The Relationship between REER and Trade Flows in the Context of the Equilibrium Exchange Rate

Reimo Juks*

November 2003

The paper focuses on the time-series analysis of the traditional trade equations. The results from the cointegration, ARDL and Granger causality analyses of trade elasticities cast some doubt on the usefulness of the internal-external balance approach to the equilibrium exchange rate. The long-run impact of the REER on trade flows turned out to be statistically insignificant, being independent of method and specification of the model employed. The latter implies a secondary role for the REER in achieving a sustainable position of external balance.

Author's email address: c02jur01@student.ceu.hu

* The paper was undertaken in Eesti Pank, where the author was a visiting researcher for 2 months participating in the project of Equilibrium Exchange Rate of the Estonian kroon. The author would like to thank other participants Marit Hinnosaar, Hannes Kaadu, Lenno Uusküla and Martti Randveer for their valuable comments and suggestions.

Contents

1. Introduction 3
2. Estimation Technique and Data 4
3. Empirical Results 5
3.1. Stationarity Analysis 5
3.2. Cointegration Analysis 7
4. Alternative Specifications of Import and Export Demand Functions 11
5. Granger Causality Analysis 13
Conclusions 15
References 16
Appendix 1. Import and export demand variables 17
Appendix 2. The comparison of three different measures of exports and imports 18
Appendix 3. The results of ARDL model of import and export demand 19

1. Introduction

A method frequently used to define and derive the equilibrium exchange rate relies on the macroeconomic or internal-external balance framework. The latter includes the concepts of the Fundamental Equilibrium Exchange Rates (FEER) originated by Williamson (1984, 1994), the Desired Equilibrium Exchange Rate (DEER), the IMF version of the Internal-External Balance and the Natural Real Exchange Rate (NATREX) proposed by Stein (1994, 1999). While all these concepts differ from each other in some respect, they also have a lot in common.

One of the main characteristics common to all these concepts is the assumption concerning the responsiveness of trade flows to the real exchange rate. The latter is seen as a means for achieving the desired or sustainable level of external balance. As an illustration, consider the different steps in the calculation of equilibrium exchange rates using the typical internal-external balance framework:

1) estimate the trade model to calculate the current account position that would emerge under the prevailing market exchange rates if domestic and foreign countries were operating at potential output;
2) estimate or specify the normal or sustainable position of the external balance;
3) calculate how much the exchange rate would have to change to balance the underlying current account with the sustainable level of external balance.

Clearly, if the exchange rate does not have the potential to explain trade flows, this framework is of little help. Thus, the first step in this analysis is to obtain valid statistically significant trade elasticities, that is, real exchange rate and income elasticities of the demand for exports and imports. These estimates can be obtained directly from a time-series analysis of the standard trade equations. Despite the difficulties at the theoretical and empirical levels of this analysis, empirical studies in this area have a relatively long record. Therefore, in some cases it is possible to rely on the previous estimates of these trade elasticities.

However, there is also a group of countries without any valid historical estimates of trade elasticities. In Estonia, the length and quality of the available time-series data have set clear constraints on the scope of empirical studies.

Despite the limits set by the data, this paper seeks to contribute to the empirical literature on Estonia. The main task of the study is to determine the long-run relationship between the real exchange rate and trade flows. As already noted, a meaningful relationship between the real exchange rate and trade flows is required for the implementation of the internal-external balance approach. Therefore, this study can shed some light on the usefulness of the aforementioned approach in the case of Estonia.

A time-series analysis is used to explore the long-run relationship between trade flows and the real exchange rate. As a first step, the stationarity analysis is carried out for the variables entering the trade equations. Next, the cointegration analysis is applied to obtain the long-run estimates of import-export equations. In addition, the stability and adjustment speed of the long-run relationship are tested employing error-correction models for the trade equations. To address some of the critique emerging from the literature, two alternative specifications of traditional demand models are also considered. The first extends the traditional analysis by including the FDI stock into the export demand equation. The second dismisses cointegration and considers the stationary autoregressive distributed lag (ARDL) approach to trade equations. Finally, the Granger causality analysis is employed to explore the short-term relationship between the REER and trade flows.

