (the weight of the goods excluding packaging material) are recorded in the statistics in kilograms. If the supplementary unit of measure is specified in the Turkish Customs Tariff Schedule in addition to the kilograms, the amount of the goods is also monitored according to the specified unit of measure. In this paper, we use the net weight in kilograms as our export quantity indicator.

5.2 Annual Industry and Services Statistics Database (AISS)

The AISS is based on surveys covering firms intensive in manufacturing as well as services sectors. These surveys were carried out on a yearly basis by the Turkish Statistical Institute (TurkStat) between 2003-2015. In the recent years, TurkStat started compiling this data from administrative records that are generally completed by obtaining data from relevant sources such as the Revenue Administration and the Social Security Institution. This new data goes back only until 2009. Therefore, we are forced to use the survey-based data to cover the early-2000s.

The database contains information on a wide array of firm characteristics such as production, employment, wages, investment, taxes, profits, foreign ownership, information on different local units as well as a plethora of different sub-categories of revenue and cost items. Firms are classified within 4-digit NACE Rev2 sectors.

The data for firms with 20+ employees are collected using the full enumeration method while the data for firms with 19 or less employees come from a random sample of firms. In this paper, we use firms with 20+ employees to avoid sampling issues particularly in the micro-scale firms (1-9 employees). At this point, let us note that although firms with 20+ employees compose only 3 percent of the firm population in Turkey; their sales, output and value added shares are 77 percent, 82 percent and 85 percent, respectively.

When we investigate the distribution of manufacturing and services-intensive firms on an annual basis, we observe that the number of firms with 20+ employees in these sectors went up from 15,528 to 74,853 from 2003 to 2015. In these 13 years, the share of manufacturing firms declined from 61 percent to 34 percent, which is a sign of ongoing de-industrialization process in Turkey in the last decade.

Furthermore, the data exhibit a very high degree of entry-exit of firms. More than one-fifth of the firms appear only once in the sample. The share of firms that survive throughout the entire sample period is only 4 percent while it decreases to less than 2 percent for the services-intensive firms. More generally, less than 50 percent of the firms have 4+ years of life-span within the sample period.

5.3 Sample of Analysis

Starting from the universe of Turkish firms with 20+ employees, we merge firm level data from the AISS database with the firm-product level trade data from the FTS database. Our sample period is dictated by the available years in the AISS, namely 2003-2015. We convert our data

into quarterly observation as discussed below to construct the 2003q1-2015q4 time span. The unit of observation of each cross-section in the merged data is firm-product. Both the AISS and the FTS databases have a common firm identifier, which makes our merge process consistent and effective with a 70 percent merge rate. The remaining 30 percent is due to exporters with 1-19 employees that are not in the AIIS and purely domestic firms with no exports in the AISS database.

We begin with the FTS database and exclude countries with a share lower than 0.5 percent in exports as well as Northern Cyprus due to sharing the same currency. This leaves us with 41 export partners of Turkey, accounting 84.3 percent and 85.3 percent of exports of Turkey in 2003 and 2015, respectively. Furthermore, on the imports side, we work with intermediate and capital goods imports only to measure the extent of natural hedging. This requires dropping all consumer goods imports that we identify using the Broad Economic Categories (BEC) classification of the United Nations. In other words, imports that have the BEC classification values of 61-63, 112, 122 and 522 are excluded from our data.

Secondly, we aggregate product level data at the firm level to compose firm-country pairs in each cross section between 2003m1-2015m12.

Thirdly, to be able to build our real exchange rate measure on a quarterly basis, we reconstruct our frequency by aggregating trade over corresponding three months to arrive at the 2003q1-2015q5 time period.

Finally, before the final merge we convert the yearly AISS database into quarterly by dividing the yearly figures into four and distributing equally over quarters. After the final merge we clean our data of outliers in the bottom and top 1st percentiles of export value, quantity and real GDP variables to prevent our results to be driven by extreme observations.

Dependent variable

Quantity of exports: Dependent variable in equation 3 is quantity of exports, x_{fjt}. Here, f represents all exporting firms of Turkey. Exporting partners of Turkey is represented by j, Finally, t represents time span from 2003q1 to 2015q4.

Independent variables

Real exchange rate:

$$rer_{jt} = er_{jt} \frac{cpi_{jt}}{cpi_{TUR,t}} \tag{2}$$

where er_{jt} is nominal exchange rate of each export partner at time t (denoted as export partner's currency/TL). Moreover, $cpi_{TUR,t}$ and cpi_{jt} are consumer price indices of Turkey and the

export partner at time t, respectively. Note that, an increase in the real exchange rate denotes a depreciation of TL. We use averages to obtain the quarter frequency.

Real exchange rate volatility: We calculate exchange rate volatility for short-term and long-term, separately. The former is the standard deviation of the real exchange rate for the months of the current quarter and the last quarter (for 6 months), while the latter is the standard deviation of the real exchange rate for the months of the current quarter and the last 3 quarters (for 12 months).

Real GDP: Real GDP is in constant local currency and annual. Quarterly real GDP data from IMF-IFS has missing observations that are more than half of our sample and thus cannot be used. As a second-best solution, the quarter frequency is obtained by dividing the yearly figures into four and distributing equally over quarters.

