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Real Effective Exchange Rate and Trade Balance
Adjustment: The Case of Turkey

by Plamen Iossifov and Xuan Fei

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I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

European Department

Real Effective Exchange Rate and Trade Balance Adjustment: The Case of Turkey¹**Prepared by Plamen Iossifov*, Xuan Fei******International Monetary Fund; ** State Administration of Foreign Exchange*

Authorized for distribution by Donal McGettigan

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Abstract

There is an ongoing debate in the literature on whether global trade flows have become disconnected from the large real effective exchange rate movements in the wake of the global financial crisis. The question has important policy implications for the role of exchange rates in supporting growth and restoring external balance. In this paper, we use Turkey---a large and open emerging market economy that has experienced sizable swings of the real effective exchange rate---as a case study to test competing hypotheses. Our results lend support to the finding in existing cross-country studies that the real effective exchange rate remains an important determinant of trade flows. But, its effect is not symmetric in secular periods of appreciation and depreciation and is, oftentimes, dwarfed by the impact on trade flows of the income growth differential between trade partners.

JEL Classification Numbers: F140

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| | Contents | Page |
|------------|-------------------------------------------------------------------------------------------------------|------|
| I. | Introduction | 5 |
| II. | Analytical Framework | 7 |
| III. | First Look at the Data | 11 |
| IV. | Regression Estimation | 13 |
| | A. Regression Specification | 13 |
| | 1. ARDL Model | 13 |
| | 2. NARDL Model | 15 |
| | B. Regression Results | 16 |
| | 1. Long-Run Export Elasticities | 16 |
| | (a) Long-Run REER Elasticity of Exports | 16 |
| | (b) Long-Run Income Elasticity and Speed of Adjustment of Exports | 22 |
| | (c) Specification Tests | 22 |
| | 2. Long-Run Import Elasticities | 22 |
| | (a) Long-Run Income Elasticity of Imports | 22 |
| | (b) Long-Run Income Elasticity and Speed of Adjustment of Imports | 26 |
| | (c) Specification Tests | 27 |
| V. | Role of REER in Trade Balance Adjustment | 27 |
| VI. | Summary of Findings | 29 |
| | | |
| Appendices | | |
| A. | Modeling Trade Flows Net of Energy and Gold | 34 |
| B. | Data Sources | 35 |
| | B.1. Construction of Trade-Weighted Indexes of Relative Prices and Foreign Income | 35 |
| | B.2. Real Exports and Imports Series | 37 |
| | | |
| Tables | | |
| 1. | Long-Run Trade Elasticities of Real Exports (Lira) in ARDL Model | 16 |
| 2. | Long-Run Trade Elasticities of Real Exports (Lira) with REER Interaction Term in ARDL Model | 19 |
| 3. | Long-Run Trade Elasticities of Real Exports (Lira) in NARDL Model | 20 |
| 4. | Long-Run Trade Elasticities of Real Imports (USD) in ARDL Model | 23 |
| 5. | Long-Run Trade Elasticities of Real Imports (USD) with REER Interaction Term in ARDL Model | 24 |
| 6. | Long-Run Trade Elasticities of Real Imports (USD) in NARDL Model | 27 |
| A1. | Long-Run Trade Elasticities of Real Exports Net of Energy and Gold (Lira) in ARDL Model | 34 |

| | |
|------------------------------------------------------------------------------------------------------|----|
| A2. Long-Run Trade Elasticities of Real Imports Net of Energy and Gold (USD) in ARDL Model | 35 |
|------------------------------------------------------------------------------------------------------|----|

Figures

| | |
|----------------------------------------------------------------------------------------------------------------------------------|----|
| 1. Turkey: REER and Nominal Current Account, 1998-2017 | 6 |
| 2. Turkey: Nominal Current Account and Real Trade Balance, 1998-2017 | 6 |
| 3. Turkey: Comparison of REER Estimates, 1998-2017 | 11 |
| 4. Turkey: REER and Real Trade Flows, 1998-2017 | 12 |
| 5. Recursive Wald Stability Test for Long-Run REER Elasticity of Real Exports in ARDL Model | 17 |
| 6. Rolling Estimation of Long-Run Export Trade Elasticities and Error Correction Coefficient in ARDL Model | 18 |
| 7. Turkey: Annual Growth Rate of Long-Run Trend of REER, 1998-2017 | 19 |
| 8. Recursive Wald Stability Test for Long-Run REER Elasticity of Real Imports in ARDL Model | 24 |
| 9. Rolling Estimation of Long-Run Import Trade Elasticities and Error Correction Coefficient in ARDL Model | 25 |
| 10. Rolling Estimation of Marshall-Lerner Condition, 1998-2017 | 28 |
| 11. Rolling Estimation of Contribution of Domestic-Foreign Income Growth Differential to Real Trade Balance Adjustment | 29 |

I. INTRODUCTION

Turkey is a large and open emerging market economy that has experienced sizable swings of the real effective exchange rate (REER) over the last 20 years. This makes it a suitable case study of the importance of REER adjustments in restoring external balance. This question has gained prominence in the wake of the global financial crisis, due to a perception that the sizable REER realignments across the world have not translated in a commensurate correction of global external imbalances. On the one hand, cross-country studies have tended to confirm the stability of the link between REER and real trade balances (Cardarelli and Rebucci, 2007; Leigh and others, 2015). On the other hand, analyses of individual country experiences often discount REER's importance in correcting trade imbalances (Aldan, Bozok, and Gunay (2015), Çulha and Kalafatçılar (2014); and Bozok, Dogan, and Yunculer (2015) in the case of Turkey; Li, Ma, and Xu (2015) for China).

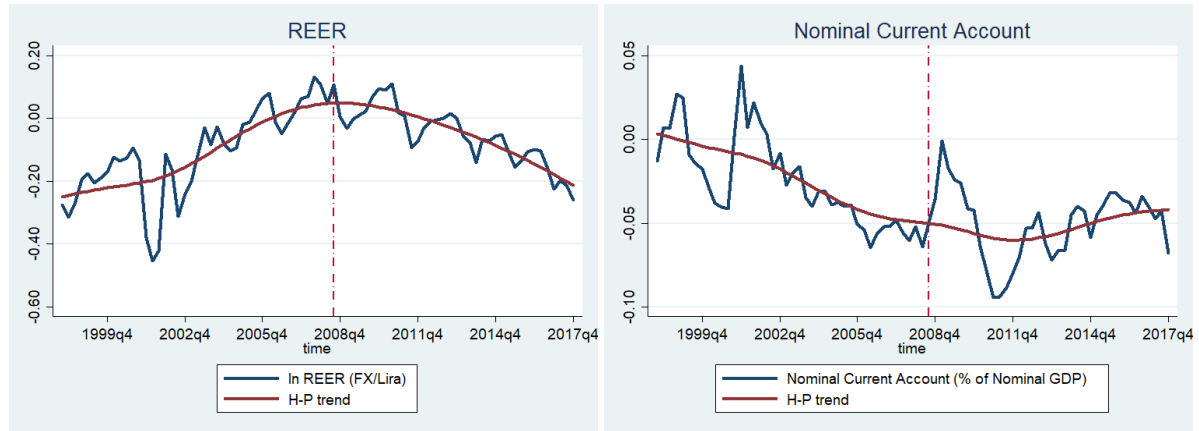
In Turkey, the REER appreciated by close to 25% over the ten years before the 2008-09 global financial crisis, before relinquishing most of these gains through end-2017 (Figure 1, left panel).¹ During the REER appreciation phase, in line with theoretical priors, the current account deficit widened to over 5% of GDP (Figure 1, right panel). However, it has since hardly bulged, despite sustained REER depreciation. This is mainly due to a wedge between the nominal current account-to-GDP and the real trade balance-to-GDP ratios, which has opened since the mid-2010 (Figure 2, left panel). The real trade balance—which is behaviorally linked to the REER—has been much more responsive to REER movements, but its post-2008 improvement has still fallen short of retracing its preceding deterioration (Figure 2, right panel).

Given its sizeable and persistent current account deficit, the size of Turkey's trade elasticities has been studied extensively. Ekinçi, Kilinc and others (2013) survey empirical studies of REER elasticities of real exports and imports, carried out mostly with pre-2008 data. They find large dispersion of coefficients, with absolute values of the two elasticities in the range of 0.3 to 0.9. Çulha and Kalafatçılar (2014) survey empirical studies of income and REER elasticities of real exports, also carried out mostly with pre-2008 data. The authors report even wider range of estimates of the REER elasticity that includes both positive and negative values. At the same time, income elasticities were found to be typically higher than the absolute value of the REER elasticities and larger than one. Aldan, Bozok, and Gunay (2015) summarize the findings of the received literature on import elasticities as showing that the income elasticity of imports is also higher than their price elasticity. In the case of both exports

¹The data sample used in the paper ends in 2017, as the empirical analysis was carried out in the summer of 2017 and finalized by mid-2018.

(Bozok, Dogan, and Yunculer, 2015) and imports (Aldan, Bozok, and Gunay, 2015), recent studies find that income is a more important determinant of trade flows than the REER.

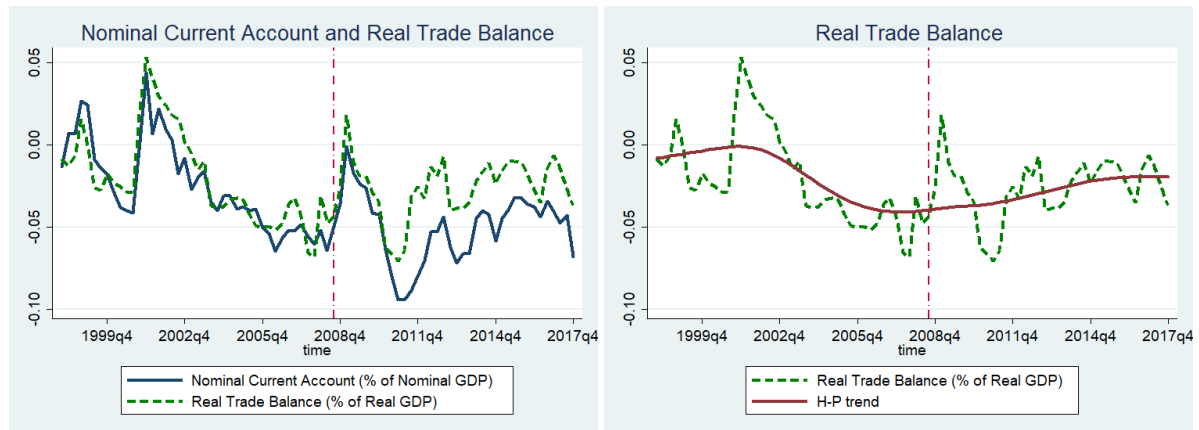
Figure 1. Turkey: REER and Nominal Current Account, 1998-2017



Source: Turkey Statistical Institute and authors calculations.