2. Estimation Technique and Data

The standard import and export equations in the log-linear specification are estimated using the cointegration framework. The Johansen cointegration vectors are estimated and later normalised with respect to the first variables in the following way:

(1) $\alpha \, log(X) + \beta \, log(FY) + \gamma \, log(REER)$

(2) $a \, log(M) + b \, log(Y) + c \, log(REER)$

where X and M denote real exports and imports; Y and FY are domestic real GDP and the index of real GDP growth of the 9 major trading partners; *REER* is the real effective exchange rate expressed in the price of foreign currencies. These two equations stem directly from conventional demand theory, where the trade quantity demanded is a function of the level of income in the host region and some measure of the competitiveness, often expressed as the ratio of the goods' own price to the price of substitutes. For the purpose of this paper, REER is used as a measure of competitiveness. The CPI and PPI based REER indices are used to obtain the best proxy for the competitiveness of exports and imports.

In addition, the analysis is carried out employing different measures of exports and imports. Starting from the most general definition, trade flows are classified as: 1) goods and services, 2) goods according to the general trade system and 3) goods according to the normal trade system. The reason for this classification stems from the hypothesis that price and income elasticities can significantly differ across different groups of exports and imports. Moreover, it is believed that the potential of the real exchange rate to explain changes in trade flows decreases with the degree of generality in the definition of trade flows.

The cointegration analysis provides a natural way to obtain a valid long-run relationship between the variables of interest. The key idea behind this analysis is that if there is an equilibrium relationship, the deviation from the equilibrium must be temporary. Thus, the cointegration analysis seeks stationary linear combinations of variables. In this paper two alternative cointegration approaches are considered: 1) the Johansen cointegration technique and 2) the two-step Engle-Granger method. The latter is believed to have some disadvantages over the former (see eg Enders, 1995). However, in the context of a short sample period, neither of the two options tends to yield better results (see eg Baffes, 1997). Therefore, in addition to the Johansen cointegration analysis, the results of the Engle-Granger approach are presented to add some weight to the final conclusions.

The estimation of the log-linear demand equations using cointegration is a standard way to model long run trade elasticities. However, this approach has also received a lot of criticism. One line of criticism claims that the standard demand equation does not take into account supply factors, not to mention the changes in variety and quality of goods (Driver and Wren-Lewis, 1999). The solution is to include some proxy for the supply and quality factors. In this study, the standard framework is extended and the FDI stock variable is included into the export equation to control for the innovation and quality change of exports.

The second line of criticism argues that the log-linear specification in levels is unable to identify price and income elasticities, yielding unreliable results (Marquez, 1999). The proposed solution to the problem is to use variables in first difference rather than in levels[1]. This approach is followed here by modelling the growth rate of traditional export-import variables using autoregressive distributed lag (ARDL) models.

The analysis is based on quarterly data from 1995 Q1 to 2003 Q1. An exception is the PPI index, which is available up to the last quarter of 2002. The data on Estonia is taken from the Statistical Office of Estonia and Eesti Pank. The GDP measures of the main trading partners are from the EcoWin database.

3. Empirical Results

3.1. Stationarity Analysis

The integration order of all the variables in the trade equations is determined employing the augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests. All the variables, with the exception of the real exchange rate and FDI stock, were seasonally adjusted before performing unit root tests. In addition, as trade equations are estimated in the traditional log-linear specification, unit root tests are applied to the logarithmic form of the variables[2].