Alpha: To account for the natural hedging arising from the imported inputs, we calculate the imported input intensity at the firm-level:

$$\alpha_{ft} = \begin{cases} \dfrac{m_{ft}}{sales_{ft}} \\ \\ 0 \qquad otherwise \end{cases} \tag{2}$$

where m_{ft} represents the value of imported intermediate inputs in Turkish Liras by firm f across exporting partners (41 countries) at time t.

Productivity: We use both labor productivity and total factor productivity (TFP) as two alternative measures of productivity, $\emptyset_f$. Labor productivity is the ratio of value added to employment. Results presented in the upcoming sections are based on TFP for brevity.

Our productivity measure is revenue TFP (TFPR) rather than physical TFP (TFPQ) due to data limitations. There is no input quantity data at the product level. Estimating TFPQ for a sample of single-product firms is another alternative but that option limits the observations numbers at a great extent. As a result, we provide a TFPR measure based on value-added figures using the augmented Olley-Pakes method offered by Ackerberg, Caves and Frazer (2015). Data for capital stock is not readily available at the firm-level in Turkey. Therefore, we construct capital stock values via the Perpetual Inventory Method and use 2-digit PPI (2003-based) values to deflate the nominal variables in line with national accounts statistics provided by TurkStat.

Other Firm Level Variables: Firm level controls, χ_f, are Employment, Capital-Intensity in real terms and share of foreign capital of the firm.

Table 1 presents a compact picture of variable definitions.

6 Results

The baseline PPML estimates for the full sample of firms suggest that depreciation in the previous year (rise in rer_{jt-1}) may be associated with an increase in the quantity of exports in the following year (see columns 1 and 2 of Table 2) but this increase may be muted by Turkey's backward integration into value chains (the interaction term, $rer_{jt-1}{}^{*}\alpha_{ft-1}$, is negative in column 1). Column 1 suggests that a 10% depreciation of the TL may be associated with a 12.25% increase in the quantity of Turkish exports, but since this depreciation renders imported intermediates more expensive, the interaction term reduces the magnitude of the increase to 3.75%.

Columns 1 and 2 of Table 2 also allude to an adverse effect of exchange rate volatility in the previous period on the quantity of exports in the following year – the coefficient estimate ranges from -1.35 in column (2) to -2.29 in column (1). More limited evidence also suggests that Turkey's backward integration into GVCs seems to offset this adverse effect of exchange rate volatility as the coefficient of the interaction term ($MRvol_{jt-1}{}^{*}\alpha_{ft-1}$) is positive, but only in column (1) and even this is found to be weakly significant.

The coefficient estimates in column 2 of Table 2 also suggest that medium, large and more productive firms tend to export more, while foreign-owned and more capital-intensive firms tend to export less. The effect of foreign demand on the quantity of Turkish exports also comes through strongly in these results in columns 1 and 2.

Replicating this analysis for the sub-sample of manufacturing (column 3) and services-intensive (column 4) firms, respectively, suggests that the overall results may be driven by the manufacturing firms in the full sample. In particular, the coefficient of the "natural hedging" term is statistically indifferent from zero in the sub-sample of services-intensive firms though exchange rate volatility has an adverse effect on both manufacturing and services-intensive firms in columns 3 and 4 of Table 2.

As Figures 1-3 show, the period before 2011 was associated with an appreciation of the TL followed by depreciation. However, both periods of appreciation (pre-2011) and depreciation (post-2010) of the TL seem to be associated with a rise in the quantity of exports, especially for manufacturing firms and an adverse effect of exchange rate volatility, especially for services-intensive firms (see Table 3). Thus, demand for Turkey's manufacturing exports seemed resilient to TL-appreciation-induced costs, which is suggestive of inelastic demand for these products in Turkey's major destination markets or of incomplete exchange rate pass-through into export prices. Note that the effect of value chain integration also does not come through consistently when the time period is bifurcated into appreciation and depreciation episodes for empirical analysis.

Table 4 reports PPML estimates by firm ownership (domestic vs foreign). Depreciation of the TL is found to be associated with an increase in the quantity of manufacturing firm exports irrespective of firm ownership, though the effect is found to be weakly significant for services-

intensive firms. The effect of GVC-integration is not observed via the $rer_{jt-1}{}^{*}\alpha_{ft-1}$ interaction effect for either manufacturing or services-intensive firms. Meanwhile, exchange rate volatility is found to be adversely associated with export quantities of all foreign-owned firms (and weakly for domestic services-intensive firms) with the effect of imported inputs offsetting this adverse effect for all foreign-owned firms (the coefficient of the interaction term ($MRvol_{jt-1}{}^{*}\alpha_{ft-1}$) is strongly positive and large in magnitude in columns 4 to 6).

Table 5 reports PPML estimates by technology class of the underlying sectors. These estimates suggest that all expected effects of currency depreciation are only observed in the case of medium-high-tech sector producing firms. A positive effect of the TL depreciation on exports is also observed for medium-low-tech firms. Meanwhile, exchange rate volatility seems to be positively associated with export quantities of high-tech firms, which is a counter-intuitive result, also in terms of the observed effect of GVC-integration.