Notes: Increase of REER corresponds to real appreciation of the Lira.

Figure 2. Turkey: Nominal Current Account and Real Trade Balance, 1998-2017



Source: Turkey Statistical Institute and authors calculations.

Notes: Real trade balance is equal to the difference between real exports (nominal values deflated by the export deflator) and real imports (nominal values deflated by the import deflator).

In this paper, we seek to contribute to the empirical literature on the drivers of real trade balance adjustment in Turkey and the broader debate on the role of exchange rates in restoring external balance in the wake of the global financial crisis. We estimate the long-run elasticities of real exports and imports in a partial-equilibrium model that is common in the empirical literature (Hooper, Johnson, and Marquez, 2002; Krugman, 1989). The wide range of estimates of trade elasticities in Turkey—derived from data covering different time periods and using different econometric techniques—hints at the likely presence of structural breaks in

the estimated relationships. We address this issue systematically, by using longer time series and estimation techniques, such as rolling, sub-sample, autoregressive-distributed lag (ARDL) regressions, full-sample ARDL regressions with REER interaction terms, and non-linear autoregressive distributed lag (NARDL) regressions, that allow us to detect and control for structural breaks in the data.

The remainder of the paper is organized as follows. Section II presents the analytical framework used. Section III discusses the data and presents some stylized facts. Section IV contains the main regression findings, with robustness checks shown in Appendix A. Section V interprets the empirical results with references to recent advances in the literature on REER effectiveness. Section VI provides a summary of our main findings.

II. ANALYTICAL FRAMEWORK

In the partial-equilibrium, trade-elasticities approach, the trade balance is determined by the real incomes and relative prices in trade partners (Montiel, 2002). It is a structural model that is consistent with more complex general equilibrium models (Dekle, Eaton, and Kortum, 2007; Eaton and Kortum, 2002; Montiel, 2002). In its most concise formulation, the trade balance depends on a single relative price, namely the real effective exchange rate (Krugman, 1989).

In this paper, the real effective exchange rate (REER or Q' in the equations below) is defined as the ratio of the domestic (e.g., Turkey's) price level to a trade-weighted index of foreign price levels, each converted into Turkish Lira using the bilateral nominal exchange rates (Montiel, 2002). The real trade balance can then be written as:²

$$TB = X - M = X - \frac{\tilde{M}}{Q'} \quad (1)$$

TB — real trade balance in chain-linked Turkish Lira (reference year = 2009) (i.e., expressed in domestic consumer goods baskets);

X — real exports in chain-linked Turkish Lira (reference year = 2009);

\tilde{M} — real imports in chain-linked foreign currency (i.e., expressed in foreign consumer goods baskets);

²For simplicity, we derive the main relationships in the model for the special case of one trade partner. See Appendix B.1 for the general formula of the REER used in the empirical part of the paper.

$\frac{1}{Q}$ — transforms foreign consumer goods baskets in equivalent amount of domestic ones.

Box 1. Definition of Real Effective Exchange Rate

In the two-country case, the REER is given by the following expression:

$$Q' = \frac{P}{S \cdot \tilde{P}}$$

P — domestic CPI;

\tilde{P} — CPI in trade partner;

S — exchange rate expressed as domestic currency units per one unit of foreign currency.

The REER is the relative price of the domestic and foreign consumer goods baskets, both expressed in domestic currency units. Everything else held constant, a nominal depreciation (higher S) would translate in lower Q' . The relative price of the domestic and foreign consumer goods baskets declines as a result of the loss of value of the domestic currency. A decline/increase of Q' reflects real depreciation/appreciation of the domestic currency, as can be seen by re-arranging the RHS of the equation:

$$Q' = \frac{\frac{1}{S} \cdot \frac{1}{\tilde{P}}}{\frac{1}{P}}$$

The denominator of the ratio can be interpreted as the fraction of the domestic consumer goods basket that can be bought with one unit of the domestic currency. The nominator is the fraction of the foreign consumer goods basket that can be purchased by converting one domestic currency unit into the foreign currency. A decrease in Q' would then mean that one domestic currency unit would buy less of the foreign goods basket than of the domestic one than before, resulting in real depreciation of the domestic currency.

Source: [McCallum \(1996\)](#)

Both real exports and imports are functions of the relative price of the domestic and foreign goods and real incomes at home and abroad, respectively.

For imports, the relationship captures the domestic demand for imports, which is positively related to both the real domestic income (GDP) and the relative price of the domestic and

foreign consumer goods baskets (Montiel, 2002):

$$\tilde{M} = \tilde{M}(Y, Q') \quad (2)$$

Y — Turkey's real GDP in chain-linked Turkish Lira (i.e., expressed in domestic consumer goods baskets);

$$\frac{\partial \tilde{M}}{\partial Y} > 0; \text{ and } \frac{\partial \tilde{M}}{\partial Q'} > 0.$$

For exports, the relationship can be interpreted as the foreign demand for Turkey's exports or as Turkey's supply of exports, depending on the underlying assumptions about the properties of the domestic supply of exports and foreign demand for them (Montiel, 2002). In both cases, exports are positively related to real foreign income (GDP) and negatively related to the relative price of the domestic and foreign consumer goods baskets:

$$X = X(\tilde{Y}, Q') \quad (3)$$

\tilde{Y} — foreign real GDP (i.e., expressed in foreign consumer goods baskets);

$$\frac{\partial X}{\partial \tilde{Y}} > 0; \text{ and } \frac{\partial X}{\partial Q'} < 0.$$

Equation (1) can be differentiated with respect to time (t):

$$\frac{dT B}{dt} = \frac{\partial X}{\partial \tilde{Y}} \frac{d\tilde{Y}}{dt} + \frac{\partial X}{\partial Q'} \frac{dQ'}{dt} - \frac{\frac{\partial \tilde{M}}{\partial Y} Q'}{Q'^2} \frac{dY}{dt} - \frac{\frac{\partial \tilde{M}}{\partial Q'} Q' - \tilde{M}}{Q'^2} \frac{dQ'}{dt} \quad (4)$$

We can then define the elasticities of real exports and imports with respect to the real exchange rate in such a way that they are both positive numbers (McCallum, 1996):

$$\eta^X = -\frac{\partial X}{\partial Q'} \frac{Q'}{X} > 0$$

$$\eta^{\tilde{M}} = \frac{\partial \tilde{M}}{\partial Q'} \frac{Q'}{\tilde{M}} > 0$$

The elasticities of real exports and imports with respect to the real foreign and domestic income, respectively, are given by:

$$\epsilon^X = \frac{\partial X}{\partial \tilde{Y}} \frac{\tilde{Y}}{X} > 0$$

$$\epsilon^{\tilde{M}} = \frac{\partial \tilde{M}}{\partial Y} \frac{Y}{\tilde{M}} > 0$$

Substituting the relative price and income elasticities in equation (4) gives:

$$\frac{dT B}{dt} \frac{1}{T B} = \frac{X}{T B} (\varepsilon^X \tilde{y} - \eta^X \dot{q}') - \frac{M}{T B} (\varepsilon^{\tilde{M}} \dot{y} + (\eta^{\tilde{M}} - 1) \dot{q}') \quad (5)$$

$\dot{y} = \frac{dY/dt}{Y}$, $\tilde{y} = \frac{d\tilde{Y}/dt}{\tilde{Y}}$, and $\dot{q}' = \frac{dQ'/dt}{Q'}$ — growth rates of domestic income (Y), foreign income (\tilde{Y}), and REER (Q'), respectively;

M — real imports expressed in domestic consumer goods baskets;

$\frac{dT B/dt}{T B} = \dot{t}b$ — growth rate of the real trade balance.

Defining the real export-import ratio as $\alpha = \frac{X}{M}$ and substituting it in equation (5) allows us to further simplify the expression:

$$\dot{t}b = \frac{\alpha}{\alpha - 1} (\varepsilon^X \tilde{y} - \eta^X \dot{q}') - \frac{1}{\alpha - 1} (\varepsilon^{\tilde{M}} \dot{y} + (\eta^{\tilde{M}} - 1) \dot{q}') \quad (6)$$

$$\dot{t}b = \frac{1}{1 - \alpha} \left(\underbrace{\varepsilon^{\tilde{M}} \dot{y} - \alpha \varepsilon^X \tilde{y}}_{\text{Income Effect}} + \underbrace{\dot{q}' (\alpha \eta^X + \eta^{\tilde{M}} - 1)}_{\text{Substitution Effect}} \right) \quad (7)$$

Equation (7) decomposes the growth rate of the real trade balance into contributions from changes of the REER and the domestic-foreign income growth differential. Starting from a real trade deficit ($1 - \alpha > 0$), a narrowing of the deficit ($\dot{t}b < 0$)³ requires the following condition to be met:⁴

$$\underbrace{\varepsilon^{\tilde{M}} \dot{y} - \alpha \varepsilon^X \tilde{y}}_{\text{Income Effect}} + \underbrace{\dot{q}' (\alpha \eta^X + \eta^{\tilde{M}} - 1)}_{\text{Substitution Effect}} < 0 \quad (8)$$

The Marshall-Lerner condition is a special case of condition (8), when the income effect is zero. In the case of REER depreciation ($\dot{q}' < 0$), narrowing of the trade deficit in levels requires:

$$\alpha \eta^X + \eta^{\tilde{M}} > 1 \quad (9)$$

The domestic-foreign income growth differential would contribute to the narrowing of the real trade balance, if the ratio of domestic to foreign income growth rates is smaller than the

³Starting from ($T B < 0$), a narrowing of the deficit in levels ($\frac{dT B}{dt} > 0$) implies a negative growth rate of the real trade balance ($\dot{t}b = \frac{dT B}{dt} \frac{1}{T B} < 0$).