Before presenting the results of the formal unit root tests, it is useful to start with a graphical inspection of the variables (see Appendices 1 and 2). All the series exhibit an upward trend suggesting that each of the variables could be (a) trend-stationary, (b) random walk with a drift or (c) random walk with a drift and linear time trend. In addition, the jump in the REER in the second quarter of 1998 indicates the possibility of a structural change. This jump in the REER is mainly due to the devaluation of the Russian rouble followed by accelerating inflation. Taking into account the length of the

[1] However, the analysis with data in first difference may loose some valuable long-term information. In this respect, the results obtained are less reliable than those from the cointegration analysis.
[2] The only exception is the FDI stock variable, which is used later in the further analysis.

underlying time series and complications involved in the formal testing of structural changes, the following unit root tests are carried out assuming the presence of no structural change. Clearly, the results obtained are conditional on this premise.

Table 1. The results of the ADF and PP unit root tests

Augmented Dickey-Fuller unit root test								
Series name	Series level	Determ terms	Lags	t-statistics	Series level	Determ. terms	Lags	t-statistics
L(IMP)	0	2	1	-3.315*	1	1	0	-3.310**
L(IMP_gds)	0	2	2	-3.161	1	1	0	-3.778***
L(IMP_gds_n)	0	2	1	-2.668	1	1	0	-4.168***
L(GDP)	0	2	2	-3.474*	1	1	0	-6.353***
L(EXP)	0	2	2	-3.008	1	1	0	-4.181***
L(EXP_gds)	0	2	2	-2.505	1	1	3	-3.266**
L(EXP_gds_n)	0	2	3	-3.134	1	1	3	-3.109**
L(FGDP)	0	2	0	-0.884	1	1	0	-4.866***
FDI stock	0	2	0	-2.363	1	1	1	-5.249***
L(REER_CPI)	0	1	0	-2.057	1	0	0	-5.063***
L(REER_PPI)	0	1	1	-1.725	1	0	0	-4.217***
The Phillips-Perron unit root test								
Series name	Series level	Determ terms	Bandwidth	t-statistics	Series level	Determ. terms	Band-width	t-statistics
L(IMP)	0	2	2	-2.260	1	1	0	-3.310**
L(IMP_gds)	0	2	2	-1.780	1	1	1	-3.746***
L(IMP_gds_n)	0	2	2	-1.860	1	1	2	-4.255***
L(GDP)	0	2	0	-2.305	1	1	0	-6.353***
L(EXP)	0	2	0	-1.371	1	1	4	-4.163**
L(EXP_gds)	0	2	2	-1.384	1	1	1	-3.360**
L(EXP_gds_n)	0	2	3	-2.058	1	1	2	-5.582**
L(FGDP)	0	2	3	-1.258	1	1	3	-4.932***
FDI stock	0	2	4	-2.290	1	1	0	-5.250***
L(REER_CPI)	0	1	2	-2.066	1	0	1	-5.073***
L(REER_PPI)	0	1	1	-1.397	1	0	0	-4.217***

Notes to ADF: Series level: 0 - level, 1- first difference; Deterministic terms: 0 – no constant and trend, 1 – constant, 2 – constant and trend; Number of lags is selected by Schwartz Info criterion (SIC) taking the number of maximum lags equal with 8. The null hypothesis is that the series contains a unit root. 1%, 5% and 10% levels of significance are indicated by ***, ** and * respectively.
Notes to PP: Series level: 0 - level, 1- first difference; Deterministic terms: 0 – no constant and trend, 1 – constant, 2 – constant and trend; PP is estimated using Newey-West bandwidth and Bartlett kerner spectral estimation method. The null hypothesis is that the series contains a unit root.

The results of the ADF and PP tests are presented in Table 1. It can be concluded that all the variables, except GDP and total imports (IMP), are clearly integrated of order 1. A little caution is needed with respect to the GDP and IMP variables, as the tests yield different results. The ADF suggests that the underlying variables are trend stationary at 10% level of significance, but difference stationary at 5% level of significance. However, as the PP test[3] implies the presence of a unit root at the conventional levels of significance, the variables are treated as I(1).

3.2. Cointegration Analysis

To estimate the long-run relationship between trade flows and REER, the Johansen cointegration technique is employed below. For a comparison, the results of the Engle-Granger method are presented afterwards.