Table 6 reports PPML estimates by firm size depending on whether the number of employees is between 20 and 50 ("small"), between 50 and 250 ("medium") or in excess of 250 ("large"). These results suggest that the depreciation of the TL is associated with an increase in the quantity of manufacturing firm exports irrespective of firm size; in contrast, the expected effect is observed only for small services-intensive firms. The natural hedging effect of GVC-integration more than offsets the positive effect of depreciation on export quantity but only for small manufacturing firms. Interestingly, this effect is counter-intuitive for both small and medium-sized services-intensive firms i.e. despite imported inputs becoming more expensive, small and medium-sized services-intensive firms seem to be importing more of these (the interaction term, $rer_{jt-1}{}^{*}\alpha_{ft-1}$, is positive in columns 7 and 8), possibly alluding to the importance of these inputs in services production in Turkey. Meanwhile, exchange rate volatility is found to be adversely associated with export quantity of small manufacturing firms only, though GVC-integration is found to outweigh this adverse effect for this set of firms.

The effects of the TL depreciation by sector exhibit considerable heterogeneity in the results reported in Table 7. A positive export effect of currency depreciation is observed for the chemicals, transport equipment, furniture and (weakly) for basic fabricated metals sectors. The computer electronics and electrical equipment sector, in contrast, witnesses a counter-intuitive effect: a depreciation of the TL is associated with a decline in export quantity in that sector, which either suggests inelastic demand in destination markets or incomplete exchange rate pass-through into export prices. The expected natural hedging effect is also only observed in the transport equipment, furniture and computer electronics and electrical equipment sectors. In contrast, the leather, basic fabricated metals and machinery sectors seem to import more intermediate inputs despite currency depreciation, which could possibly allude to the importance of these inputs in Turkey's production of these products. Meanwhile, exchange rate volatility only seems to affect the computer electronics and electrical equipment sector, though GVC-integration is unable to offset this adverse effect.

Finally, PPML estimates by broad geographical regions based on the location of the firms are reported in Table 8. These results suggest that TL depreciation is associated with an increase in export quantities for firms located in Marmara, Aegean and Central Anatolia but with a decline for firms located in the Mediterranean region. Meanwhile, firms located in Eastern and Southeastern Anatolia and the Black Sea do not report any statistically significant effects of currency depreciation at the intensive margin. The expected "natural hedging" effect is also only observed for firms located in the Marmara region. Exchange rate volatility is found to be adversely associated with the intensive margin only for firms located in Marmara, Aegean and Central Anatolia, while the offsetting effect of GVC-integration is only observed for firms located in Marmara and Central Anatolia.

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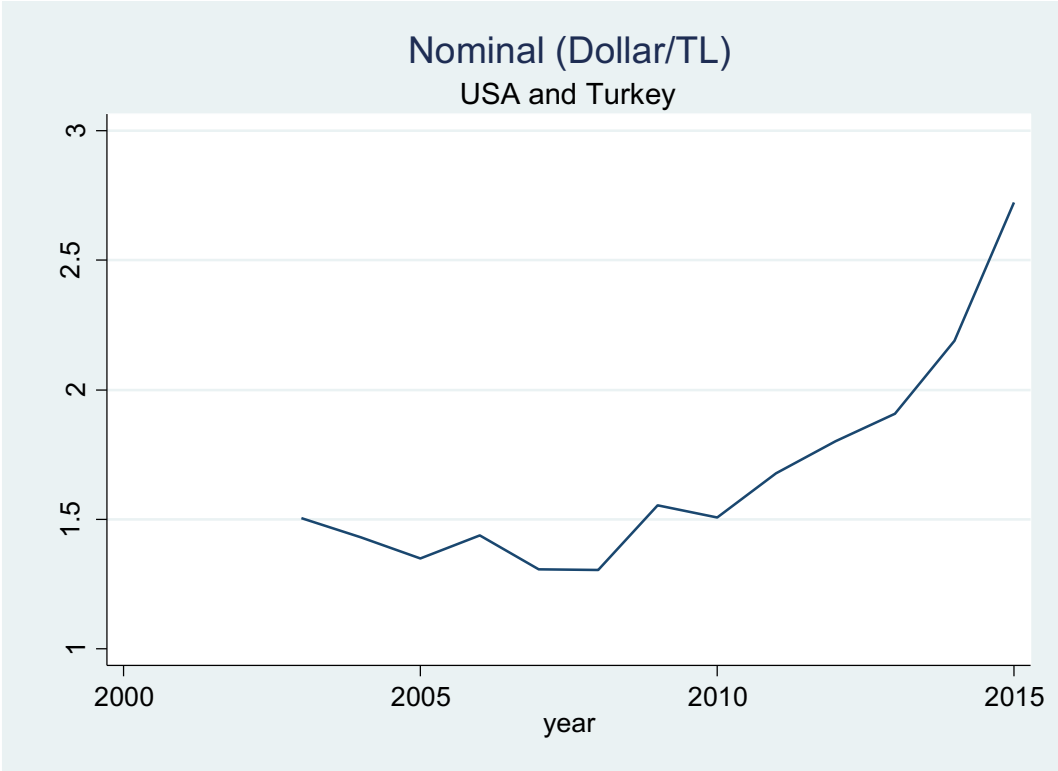
Figure 1: USD-TL exchange rate, nominal and real