⁴Krugman (1989) derived equation (8) in the special case, in which the initial real trade balance is zero (see Hooper, Johnson, and Marquez (2002) for a correction to the published formula).

appropriately scaled ratio of income elasticities of real exports and imports:

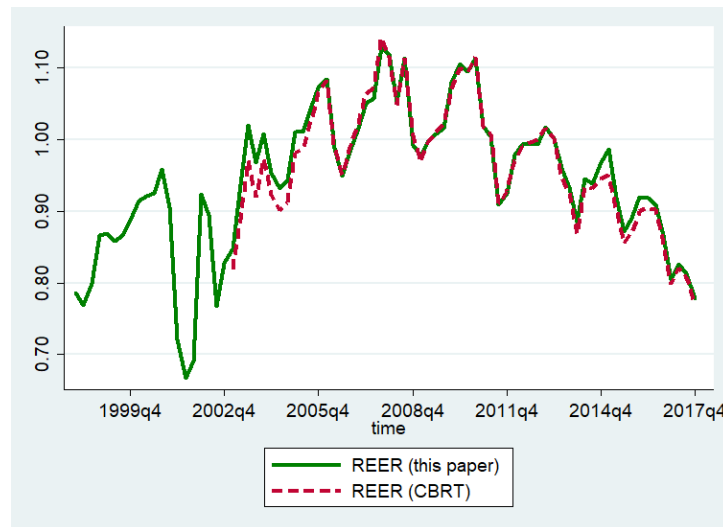
$$\frac{\dot{y}}{\bar{y}} < \frac{\alpha \varepsilon^X}{\varepsilon^M} \quad (10)$$

In the general case, REER depreciation ($\dot{q}' < 0$) will result in an improvement of the real trade balance ($\dot{t}b < 0$), if the substitution effect dominates the effect of the domestic-foreign income growth differential.

III. FIRST LOOK AT THE DATA

Our sample consists of quarterly data over the period 1998-2017.⁵ The central bank of Turkey (CBRT) publishes data on the consumption-based real effective exchange rate (CPI-based REER) starting in 2003. We construct longer CPI-based REER series and use them to back-cast the pre-2003 levels of TurkStat's REER series (Appendix B.1). Our calculations are closely aligned with TurkStat's published REER series from 2003 onward (Figure 3). Data on exports and imports include both goods and services. Their nominal and real values are taken from TurkStat's national accounts data and are the same series used in the expenditure-side GDP compilation. Details on the calculation of the real domestic and foreign incomes can also be found in Appendix B.1.

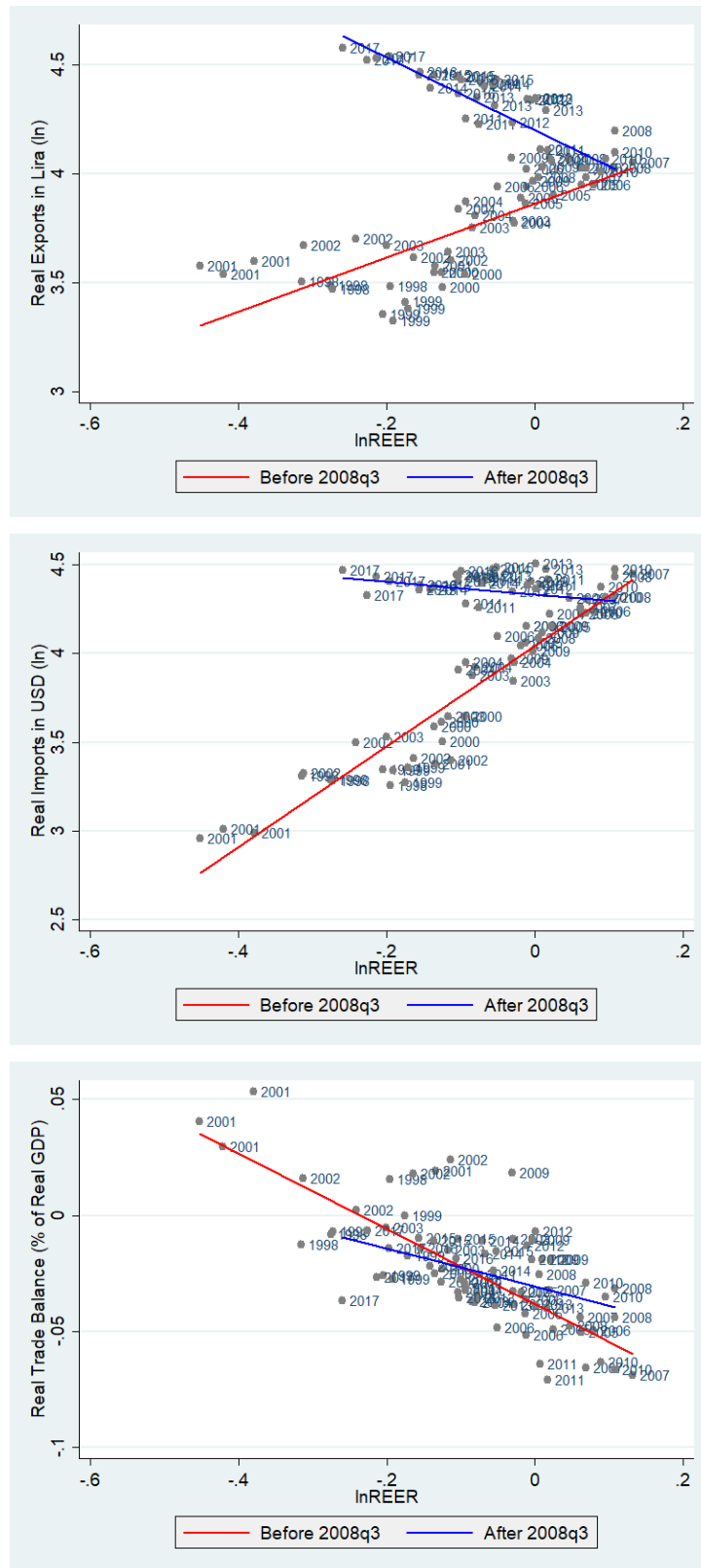
Figure 3. Turkey: Comparison of REER Estimates, 1998-2017



Source: Turkey Statistical Institute and authors calculations.

⁵The starting year of the sample is determined by the availability of the revised GDP data published by TurkStat. The sample ends in 2017, as the empirical analysis was carried out in the summer of 2017 and finalized by mid-2018.

Figure 4. Turkey: REER and Real Trade Flows, 1998-2017



Source: Turkey Statistical Institute and authors estimations.

Our theoretical priors suggest a positive relationship of the REER—which proxies the relative price of the domestic and foreign consumer goods baskets—with real imports and a negative one with real exports. The link between the REER and the real trade balance, which is given by the difference between real exports and imports, would depend on whether the Marshall-Lerner condition is met and whether the substitution effect, triggered by the REER depreciation, is greater in absolute term than the income effect (Section II).

The scatter plots of real exports and imports against the REER (Figure 4) suggest that whereas the interdependence between the variables can be reasonably described by linear relationships, there are structural breaks around the time the direction of the secular REER trend changed from appreciation to depreciation (Figure 1). Despite these structural breaks, the real trade balance is negatively correlated with the REER both in the full sample and in each of the two sub-samples (Figure 4). The reason for this is that, prior to the third quarter of 2008, the link between real imports and the REER was very strong, and the real trade balance was further supported by the lack of a negative impact of REER appreciation on real exports (Figure 4). After the third quarter of 2008, the sign of the correlation between exports and the REER turned negative, which was conducive of real trade balance correction, counteracting the weakening of the link between real imports and the REER.

IV. REGRESSION ESTIMATION

A. Regression Specification

We estimate the long-run elasticities of trade flows in Turkey using a complementary set of econometric techniques that allow us to detect and control for structural breaks in the data.

1. ARDL Model

We base our empirical analysis on the estimation of the Turkish demand for imports (Equation (2)) and the foreign demand for exports from Turkey (Equation (3)) in their autoregressive-distributed lag (ARDL) forms (Hendry, 1995).⁶ The ARDL model captures both the short- and long-run dynamics of the relationship between the dependent and explanatory variables:

$$y_t = \alpha_0 + \sum_{i=1}^p \alpha_i y_{t-i} + \sum_{i=0}^p \beta'_i x_{t-i} + \varepsilon_t \quad (11)$$

⁶We also estimate a model of Turkey's real trade balance to GDP ratio, in which the income variable is the ratio between domestic and foreign real incomes.

y — Turkey's real exports expressed in Turkish Lira or Turkey's real imports expressed in US dollars, both in logs;

\mathbf{x} — includes the log of REER and the real income in Turkey or in its trade partners, both in logs;

p — lag-length chosen to ensure uncorrelated residuals.

The long-run trade elasticities ($\boldsymbol{\delta}$) can then be derived from the ARDL model (Equation (11)), under the stability condition that all roots of the lag polynomial $1 - \sum_{i=1}^p \alpha_i L^i$ are outside the unit circle:

$$y^* = \frac{\alpha_0}{(1 - \sum_{i=1}^p \alpha_i)} + \boldsymbol{\delta}' \mathbf{x}^* \quad (12)$$

$$\boldsymbol{\delta} = \frac{\sum_{i=0}^p \boldsymbol{\beta}_i}{(1 - \sum_{i=1}^p \alpha_i)} \text{ — long-run trade elasticities.}$$

The equilibrium-correction (EC) model isomorphic to Equation (11) is given by:

$$\Delta y_t = -\underbrace{\theta \left(y_{t-1} - \frac{\alpha_0}{\theta} - \boldsymbol{\delta}' \mathbf{x}_{t-1} \right)}_{\text{Error-correction term}} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{p-1} \boldsymbol{\rho}'_i \Delta \mathbf{x}_{t-i} + u_t \quad (13)$$

$\theta = 1 - \sum_{i=1}^p \alpha_i$ — fraction of last period's disequilibrium (i.e., deviation of the dependent variable from its value consistent with long-run fundamentals) eliminated in the current one.⁷

Pesaran and Shin (1998) show that the estimates of the short-run and long-run coefficients derived from the ARDL model are consistent, irrespective of whether the regressors are exogenous or endogenous and whether they have unit roots or not.