The general estimation strategy behind the Johansen cointegration technique is as follows. First, the lag length and form of the cointegration equation (CE) are determined. The suitable lag length is chosen as follows. The VAR of undifferenced data is estimated and the lag length tests based on various information criteria (LR, AIC, SIC) are carried out. From the results obtained, the smallest number of lags[4] satisfying the Jarques-Bera normality and LM autocorrelation tests at 5% level is selected to be the most suitable lag length. The latter is denoted by (*). As for the CE, the constant term is included to the CE and VAR to capture the linear deterministic trend in the data (see ADF and PP tests)[5].

Second, the number of cointegration vectors or rank is tested using the trace and maximum eigenvalue statistics. The first statistic is based on the sum of r eigenvalues, while the second statistic relies on the significance of the i^{th} eigenvalue. Obviously, these tests can give conflicting results at any level of significance. As a solution, the results of the trace test are preferred[6]. In addition, there might be more than one cointegration vector. Some papers (eg Baffes, 1997) compute the short sample adjusted critical values proposed by Cheung and Lai (1993) to solve the problem. This approach is followed here whenever necessary.

Third, the normalised cointegration vectors are presented and the stability of the long-run relationship is explored by estimating an error correction model (ECM). The negative sign of the adjustment coefficients obtained for ECM is required for the model to be

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[3] Unlike the ADF test, PP does not require errors to be statistically independent and homoscedastic (Enders, 1995). In this respect, the results of the PP test are more reliable than those obtained from the ADF test.

[4] As the length of the sample is short (only 33 observations), the increase in the number of lags reduces the degrees of freedom significantly, causing potential problems in hypothesis testing. Therefore, it is reasonable to select the smallest number of lags satisfying certain criteria.

[5] The alternative option is to add a constant and a linear trend. Some papers (eg Anderton, 1991) argue that the inclusion of a time trend is required to obtain any meaningful results. However, adding a time trend in the long-run relationship does not have any theoretical justification. An acceptable solution is to include an upward trending variable, which also has an economic interpretation. This approach is considered later when the basic framework is modified and extended.

[6] According to Pantula (1989) and Johansen (1994), the trace test has some advantages over the max eigenvalue test.

stable. Finally, J-B normality and LM autocorrelation tests are carried out to explore the robustness of the equilibrium relation in ECM.

Before presenting the results, an additional explanation is required. All the different steps in the cointegration analysis are conditional on the previous steps. For instance, the third step makes sense only if there is a significant long-run relationship identified in the second step; the second step, in turn, is conditional on the correct form of the model specified in the first step. Therefore, presenting the entire modelling process provides further insights into the sensitivity of the results to small changes in the baseline specification. The latter is especially relevant in small samples, where the reliability of the results in general and the robustness of the results more specifically tend to have clear limitations.

Starting with the import equation, all the results of different specifications are presented in Table 2. To illustrate the results and the logic of the Table, consider the first model of import demand based on REER_CPI and total import of goods and services. This model has one lag suggested by Schwartz information criteria. The trace and max statistics indicate no cointegration vector at 1 and 5% levels of significance. The presented insignificant cointegration vector implies a price elasticity of 0.66% and income elasticity of 1.62% of the demand for total imports. The model has no autocorrelation and satisfies the normality assumption of the residuals at 5% level. The adjustment parameter from the ECM has a required negative sign and is significant at 5% level.

When considering the whole Table, it can be concluded that the models based on REER_CPI, as well as those based on REER_PPI indicate a clear lack of a significant long-run relationship based on the preferred lag length denoted by (*). More surprisingly, the main result of no cointegration does not differ across alternative measures of imports. In addition, the number of cointegration vectors as well as estimated trade elasticities tend to be highly sensitive to the number of lags. When only considering the subset of the significant cointegration vectors with a theoretically correct sign of at least one parameter[7], the price elasticity of demand for imports ranges from 1.2 to 22.6%, while income elasticity varies from 1.3 to 24%. The high sensitivity of the results is in sharp contrast with the standard range of income and price elasticities obtained from the studies of developed and developing countries.