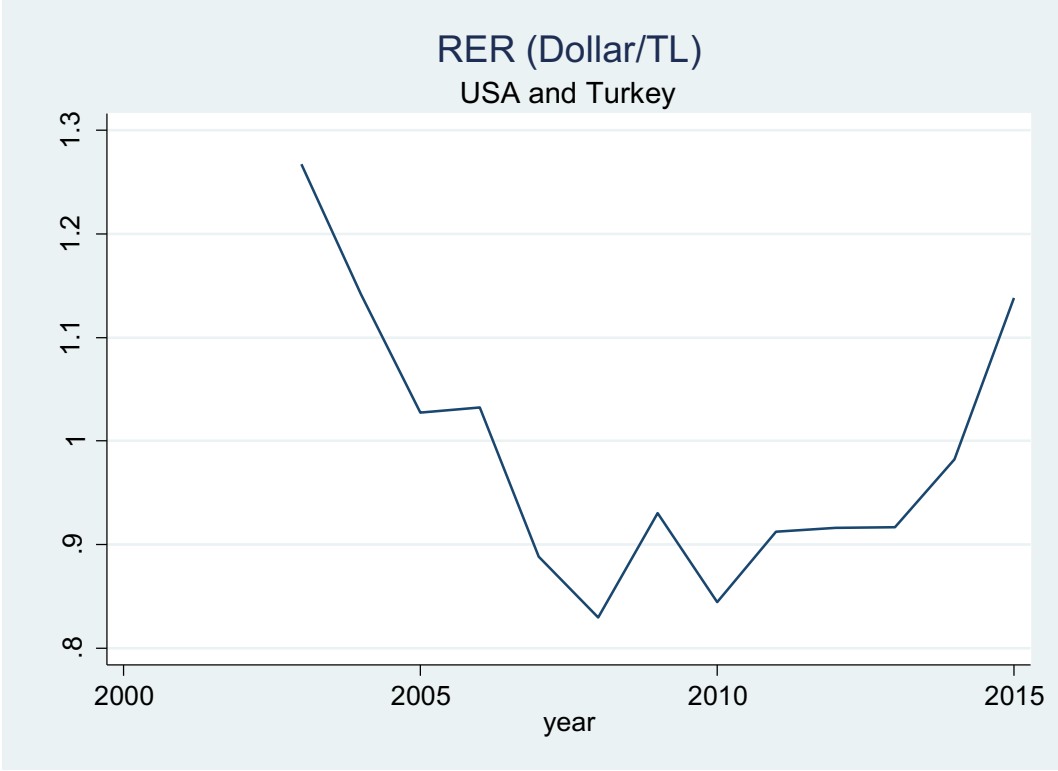
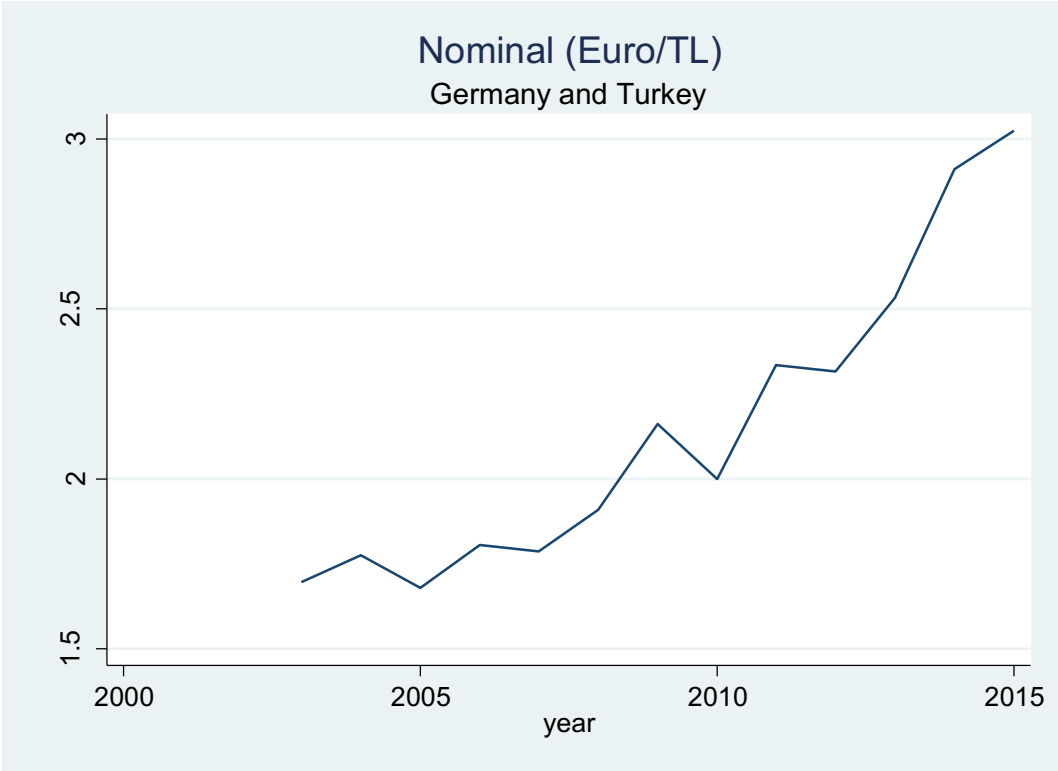