Given the likely presence of structural breaks in the link between real trade flows and the REER (Figure 4), we fit the ARDL model on both the full sample and different data subsamples. We complement the ARDL sub-sample regression findings with results from using the full sample to estimate ARDL model with REER interaction term. Compared to the sub-sample ARDL regressions, such a specification has the advantage of using more data in estimating the coefficients not affected by structural breaks. We use Stata's *ardl* package to report the long-run coefficients of the estimated models, derived from their equilibrium-correction forms (Equation (13)).

⁷It is the existence of this correction mechanism that ensures that the dynamic adjustment of real trade flows will eventually bring them to their long-run steady states.

2. NARDL Model

The raw data suggest that structural breaks in the relationship between the REER and real trade flows occurred around the time the direction of the secular REER trend changed from appreciation to depreciation (Figures 1 and 4). The sub-sample ARDL regressions and the full-sample ARDL regressions with REER interaction-term offer a more robust way of pinpointing the timing of the structural breaks. A complementary approach is to formally test for asymmetry in the impact of the REER on real trade flows in periods of appreciation and depreciation, using the nonlinear autoregressive distributed lag (NARDL) model.

Shin, Yu, and Greenwood-Nimmo (2014) extend the standard ARDL model to allow for short- and long-run nonlinearities in the relationship between the dependent and explanatory variables, which are introduced via positive and negative partial sum decompositions of the explanatory variables in Equation (11):

$$y_t = \phi_0 + \sum_{j=1}^n \phi_j y_{t-j} + \sum_{j=0}^n (\boldsymbol{\theta}_j^{+'} \mathbf{X}_{t-j}^+ + \boldsymbol{\theta}_j^{-'} \mathbf{X}_{t-j}^-) + \varepsilon_t \quad (14)$$

\mathbf{X}_t — $k \times 1$ vector of regressors defined such that $\mathbf{X}_t = \mathbf{X}_0 + \mathbf{X}_t^+ + \mathbf{X}_t^-$;

\mathbf{X}^+ and \mathbf{X}^- — partial sum processes of positive and negative changes in \mathbf{X}_t ;

$\mathbf{X}^+ = \sum_{j=1}^t \Delta \mathbf{X}_j^+ = \sum_{j=1}^t \max(\Delta \mathbf{X}_j, 0)$;

$\mathbf{X}^- = \sum_{j=1}^t \Delta \mathbf{X}_j^- = \sum_{j=1}^t \min(\Delta \mathbf{X}_j, 0)$;

$\boldsymbol{\theta}_j^+$ and $\boldsymbol{\theta}_j^-$ — asymmetric distributed-lag parameters.

Equation (14) can also be re-written and estimated in its equilibrium-correction form. The NARDL model corrects for weak endogeneity of nonstationary explanatory variables, while the choice of an appropriate lag structure renders the model free from residual autocorrelation.

We estimate NARDL models for real exports, imports, and trade balance, allowing for asymmetry only in the long-run REER elasticities. We use Stata package, developed by Shin, Yu, and Greenwood-Nimmo (2014), to report the long-run coefficients of the estimated models, derived from their equilibrium-correction forms.

B. Regression Results

1. Long-Run Export Elasticities

(a) Long-Run REER Elasticity of Exports

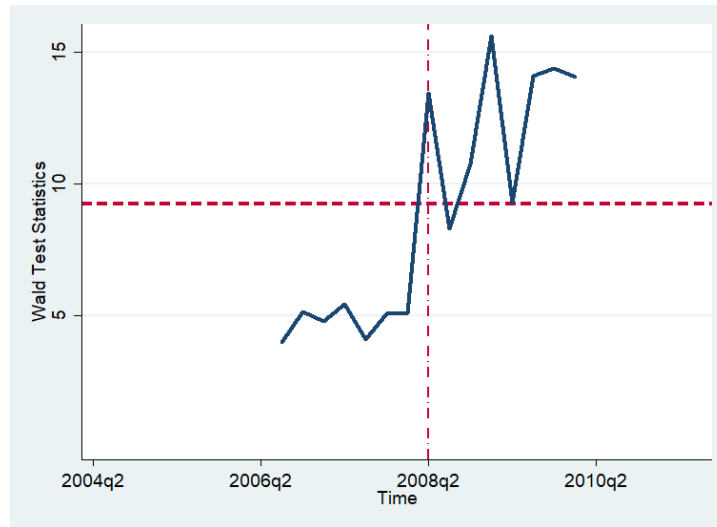
Table 1 shows the estimates of the long-run elasticities of real exports and the error-correction coefficient over different sample periods. Over the full sample, the long-run REER elasticity of real exports is statistically insignificant. However, as seen in Figure 4, there is evidence of a structural break in the relationship, which raises questions about the relevance of the full-sample estimate for the most recent period. To formally test for the existence of structural breaks, we split the sample in two at different interior data points and perform a Wald test of the hypothesis that the REER coefficient is the same in the two sub-samples. Results point to a structural break in the second half of 2008 (Figure 5).

Table 1. Long-Run Trade Elasticities of Real Exports (Lira) in ARDL Model

| | 1998q1-2017q4 | 1998q1-2008q2 | 2008q3-2017q4 |
|------------------------------|--------------------|--------------------|--------------------|
| Error-correction coeff. | -0.46*** (0.09) | -0.59*** (0.13) | -0.35*** (0.13) |
| Long-run coeff. ln REER | 0.04 (0.10) | 0.14 (0.14) | -0.73 (0.51) |
| ln Foreign Income | 3.06*** (0.10) | 2.87*** (0.21) | 2.03*** (0.74) |
| R^2 | 0.98 | 0.97 | 0.94 |
| N | 76 | 38 | 38 |
| Bounds test F-stat | 8.68*** | 7.67*** | 3.40*** |
| B-G 1st order F-stat | 0.14 | 0.06 | 0.70 |
| B-G 2nd order F-stat | 0.55 | 0.17 | 0.46 |

Notes: The lag structure is selected automatically based on the AIC and BIC criteria. The Bounds Test F-statistic tests the null hypothesis of no long-run/cointegrating relationship. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. ***p<0.01, **p<0.05, *p<0.1. The long-run specification includes a constant, which is omitted from the regression output. The R^2 reported in the table are estimated from the ARDL specification in levels.

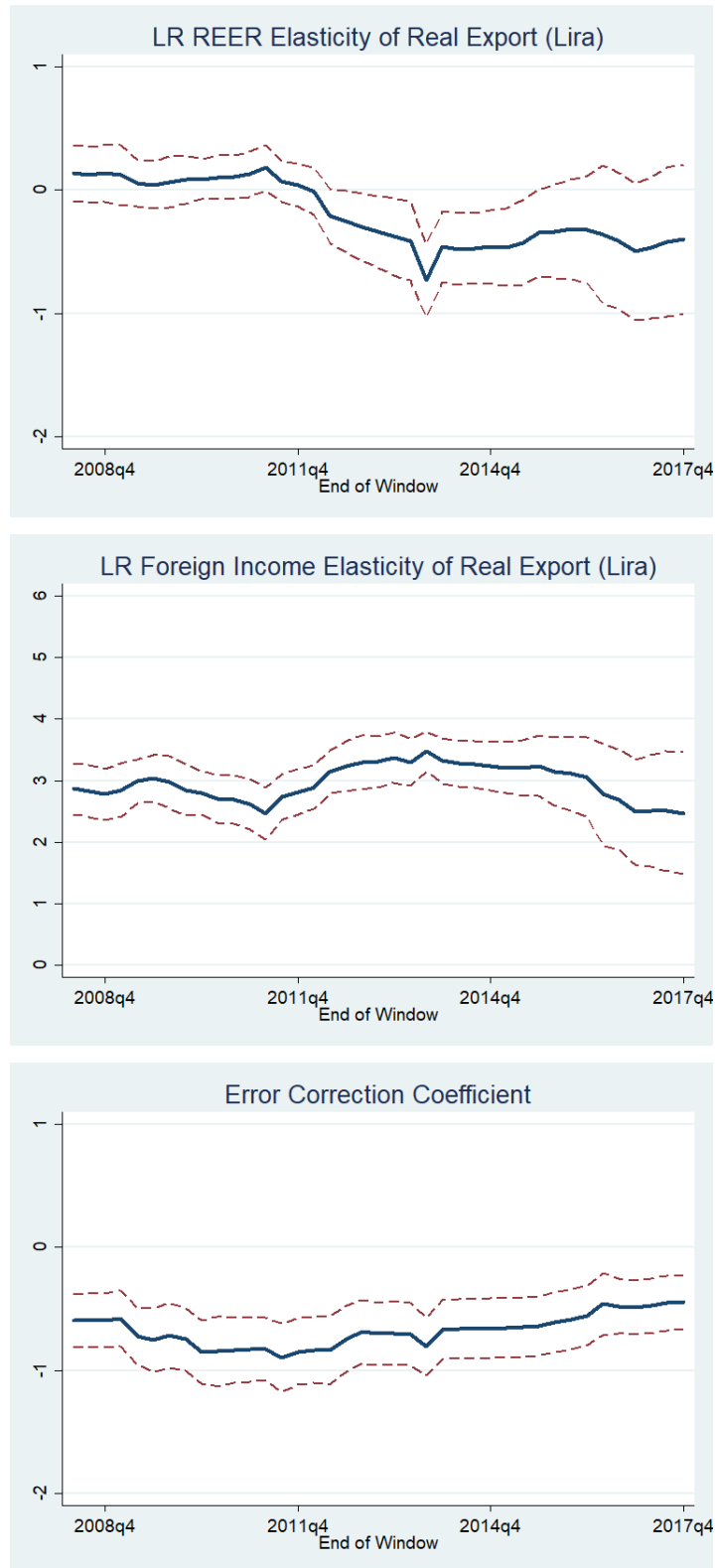
Figure 5. Recursive Wald Stability Test for Long-Run REER Elasticity of Real Exports in ARDL Model



Notes: Plotted are the Wald statistics for coefficient stability across pairs of sub-samples, created by splitting the full sample at each point shown on the horizontal axis. The horizontal red line shows the 10 percent critical value with 5 degrees of freedom. The common lag structure used on all sub-samples is the one derived from full-sample ARDL specification.

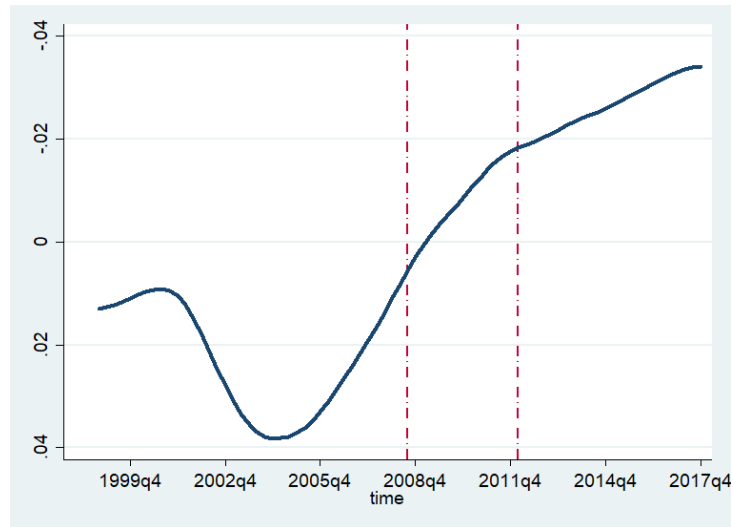
Re-estimation of the regression before and after 2008 suggests that the sign of the REER elasticity of real exports switched from positive to negative after the crisis, though the lack of long enough series prevents the precise estimation of the regression coefficients (Table 1). The two sub-samples roughly correspond to the secular periods of real appreciation and depreciation of the Lira (Figure 1), confirming the data patterns observed in Figure 4. Rolling estimation of the long-run elasticities points to the importance of the post-2011 observations for the switch of the sign of the REER elasticity of real exports (Figure 6). This is around the time when the long-run REER depreciation intensified to over 2% per year (Figure 7).

Figure 6. Rolling Estimation of Long-Run Export Trade Elasticities and Error Correction Coefficient in ARDL Model



Notes: 42 quarter (around 10.5 years) rolling window. The horizontal axis shows the end period of the rolling window. Red lines indicate the 95 % confidence interval.

Figure 7. Turkey: Annual Growth Rate of Long-Run Trend of REER, 1998-2017



Data Sources: Turkey Statistical Institute and authors calculations.

Notes: 4-Quarter difference of H-P trend of REER. The scale of the vertical axis is inverted. Decrease of REER corresponds to real depreciation of the Lira.

Table 2. Long-Run Trade Elasticities of Real Exports (Lira) with REER Interaction Term in ARDL Model

| | | In Real Exports (Lira) |
|-------------------------|-----------------------------|------------------------|
| Error-correction coeff. | | -0.38*** (0.08) |
| Long-run coeff. | In REER | -0.39 (0.29) |
| | InREER×Dummy (pre-2008q3=1) | 0.24* (0.13) |
| | In Foreign Income | 2.71*** (0.24) |
| R^2 | | 0.98 |
| N | | 79 |
| Bounds test F-stat | | 8.16*** |
| B-G 1st order F-stat | | 0.75 |
| B-G 2nd order F-stat | | 0.98 |

Notes: The lag structure is selected automatically based on the AIC and BIC criteria for the model without interaction term. The Bounds Test F-statistic tests the null hypothesis of no long-run/cointegrating relationship. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The long-run specification includes a constant, which is omitted from the regression output.

In Table 2, we report the results from estimating the full-sample ARDL model with an interaction term between REER and a dummy variable that takes a value of one prior to the third quarter of 2008 and zero afterward. Results confirm the finding from the sub-sample estimates in Table 1 that the sign of the REER elasticity of real exports switched from positive to negative at end-2008.

Table 3. Long-Run Trade Elasticities of Real Exports (Lira) in NARDL Model

| Var. | Coeff. | F-statistics | P-value |
|-------------------------|----------|--------------|---------|
| $\ln REER^+$ | 0.041 | 0.099 | 0.754 |
| $\ln REER^-$ | -0.234 | 1.771 | 0.188 |
| In Foreign Income (USD) | 1.851*** | 9.577 | 0.003 |
| R^2 | | 0.334 | |
| F_{PSS} | | 4.724*** | |
| W_{LR} | | 0.275** | |
| B-G 1st order F-stat | | 0.32 | |
| B-G 2nd order F-stat | | 0.75 | |

Notes: $\ln REER^+$ and $\ln REER^-$ denote the partial sum process of positive and negative changes of $\ln REER$ and we report the long-run coefficients of $\ln REER^+$ and $\ln REER^-$ here. The preferred specification is selected starting with 4 lags for all variables and dropping the variables with insignificant coefficients. F_{PSS} is the PSS F-statistic for the existence of an asymmetric (cointegrating) long-run relationship in the NARDL model. W_{LR} refers to the Wald test of long-run symmetry ($\ln REER^+ = \ln REER^-$) and p-value is in the bracket. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. ***p<0.01, **p<0.05, *p<0.1.

Results from the full-sample NARDL model provide further evidence of asymmetry of the impact of the REER on real exports in secular periods of real appreciation and depreciation (Table 3). The Wald test of the equality of the long-run coefficients $\ln REER^+$ and $\ln REER^-$ rejects the null hypothesis at the 99 percent confidence level.⁸ The sign of the REER elasticity of real exports is negative in periods of depreciation and positive when the REER appreciates, though both coefficients are not statistically significant at the 90 percent confidence level.

⁸Here, $\ln REER^+$ and $\ln REER^-$ are the partial sum processes of positive and negative changes of $\ln REER$. The details of the variable's constructions are in Equation (14).

Taken together, the results from the estimation of the sub-sample ARDL regressions, the full sample ARDL regression with REER interaction term, and the NARDL regression provide strong evidence for the existence of a structural break in the REER elasticity of real exports, linked to the switch of the long-run trend of the REER from appreciation to depreciation toward the end of 2008. Since then, the sign of the REER elasticity of real exports has been in line with theoretical priors, though its relatively small size combined with the lack of long enough series do not allow the drawing of a definitive conclusion on its statistical significance. This is in line with existing studies of exchange rate pass-through to export prices in Turkey, which generally find that it has been insignificant (Bussière, Delle Chiaie, and Peltonen, 2014), implying a weak demand-pull effect for Turkish exports.

Structural breaks like this are often attributed to non-linearity and asymmetry in the exchange rate pass-through to prices. Pollard and Coughlin (2004) provides several theoretical explanations of asymmetric exchange rate pass-through, related to market share theory, substantial downward price rigidities, and binding quantity constraints. Similar to the case of Turkey, Pollard and Coughlin (2004) finds that export price elasticity is higher during depreciation than appreciation periods in the U.S. Caselli (2016) also finds evidence of non-linearities during episodes of depreciation greater than 10 and 20 percent in emerging markets. Asymmetries are reported for both import (Kal, Arslaner, and Arslaner, 2015) and export prices (Bussiere, 2013), with elasticities frequently found to be lower during appreciation periods (Delatte and López-Villavicencio, 2012).

One possible explanation for the documented asymmetry of the REER effect on exports centers on the importance of total factor productivity (TFP) as a driver of REER appreciation and depreciation. Annex I in IMF (2018) presents evidence that TFP growth was strong and positive prior to 2007, before slipping in slightly negative territory, on average, in subsequent years. IMF (2015) and IMF (2018) attribute the structural break in TFP growth to the waning impetus for structural reforms, with the most significant, productivity-enhancing structural reforms having taken place prior to 2006. Whereas, the absence of quarterly TFP series prevents us from explicitly controlling for its effect on the REER-exports nexus, buoyant exports in a period of appreciation is consistent with the predictions of standard trade models (Eaton and Kortum, 2002; Melitz and Ottaviano, 2008), if the REER appreciation is predominantly driven by the positive TFP differential between the domestic economy and its trade partners. By the same logic, the overshooting of the REER depreciation over the slightly negative TFP growth in the post-2006 period can explain the sustained buoyancy of exports in the wake of the global financial crisis.

(b) Long-Run Income Elasticity and Speed of Adjustment of Exports

Table 1 also presents the estimates of the long-run foreign demand elasticity of real exports, which are statistically significant and larger than 2 in all sub-samples. The rolling estimates of the income elasticity of real exports remain broadly stable in the post-crisis period (Figure 6). Results from the full-sample ARDL model with REER interaction term point to a value of the long-run foreign demand elasticity of real exports of 2.7 in the full sample (Table 3). Real exports are, hence, found to be more sensitive to changes in foreign demand than the REER.

In the ARDL models, the speed of adjustment of actual real exports to their value consistent with fundamentals in the long-run is relatively fast. The post-crisis estimate of the error-correction coefficient suggests that around 1/3 of any misalignment between the actual and equilibrium real exports is corrected in each quarter (Table 1).

(c) Specification Tests

The estimated ARDL regressions pass the specification tests of no residual autocorrelation and the existence of long-run cointegrating relationship, based on the reported Breusch-Godfrey Lagrange multiplier and Bounds Test F-statistics respectively (Tables 1 and 2). The high R-squares of the ARDL models suggest that they fit well the underlying data process, whereas the weaker goodness-of-fit measure of the NARDL model signal the need for caution in interpreting its findings. Rolling estimation of the error-correction and long-run elasticities coefficients suggests that controlling for the structural break in the link between real exports and the REER, the estimated foreign demand for Turkish exports has been relatively stable (Figure 6). Our findings are robust to an alternative specification of real exports that nets out energy and gold (Appendix A).