Figure 2: Euro-TL exchange rate, nominal and real



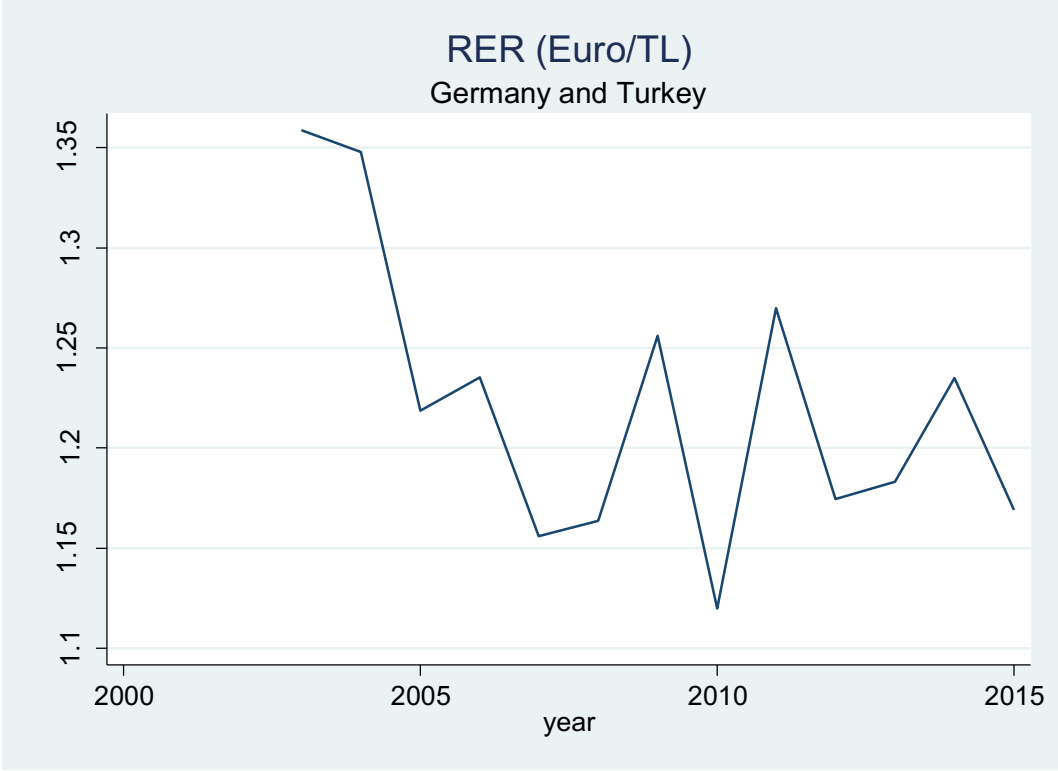
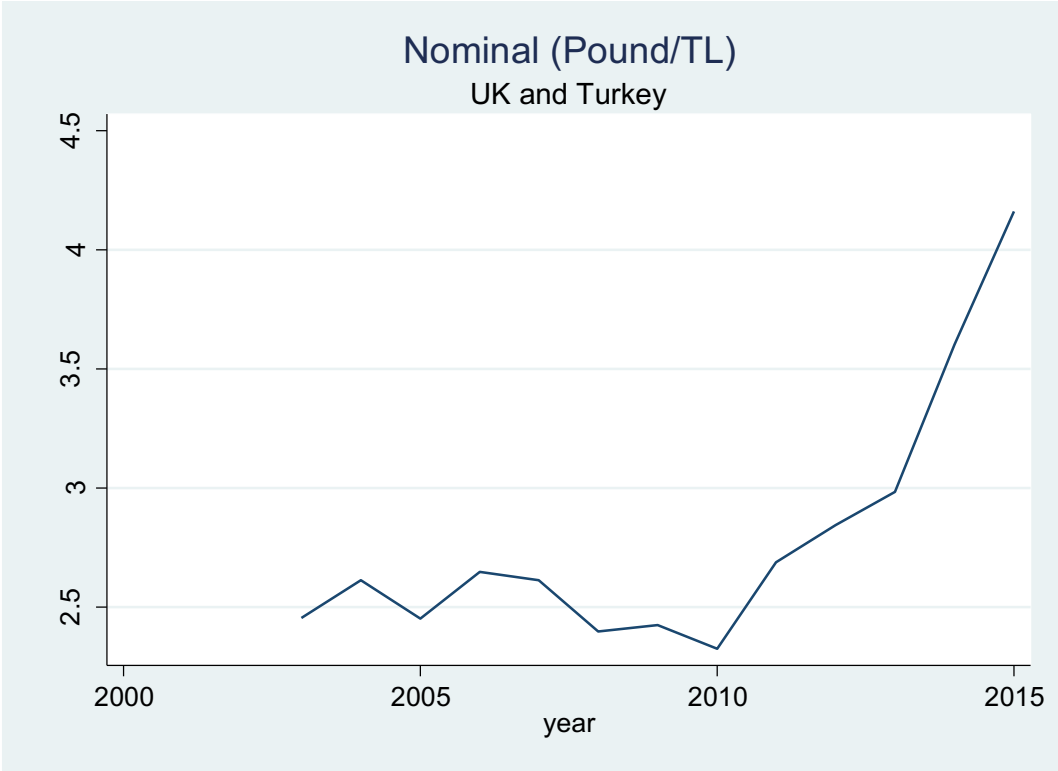