2. Long-Run Import Elasticities

(a) Long-Run Income Elasticity of Imports

Table 4 shows the estimates of the long-run elasticities of real imports and the error-correction coefficient over different sample periods. The long-run REER elasticity of real imports is statistically significant in both the full sample and the two sub-samples and greater than one. Recursive Wald tests do not offer conclusive evidence of coefficient instability (Figure 8). The statistic is marginally significant at the 90 % confidence level in the year prior to the global

financial crisis, but then falls below the threshold, as more post-crisis observations are included in the recursive estimation. Indeed, using the identified structural break in the foreign demand for exports to split the sample in two and re-estimating the regression returns sub-sample estimates of the REER elasticity of imports that are close in value to the full-sample estimate, when account is taken of the wide confidence bands (Table 4). At the same time, rolling estimation of the long-run elasticities points to some coefficient instability in samples that include observations from the start and the end of the post-crisis period, but the estimates remain positive, as predicted by theory (Figure 9).

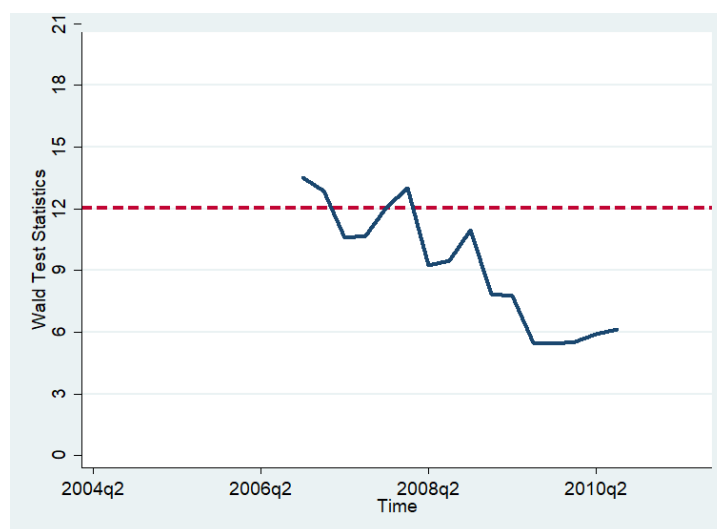
Table 4. Long-Run Trade Elasticities of Real Imports (USD) in ARDL Model

| | | 1998q1-2017q4 | 1998q1-2008q2 | 2008q3-2017q4 |
|-------------------------|--------------------|-------------------|-------------------|-------------------|
| Error-correction coeff. | | -0.20** (0.09) | -0.29** (0.14) | -0.27* (0.14) |
| Long-run coeff. | ln REER | 1.36*** (0.27) | 1.31*** (0.45) | 1.01* (0.57) |
| | ln Domestic Income | 1.15*** (0.07) | 1.49*** (0.37) | 1.02*** (0.27) |
| R^2 | | 0.99 | 0.99 | 0.94 |
| N | | 76 | 40 | 38 |
| Bounds test F-stat | | 2.79*** | 1.56* | 2.02* |
| B-G 1st order F-stat | | 0.00 | 1.60 | 1.04 |
| B-G 2nd order F-stat | | 0.62 | 0.80 | 0.80 |

Notes: The lag structure is selected automatically based on the AIC and BIC criteria. The Bounds Test F-statistic tests the null hypothesis of no long-run/cointegrating relationship. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The long-run specification includes a constant, which is omitted from the regression output. The R^2 reported in the table are estimated from the ARDL specification in levels.

In Table 5, we report the results from estimating the full-sample ARDL model with the same REER interaction term as the one used in the exports regression. Results support the finding from the sub-sample estimates in Table 4 that the long-run REER elasticity of real imports has remained broadly stable in the full sample. Estimation of the full-sample NARDL model confirms that the long-run REER elasticity of real imports is statistically significant and positive both in secular periods of real appreciation and depreciation (Tables 6). However, the Wald test of the equality of the long-run coefficients $lnREER^+$ and $lnREER^-$ rejects the null hypothesis at the 99 percent confidence level. This suggests that the long-run REER elasticity of real imports may, in fact, be smaller in periods of REER depreciation.

Figure 8. Recursive Wald Stability Test for Long-Run REER Elasticity of Real Imports in ARDL Model



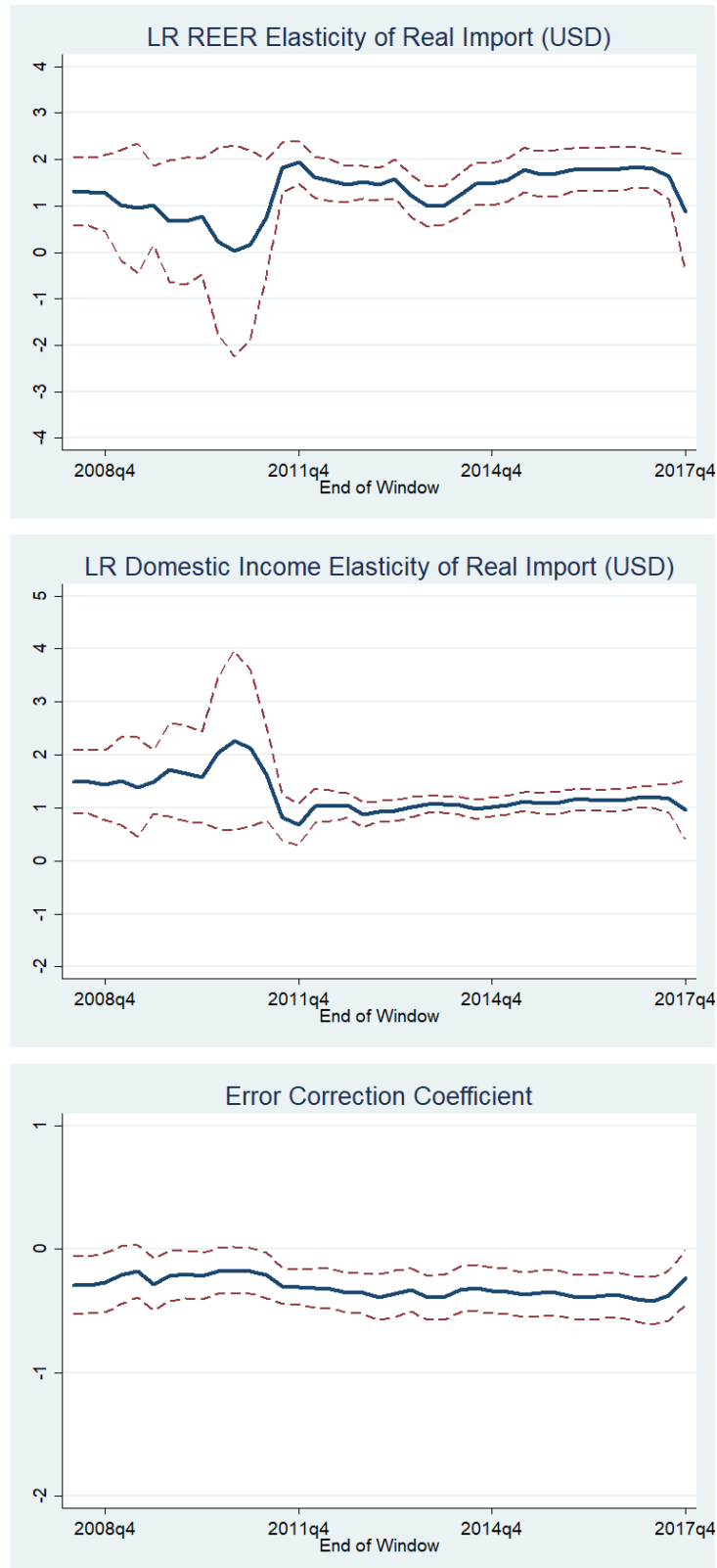
Notes: Plotted are the Wald statistics for coefficient stability across two sub-samples, created by splitting the full sample at each point shown on the horizontal axis. The horizontal red line shows the 10 percent critical value with 7 degrees of freedom. The common lag structure used on all sub-samples is the one derived from full-sample ARDL specification.

Table 5. Long-Run Trade Elasticities of Real Imports (USD) with REER Interaction Term in ARDL Model

| | | In Real Imports (USD) |
|-------------------------|-------------------------------|-----------------------|
| Error-correction coeff. | | -0.64*** (0.06) |
| Long-run coeff. | In REER | 1.42*** (0.19) |
| | InREER × Dummy (pre-2008q3=1) | 0.24 (0.18) |
| | In Domestic Income | 1.07*** (0.07) |
| R^2 | | 0.99 |
| N | | 78 |
| Bounds test F-stat | | 32.68*** |
| B-G 1st order F-stat | | 0.06 |
| B-G 2nd order F-stat | | 0.91 |

Notes: The lag structure is selected automatically based on the AIC and BIC criteria for the model without interaction term. The Bounds Test F-statistic tests the null hypothesis of no long-run/cointegrating relationship. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The long-run specification includes a constant, which is omitted from the regression output.

Figure 9. Rolling Estimation of Long-Run Import Trade Elasticities and Error Correction Coefficient in ARDL Model



Notes: 42 quarter (around 10.5 years) rolling window. The horizontal axis shows the end period of the rolling window. Red lines indicate the 95 % confidence interval.

Taken together, the results from the estimation of the sub-sample ARDL regressions, the full sample ARDL regression with REER interaction term, and the NARDL regression suggest that the sign of the relationship between REER and imports is in line with theoretical priors, with the link having been more stable than that between REER and exports over 1998-2017. There is some evidence that the REER elasticity of real imports may be smaller in periods of REER depreciation. The size of the coefficient of around 1 is consistent with existing studies of exchange rate pass-through to import prices in Turkey, which report coefficients in the range of 0.8 to 1 (Bussière, Delle Chiaie, and Peltonen, 2014; Bussière, Gaulier, and Steingress, 2016; Gopinath, 2015).⁹ A high exchange rate pass-through to prices suggests a strong demand-pull effect for Turkish imports.