Figure 3: GBP-TL exchange rate, nominal and real



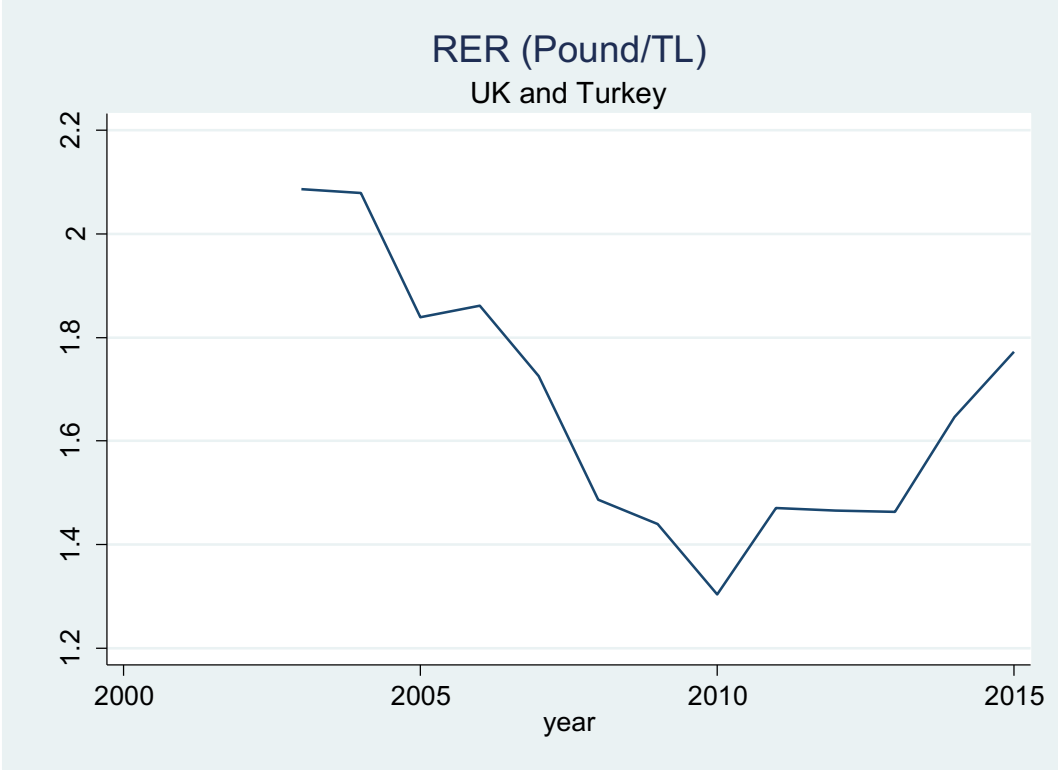


Table 1: Variable definitions and sources of data

Variable	Definition	Data Source
x_{fjt}	Export quantity, kg	FTS
m_{fjt}	Value of imported intermediate inputs in Turkish Liras	FTS
rer_{jt}	Real exchange rate	IMF-IFS
er_{jt}	nominal exchange rate (denoted as currency of c/TL)	IMF-IFS
cpi_{jt}	Consumer price index of country c	IMF-IFS
$SRvol_{jt}$	Standard deviation of exchange rate volatility in months of quarter t and t-1.	Authors' calculations
$MRvol_{jt}$	Standard deviation of exchange rate volatility in months of quarter t, t-1, t-2 and t-3.	Authors' calculations
y_{jt}	Log of real GDP of Turkey's export destinations	IMF-IFS
α_{ft}	As defined in equation (3)	Authors' calculations
$\emptyset_{ft}$	TFP calculated using ACF (2015)	Authors' calculations
$\boldsymbol{\chi_{ft}}$	Employment Capital-Labor Ratio (K/L) Foreign Share	AISS

Notes: f, j, and t denote firm, partner country and time.

Table 2: Baseline PPML estimates

Variables	All (1)	All (2)	Manuf. (3)	Serv. (4)
rer_{jt-1}	1.225***	1.381***	1.251***	1.091**
	(0.256)	(0.256)	(0.297)	(0.494)
α_{ft-1}		-0.245		
		(0.263)		
$rer_{jt-1} \times \alpha_{ft-1}$	-0.850*	0.164	-0.874*	0.320
	(0.463)	(0.424)	(0.513)	(1.203)
$MRvol_{jt-1}$	-2.286***	-1.348*	-1.652*	-3.620***
	(0.749)	(0.727)	(0.965)	(1.104)
$MRvol_{jt-1} \times \alpha_{ft-1}$	3.931*	-1.003	2.343	7.985
	(2.357)	(2.614)	(2.823)	(11.696)
TFP_{ft-1}		0.098***		
		(0.018)		
K/L_{ft-1}		-0.124***		
		(0.026)		
$Foreign$		-0.092*		
		(0.051)		
Medium		0.117***		
		(0.033)		
Large		0.154**		
		(0.065)		
y_{jt-1}	0.562***	0.552***	0.562***	0.557***
	(0.033)	(0.030)	(0.039)	(0.056)
Constant	1.146	2.057***	1.038	1.549
	(0.834)	(0.782)	(0.983)	(1.411)
Observations	695256	697524	577,957	116148
Firm FE	NO	YES	NO	NO
Firm-Time FE	YES	NO	YES	YES
Firm-Country	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Pseudo R^2	0.953	0.929	0.953	0.950

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, **5%, ***1%.

Table 3: PPML estimates (before and after 2011)

Variables	All Sample		Manufacturing		Services	
	App.	Dep.	App.	Dep.	App.	Dep.
	(1)	(2)	(3)	(4)	(5)	(6)
rer_{jt-1}	1.025***	2.013***	1.151***	2.178***	0.459	0.933
	(0.302)	(0.613)	(0.353)	(0.754)	(0.606)	(0.684)
$rer_{jt-1} \times \alpha_{ft-1}$	-1.083*	-0.690	-1.030	-0.354	-2.183	-1.240
	(0.631)	(0.544)	(0.694)	(0.593)	(1.827)	(1.225)
$MRvol_{jt-1}$	-2.717***	-1.440	-2.130*	-0.226	-4.335***	-3.334**
	(0.971)	(0.890)	(1.199)	(1.097)	(1.599)	(1.410)
$MRvol_{jt-1} \times \alpha_{ft-1}$	5.372**	-2.974	3.693	-8.230*	22.169	11.931
	(2.270)	(4.255)	(2.713)	(4.766)	(15.931)	(8.812)
y_{jt-1}	0.412***	0.210***	0.377***	0.235***	0.522***	0.084
	(0.044)	(0.045)	(0.054)	(0.052)	(0.068)	(0.074)
Constant	5.227***	9.472***	5.882***	8.699***	3.087*	13.226***
	(1.127)	(1.172)	(1.368)	(1.361)	(1.712)	(1.862)
Observations	329957	355664	279359	290696	50131	64334
Firm FE	NO	NO	NO	NO	NO	NO
Firm-Time FE	YES	YES	YES	YES	YES	YES
Firm-Country	YES	YES	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Pseudo R^2	0.959	0.967	0.960	0.967	0.952	0.968

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, *5%, ***1%.

Table 4: PPML estimates by firm ownership

Variables	Domestic firms			Foreign firms		
	All	Manuf.	Serv.	All	Manuf.	Serv.
	(1)	(2)	(3)	(4)	(5)	(6)
rer_{jt-1}	1.420***	1.514***	1.099*	1.125***	0.908***	2.171*
	(0.409)	(0.509)	(0.588)	(0.344)	(0.332)	(1.300)
$rer_{jt-1} \times \alpha_{ft-1}$	0.179	0.451	-4.577	-0.533	-0.322	-0.835
	(0.773)	(0.826)	(2.912)	(0.442)	(0.462)	(1.531)
$MRvol_{jt-1}$	-1.506	-1.265	-2.247*	-4.124***	-2.023*	-11.031***
	(0.917)	(1.292)	(1.169)	(1.139)	(1.136)	(2.835)
$MRvol_{jt-1} \times \alpha_{ft-1}$	-14.262**	-17.996**	50.717	10.274***	5.780**	31.486*
	(6.801)	(7.210)	(31.051)	(2.691)	(2.695)	(16.136)
y_{jt-1}	0.472***	0.463***	0.504***	0.360***	0.381***	0.265**
	(0.041)	(0.049)	(0.065)	(0.046)	(0.050)	(0.107)
Constant	3.443***	3.590***	2.839*	6.057***	5.359***	8.730***
	(1.015)	(1.198)	(1.630)	(1.171)	(1.280)	(2.796)
Observations	513231	424032	88256	173836	146976	26670
Firm FE	NO	NO	NO	NO	NO	NO
Firm-Time FE	YES	YES	YES	YES	YES	YES
Firm-Country	YES	YES	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Pseudo R2	0.958	0.959	0.956	0.953	0.954	0.950

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, **5%, ***1%.

Table 5: PPML estimates by technology class of sectors

Variables	Low Tech (1)	Med-Low Tech (2)	Med-High Tech (3)	High Tech (4)
rer_{jt-1}	0.333	1.965***	0.691***	-0.534
	(0.237)	(0.594)	(0.248)	(0.888)
$rer_{jt-1} \times \alpha_{ft-1}$	0.300	0.872	-1.197***	5.166***
	(0.379)	(1.346)	(0.355)	(1.326)
$MRvol_{jt-1}$	-0.284	-1.085	-1.606**	7.948***
	(0.466)	(1.465)	(0.660)	(2.250)
$MRvol_{jt-1} \times \alpha_{ft-1}$	-6.076*	-13.266	4.315***	-62.316***
	(3.565)	(11.298)	(1.651)	(14.789)
y_{jt-1}	0.488***	0.565***	0.510***	0.743***
	(0.025)	(0.049)	(0.045)	(0.063)
Constant	1.187*	1.523	1.083	-6.714***
	(0.610)	(1.246)	(1.168)	(1.625)
Observations	230945	172899	163423	10068
Firm FE	NO	NO	NO	NO
Firm-Time FE	YES	YES	YES	YES
Firm-Country	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Pseudo R2	0.939	0.952	0.938	0.933

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, **5%, ***1%.