(b) Long-Run Income Elasticity and Speed of Adjustment of Imports

Table 4 also presents the estimates of the long-run domestic demand elasticity of real imports, which are statistically significant and larger than 1 in all sub-samples. The rolling estimates of the income elasticity of real imports remain broadly stable in the post-crisis period (Figure 9). Results from the full-sample ARDL model with REER interaction term point to a long-run domestic demand elasticity of real imports of around one in the full sample (Table 6). In contrast to the export regression, the long-run sensitivity of real imports to changes in income and the REER are of similar magnitudes.

In the ARDL models, the speed of adjustment of actual real imports to their fundamentals-consistent values in the long-run is lower than that of real exports. The post-crisis estimate of the error-correction coefficient suggests that around 1/4 of any misalignment between the actual and equilibrium real imports is corrected in each quarter (Table 4).

⁹The high exchange rate pass-through into import prices in Turkey could be explained by dollar dominance in trade invoicing (Gopinath, 2015). Only 3% of Turkish imports are invoiced in Lira.

Table 6. Long-Run Trade Elasticities of Real Imports (USD) in NARDL Model

| Var. | Coeff. | F-statistics | P-value |
|---------------------------|----------|--------------|---------|
| $\ln REER^+$ | 1.409*** | 102.4 | 0.000 |
| $\ln REER^-$ | 1.151*** | 34.95 | 0.000 |
| In Domestic Income (Lira) | 0.642*** | 12.970 | 0.001 |
| R^2 | | 0.909 | |
| F_{PSS} | | 3.148*** | |
| W_{LR} | | 0.258*** | |
| B-G 1st order F-stat | | 0.20 | |
| B-G 2nd order F-stat | | 0.61 | |

Notes: $\ln REER^+$ and $\ln REER^-$ denote the partial sum process of positive and negative changes of $\ln REER$ and we report the long-run coefficients of $\ln REER^+$ and $\ln REER^-$ here. The preferred specification is selected starting with 4 lags for all variables and dropping the variables with insignificant coefficients. F_{PSS} is the PSS F-statistic for the existence of an asymmetric (cointegrating) long-run relationship in the NARDL model. W_{LR} refers to the Wald test of long-run symmetry ($\ln REER^+ = \ln REER^-$) and p-value is in the bracket. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. ***p<0.01, **p<0.05, *p<0.1.

(c) Specification Tests

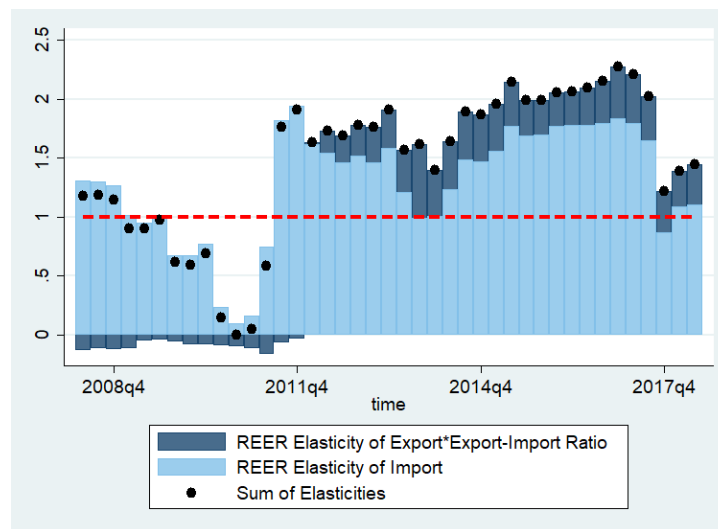
The estimated ARDL regressions pass the specification tests of no residual autocorrelation and the existence of long-run cointegrating relationship, based on the reported Breusch-Godfrey Lagrange multiplier and Bounds Test F-statistics respectively (Tables 4 and 5). The high R-squares of the ARDL and NARDL models suggest that they fit well the underlying data process. Rolling estimation of the error-correction and long-run elasticities coefficients point to the relative stability of the estimated domestic demand for imports (Figure 9). Our findings are robust to an alternative specification of real imports that nets out energy and gold (Appendix A).

V. ROLE OF REER IN TRADE BALANCE ADJUSTMENT

In the preceding section, we analyzed the trade elasticities of real exports and imports separately. The overall effect of the REER on the real trade balance can, then, be derived from the Marshall-Lerner condition (Equation (9)), which abstracts from the effect of the domestic-foreign income growth differential (Section II).

Figure 10 plots the Marshall-Lerner condition, derived from the rolling window estimation of REER elasticities (Figures 6 and 9). Results show that the REER depreciation, taken on its own, has had a positive impact on the real trade balance once data from late-2011 onwards is included in the sample. This is around the time when the long-run REER depreciation intensified to over 2% per year (Figure 7). Whereas the associated export expansion has since contributed to the narrowing of the real trade balance, import compression through its price elasticity has remained a dominant factor.

Figure 10. Rolling Estimation of Marshall-Lerner Condition, 1998-2017



Notes: Estimates of REER elasticities are obtained from 42 quarter (around 10.5 years) rolling window. The horizontal axis shows the end period of the rolling window. The dashed red line shows the Marshall-Lerner Condition $\alpha\eta^X + \eta^M > 1$. $\alpha = \frac{X}{M}$ is estimated for each quarter and then averaged over the rolling window.

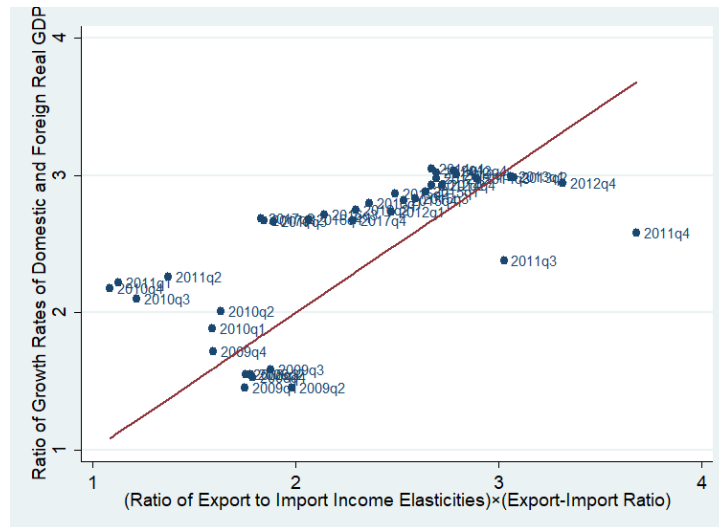
The dynamics of the Marshall-Lerner condition in the secular depreciation period can be interpreted as reflecting the J-curve effect (Magee (1973)).¹⁰ Between 2009 and mid-2011, the Marshall-Lerner condition is not met, suggesting that the Lira devaluation is likely to have initially worsened the real trade balance (Figure 10).

Despite the positive contribution of the REER to the narrowing of the real trade balance in Turkey, its post-2008 improvement has fallen short of its deterioration in the years prior to the global financial crisis (Figure 2, right panel). The reason for this is that, throughout much

¹⁰In the economic literature, the J-curve effect is often attributed to rigidities (e.g., non-negotiable, pre-existing trade contracts) preventing the adjustment in volumes of imports and exports in the short-run, whereas in the long-run prices adjust and the real trade deficit improves.

of the period, the domestic-foreign income growth differential has contributed to the widening of the real trade balance, partly offsetting the REER effect. This can be seen in Figure 11, which shows that the ratio of domestic to foreign income growth rates has exceeded the appropriately scaled ratio of income elasticities of exports and imports in most rolling sub-samples.

Figure 11. Rolling Estimation of Contribution of Domestic-Foreign Income Growth Differential to Real Trade Balance Adjustment



Notes: Estimates of income elasticities are obtained from 42 quarter (around 10.5 years) rolling window. The date labels show the end period of each rolling window. Values below the 45-degree line indicate that domestic-foreign income growth differential would contribute to the narrowing of the real trade balance (Equation (10)). Export-to-import ratio is calculated for each quarter and then averaged over the rolling window. The growth rates of domestic and foreign income are the quarter-on-same quarter of previous year averaged over the rolling window.

VI. SUMMARY OF FINDINGS

In this paper, we revisit the question of the main drivers of real trade balance adjustment in Turkey, posed in the broader debate on the role of exchange rates in restoring external balance in the post-2008 period. Compared to existing studies on the topic, we use sufficient number of quarterly observations to draw inferences about developments before and after the global financial crisis. In our analysis, we systematically use a complementary set of econometric techniques that allow us to detect and control for structural breaks in the data.

We find that the REER has been an important determinant of real trade balances throughout the period 1998-2017. In the secular period of REER appreciation through 2008:Q3, the transmission channel operated mainly through the boost to imports from Turkey's higher purchasing power in terms of foreign goods baskets. Over the same period, exports continued to thrive, consistent with the REER appreciation being predominantly driven by a positive TFP differential with trade partners. In the post-crisis period of REER depreciation, the transmission channel has operated through both export promotion and import compression through their price elasticities, as the REER depreciation appears to have overshoot the slightly negative TFP growth in the post-2006 period. The presented evidence of a structural break in the REER elasticity of real exports—linked to the switch of the long-run trend of the REER from appreciation to depreciation toward the end of 2008—is a novel finding in the literature.

Whereas the real trade balance does respond to REER movements, its post-2008 improvement has fallen short of retracing its preceding deterioration. This underscores the important role played by the domestic-foreign income growth differential in driving trade flows. The pattern of higher income elasticity of exports than that of imports remains a feature of the post-2008 data, but its potentially positive effect on the real trade balance has been more than offset by the post-crisis widening of the domestic-foreign income growth differential, driven by rapid private sector credit growth and stepped up public-private partnerships (PPP) activity (IMF, 2018).