Table 6: PPML estimates by firm size

Variables	All Sample			Manufacturing			Services		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
rer_{jt-1}	1.319***	1.841***	1.213**	0.712***	1.393***	1.292***	2.772***	0.383	-1.659
	(0.344)	(0.300)	(0.474)	(0.245)	(0.295)	(0.489)	(0.909)	(0.874)	(2.003)
$rer_{jt-1} \times \alpha_{ft-1}$	-0.272	0.464	-1.274	-1.300***	0.554	-1.255	2.583**	2.476*	-5.975
	(0.520)	(0.512)	(0.879)	(0.372)	(0.504)	(0.890)	(1.133)	(1.316)	(6.537)
$MRvol_{jt-1}$	-1.339*	-1.197	-1.635	-1.809***	-1.423	-1.414	-0.856	1.352	-7.970
	(0.688)	(0.891)	(2.064)	(0.492)	(0.913)	(2.130)	(1.778)	(2.017)	(5.174)
$MRvol_{jt-1} \times \alpha_{ft-1}$	4.921	-5.174	2.961	9.109**	-6.450	2.452	2.670	-13.920	24.913
	(5.123)	(5.184)	(5.054)	(3.681)	(5.322)	(5.208)	(9.143)	(10.568)	(50.614)
y_{jt-1}	0.379***		0.559***	0.355***	0.580***	0.560***	0.394***	0.580***	0.370
	(0.047)		(0.068)	(0.027)	(0.037)	(0.068)	(0.122)	(0.074)	(0.378)
Constant	4.255***	14.346***	2.190	4.404***	0.106	2.109	4.622	0.527	8.427
	(1.159)	(0.130)	(1.717)	(0.650)	(0.927)	(1.734)	(3.067)	(1.932)	(9.118)
Observations	183568	213058	57439	164611	197906	53502	18770	15026	3914
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO	NO
Firm-Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-Country	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R2	0.954	0.946	0.938	0.950	0.949	0.939	0.949	0.951	0.926

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, **5%, ***1%.

Table 7: PPML estimates by broad sectors

Variables	Food Beverage Tobacco (1)	Textiles & Apparel (2)	Leather (3)	Chemicals Rubber & Plastic (4)	Basic Fabricated Metals (5)	Machinery (6)	Transport Equipment (7)	Furniture (8)	Computer & Electronics (9)
rer_{jt-1}	-0.035	-0.262	-0.020	0.948***	1.044*	0.256	1.051***	2.641***	-0.754***
	(0.354)	(0.265)	(1.373)	(0.293)	(0.543)	(0.360)	(0.350)	(0.400)	(0.210)
$rer_{jt-1} \times \alpha_{ft-1}$	-0.066	-0.082	8.484**	-0.997	2.775**	2.457***	-1.517***	-4.777***	1.429**
	(0.816)	(0.447)	(4.071)	(0.660)	(1.161)	(0.516)	(0.415)	(1.575)	(0.564)
$MRvol_{jt-1}$	1.034*	0.258	-1.152	0.120	-0.043	0.793	0.280	0.560	-3.191***
	(0.603)	(0.665)	(3.848)	(1.067)	(1.420)	(1.006)	(0.592)	(0.768)	(0.963)
$MRvol_{jt-1} \times \alpha_{ft-1}$	-18.815***	-2.508	-81.231*	-6.136	-30.271**	-8.086*	1.053	49.108***	0.111
	(7.164)	(3.811)	(42.969)	(5.827)	(11.835)	(4.501)	(1.524)	(15.807)	(5.431)
y_{jt-1}	0.281***	0.705***	0.334***	0.419***	0.550***	0.547***	1.125***	0.608***	0.559***
	(0.035)	(0.026)	(0.098)	(0.055)	(0.057)	(0.038)	(0.071)	(0.031)	(0.035)
Constant	6.956***	-5.850***	2.745	3.141**	1.473	-2.014**	-15.249***	-5.128***	0.026
	(0.859)	(0.668)	(2.593)	(1.368)	(1.431)	(0.952)	(1.866)	(0.765)	(0.896)
Observations	43204	125455	4742	94349	77930	44858	46491	14198	44836
Firm FE	NO	NO	NO	NO	NO	NO	NO	NO	NO
Firm-Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-Country	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R2	0.924	0.921	0.923	0.933	0.943	0.908	0.938	0.915	0.943

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, **5%, ***1%.

Table 8: PPML estimates by geographical regions

Variables	Marmara (1)	Aegean (2)	Central Anatolia (3)	Mediterranean (4)	Eastern and SE Anatolia (5)	Black Sea (6)
rer_{jt-1}	1.279***	2.627***	1.426**	-1.485**	0.685	-0.556
	(0.331)	(0.482)	(0.600)	(0.595)	(0.737)	(1.172)
$rer_{jt-1} \times \alpha_{ft-1}$	-1.216*	-0.344	-1.213	-0.253	-0.445	6.486
	(0.676)	(0.923)	(0.907)	(1.469)	(1.140)	(6.017)
$MRvol_{jt-1}$	-2.975***	-2.989**	-6.076***	0.816	-2.118	-4.083
	(1.134)	(1.325)	(1.457)	(1.827)	(1.855)	(2.493)
$MRvol_{jt-1} \times \alpha_{ft-1}$	4.842*	10.498	26.344***	-12.536	3.799	-61.243
	(2.926)	(8.801)	(6.463)	(14.096)	(9.765)	(51.603)
y_{jt-1}	0.588***	0.515***	0.385***	0.162**	0.717***	0.256***
	(0.049)	(0.056)	(0.055)	(0.067)	(0.079)	(0.091)
Constant	0.642	1.291	5.012***	11.946***	-2.049	9.344***
	(1.248)	(1.433)	(1.265)	(1.630)	(1.930)	(2.333)
Observations	417716	78970	46645	27752	15047	9934
Firm FE	NO	NO	NO	NO	NO	NO
Firm-Time FE	YES	YES	YES	YES	YES	YES
Firm-Country	YES	YES	YES	YES	YES	YES
Country-Time FE	NO	NO	NO	NO	NO	NO
Sector FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Pseudo R2	0.957	0.953	0.940	0.944	0.959	0.953

Note: Standard errors are clustered by firm*destination*time. Levels of significance: *10%, **5%, ***1%.