In addition to the sluggishness of the real trade balance adjustment, we document the opening of a wedge between the nominal current account-to-GDP and the real trade balance-to-GDP ratios that started in the mid-2010. The reasons why the real trade balance is no longer the dominant driver of the nominal current account in Turkey warrant a separate study. One possible explanation is that this is a reflection of low even negative total factor productivity growth in recent years (IMF, 2018). This, alongside pressures from rising corporate external debt rollover needs, could have pushed the rate of depreciation of the Lira-USD exchange rate above the rate of growth of the GDP deflator, opening a wedge between real and nominal ratios. Another likely culprit is the widening country risk premium in recent years, which has led to a deterioration of the income balance.

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APPENDIX A. MODELING TRADE FLOWS NET OF ENERGY AND GOLD

Energy and gold are often excluded from the analysis of trade flows in Turkey, as they are known to be relatively inelastic with respect to both income and the REER, and gold trade is subject to extraordinary factors (see for example (Aldan, Bozok, and Gunay, 2015), (Çulha and Kalafatçılar, 2014), and (Bozok, Dogan, and Yunculer, 2015)).

As a robustness check, we re-estimate our regressions for real exports, imports, and the trade balance after netting out trade in gold and energy. Regression results show that our findings in the main body of the paper are not driven by idiosyncratic shocks on gold and energy flows.

Table A1. Long-Run Trade Elasticities of Real Exports Net of Energy and Gold (Lira) in ARDL Model

| | | 1998q1-2017q4 | 1998q1-2008q2 | 2008q1-2017q4 |
|-------------------------|-------------------|--------------------|--------------------|--------------------|
| Error-correction coeff. | | -0.44*** (0.09) | -0.76*** (0.14) | -0.36*** (0.13) |
| Long-run coeff. | ln REER | 0.00 (0.10) | 0.07 (0.10) | -0.48 (0.45) |
| | ln Foreign Income | 3.00*** (0.11) | 2.83*** (0.19) | 2.38*** (0.70) |
| R^2 | | 0.98 | 0.97 | 0.94 |
| N | | 76 | 38 | 40 |
| Bounds Test F-stat | | 7.66*** | 10.39*** | 2.95* |
| B-G 1st Order F-stat | | 0.09 | 0.00 | 0.08 |
| B-G 2nd Order F-stat | | 0.42 | 2.07 | 0.83 |

Notes: The lag structure is selected automatically based on the AIC and BIC criteria. The Bounds Test F-statistic tests the null hypothesis of no long-run/cointegrating relationship. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. ***p<0.01, **p<0.05, *p<0.1. The long-run specification includes a constant, which is omitted from the regression output. The R^2 reported in the table are estimated from the ARDL specification in levels.

As expected, the demand for imports net of gold and energy is much more sensitive to REER changes than the total import demand (Tables 4 and A2). The income elasticities of total imports and its subset are not, however, significantly different. Importantly, misalignments between actual and fundamentals-consistent real, non-gold, non-energy imports are closed up to 3 times faster than those for total imports.

Table A2. Long-Run Trade Elasticities of Real Imports Net of Energy and Gold (USD) in ARDL Model

| | | 1998q1-2017q4 | 1998q1-2008q2 | 2008q3-2017q4 |
|-------------------------|--------------------|--------------------|-------------------|--------------------|
| Error-correction coeff. | | -0.29*** (0.08) | -0.27** (0.13) | -0.86*** (0.08) |
| Long-run coeff. | ln REER | 1.77*** (0.18) | 1.94*** (0.52) | 1.49*** (0.17) |
| | ln Domestic Income | 1.21*** (0.07) | 1.31*** (0.44) | 1.07*** (0.09) |
| R^2 | | 0.99 | 0.99 | 0.94 |
| N | | 76 | 39 | 38 |
| Bounds Test F-stat | | 5.41*** | 1.74*** | 40.01*** |
| B-G 1st Order F-stat | | 1.13 | 1.06 | 0.09 |
| B-G 2nd Order F-stat | | 2.29 | 1.02 | 0.42 |

Notes: The lag structure is selected automatically based on the AIC and BIC criteria. The Bounds Test F-statistic tests the null hypothesis of no long-run/cointegrating relationship. The Breusch-Godfrey LM statistic tests the null hypothesis of no residual autocorrelation at a given lag. ***p<0.01, **p<0.05, *p<0.1. The long-run specification includes a constant, which is omitted from the regression output. The R^2 reported in the table are estimated from the ARDL specification in levels.

APPENDIX B. DATA SOURCES

B.1. Construction of Trade-Weighted Indexes of Relative Prices and Foreign Income

CBRT published data on the consumption-based real effective exchange rate (CPI-based REER) starting in 2003. In this paper, we backcast the pre-2003 levels of the CPI-based REER, in such a way that the quarter-on same quarter of previous year gross growth rates are given by:

$$REER_t = REER_{t-4} \prod_{i=1}^N \left[\frac{\frac{CPI_{t,TUR}}{CPI_{t,i} \times e_{t,i}}}{\frac{CPI_{t-4,TUR}}{CPI_{t-4,i} \times e_{t-4,i}}} \right]^{w_i},$$

$e_{t,i}$ — nominal bilateral exchange rate with country i at time t , defined as Turkish Liras per one unit of foreign currency,

$CPI_{t,i}$ — consumer price index in country i at time t and $CPI_{t,TUR}$ is the CPI in Turkey,

$i = 1, \dots, N$ — top 20 trade partners for both imports and exports to/from Turkey: Germany, United Kingdom, Iraq, Italy, USA, France, UAE, Spain, Iran, Netherlands, Saudi

Arabia, Israel, Egypt, Switzerland, Romania, Poland, Belgium, Bulgaria, China, Algeria. Russia is not included in the list despite being the biggest source of imports to Turkey, because trade is mostly in energy. Energy prices are quoted in US dollars on international markets, so trade flows are little affected by the relative prices and incomes in Turkey and Russia,

w_i — the weights are given by the combined shares of the top 20 partners in Turkey's exports and imports averaged over a ten-year period 2007-17. Directions of trade data is from Turkey's Statistical Institute (TurkStat).

The bilateral exchange rates of the Turkish Lira vis-a-vis the currencies of trade partners other than the US are obtained from the respective US dollar cross-rates. The source data for the CPI and real GDP series are local currency-based and seasonally adjusted.

Before constructing the index of foreign income, we transform the real GDP series of trade partners in their local currencies to a common base year 2009.¹¹ We then convert all series into constant 2009 US dollars, by dividing the local currency real GDP of each trade partner by the respective average nominal exchange rate vis-a-vis the US dollar (defined as local currency units per one US dollar) in 2009. The trade-weighted index of foreign GDP is then calculated as the weighted average.¹²

For trade partners for which CPI and/or GDP data are not available on quarterly basis, we map IMF World Economic Outlook (WEO) annual data into quarterly values, by assuming zero quarter-on-quarter growth rates within each year. We use the following sources for quarterly data:

Iraq

| series | start | end | source | concept |
|--------|--------|--------|------------------------------------------|----------------------------|
| CPI | 2015q1 | 2017q1 | Central Statistical Organization of Iraq | Consumer Prices, all items |
| RGDP | 2009q1 | 2016q2 | Central Statistical Organization of Iraq | Real Gross Value Added |

United Arab Emirates(UAE)

| series | start | end | source | concept |
|--------|--------|--------|-------------------------------|--------------------------------|
| CPI | 2008q1 | 2017q1 | National Bureau of Statistics | Consumer Prices, all items |
| RGDP | 1998 | 2016 | Ministry of Economy | Gross Domestic Product, Annual |

¹¹2009 is the base year for the chain-indexed, real GDP data for Turkey.

¹²We use algebraic mean, because in contrast to REER, the real GDP series are expressed in common units and are comparable across countries of trade partners' real GDP (in constant 2009 US dollars).

Iran

| series | start | end | source | concept |
|--------|--------|--------|----------------------------------------------|----------------------------|
| CPI | 1998q1 | 2017q1 | Central Bank of the Islamic Republic of Iran | Consumer Prices, all items |
| RGDP | 2004q1 | 2017q1 | Central Bank of the Islamic Republic of Iran | Gross Domestic Product |

Saudi Arabia

| series | start | end | source | concept |
|--------|--------|--------|----------------------------------|----------------------------|
| CPI | 1998q1 | 2017q1 | General Authority for Statistics | Consumer Prices, all items |
| RGDP | 2010q1 | 2017q1 | General Authority for Statistics | Gross Value Added |

Egypt

| series | start | end | source | concept |
|--------|--------|--------|--------------------------------------------------|----------------------------|
| CPI | 1998q1 | 2017q1 | Central Agency for Public Mobilization and Stats | Consumer Prices, all items |
| RGDP | 2006q3 | 2017q1 | Central bank of Egypt | GDP by Expenditure |

Algeria

| series | start | end | source | concept |
|--------|--------|--------|-----------------------------------------------|----------------------------|
| CPI | 2005q1 | 2017q1 | Office National des Statistiques de l'Algerie | Consumer Prices, all items |
| RGDP | 1999q1 | 2017q1 | Office National des Statistiques de l'Algerie | Gross Domestic Production |

B.2. Real Exports and Imports Series

Turkey's real exports and imports data are from Turkey Statistical Institute. The original exports and imports data are in chain-linked Turkish Lira (reference year = 2009)(i.e., expressed in domestic consumer goods baskets) and include both goods and services. In the paper, we use exports data in Lira and imports data in USD. We transform the real imports data from Lira to USD using the identity:

$$M = \tilde{M}/Q'$$

M — real imports in chain-linked Turkish Lira (reference year = 2009) (i.e., expressed in domestic consumer goods baskets),

\tilde{M} — real imports in foreign currency (i.e., expressed in foreign consumer goods baskets),

Q' — CPI-based real effective exchange rate(REER).

We construct measures of the real trade balance excluding gold and energy, by first constructing series for real exports and imports of these commodities. Nominal amounts in US dollars are available from Turkey Statistical Institute trade data. We convert them to chain-linked US dollars by using Fund staff estimates of the respective deflators.