[7] Requiring both parameters to be of correct sign, the number of cases falls to two, with income elasticity around 1.3% in both cases and price elasticity of 1.2 and 2%, respectively, in the first and second case.

Table 2. Cointegration of import demand equation

REER	Lags	Criteria	Coint. rank				Price elast.	Income elast.	Const	J-Bera (prob)	LM Auto-correlation	Adjust. param.
			Trace		Max							
			1	5	1	5						
Total import of goods and services												
CPI	1*	SIC	0	0	0	0	0.66	1.62	-9.50	0.44	No	-0.34**
	2	LR	1	2	0	2	10.54	-3.34	-7.70	0.13	No	-0.01
	3	AIC	1	2	0	2	1.25	1.30	-9.10	0.02	1st-order	-0.53**
PPI	1		0	0	0	0	2.27	1.19	-12.60	0.40	No	-0.09
	2*	ALL	0	0	0	0	3.14	1.06	-15.33	0.11	No	-0.09
	3		0	0	0	0	1.70	1.47	-12.79	0.02	No	-0.24*
Import of goods according to the general system												
CPI	1*	SIC	0	0	0	0	1.76	1.43	-6.11	0.42	1st-order	-0.18
	2	LR	0	1	0	1	16.20	-4.84	-13.13	0.16	No	-0.02
	3	AIC	2	2	2	2	-0.25	3.12	-2.55	0.06	No	-0.192**
PPI	1*	SIC	0	0	0	0	4.04	0.98	-11.92	0.34	1st-order	-0.07
	2	LR, AIC	0	0	0	0	13.12	-0.15	-42.80	0.16	No	-0.02
Import of goods according to the normal system												
CPI	1*	SIC	0	0	0	0	-7.97	5.56	-0.84	0.48	1st-order	-0.05
	2	LR	1	1	1	1	-50.90	23.87	23.32	0.22	No	-0.01
	3		1	2	2	2	-6.41	4.48	2.49	0.07	No	-0.12**
	4	AIC	1	1	1	1	1.99	1.37	7.01	0.00	No	-0.38
PPI	1*	SIC	0	0	0	0	2.00	1.72	-10.20	0.41	No	-0.05
	2	LR	1	2	1	2	22.59	-0.28	-85.93	0.09	No	0.01
	3	AIC	1	2	2	2	-15.70	3.21	57.21	0.07	No	-0.06**

Notes: The preferred lag length is denoted by (*). The lag length is chosen using Schwartz (SIC), Akaike (AIC) information criteria and sequentially modified LR test (LR).

The results of the cointegration analysis of the export demand function are presented in Table 3. Starting with models based on the preferred lag length, the analysis indicates that neither REER_CPI nor REER_PPI can explain changes in total exports of goods and services. The results change if more specific measures of trade flows are considered. Namely, there seems to be more than one cointegration vector in the case of REER_CPI and at most one in the case of REER_PPI. However, considering the short sample adjusted critical values according to Cheung and Lai (1993), the number of cointegration vectors is at most one in the first case and none in the second case. As the stability parameter of the existing cointegration vector is insignificant, the presence of cointegration can be rejected.

As for the parameter values, the income elasticity has a relatively stable magnitude and carries the correct sign in the majority of cases. However, the price elasticity of demand for exports consistently indicates an incorrect sign. That is, an appreciation of the REER results in a rise rather than a fall in exports. The latter casts some doubts on the results. Thus, it also seems reasonable to dismiss the presence of cointegration in the export demand equation.

Table 3. Cointegration of export demand equation

REER	Lags	Criteria	No of rank				Price elast.	Income elast.	Const	Normality J-Bera (prob)	Serial auto-correlation	Stab.
			Trace		Max							
			1	5	1	5						
Total exports of goods and services												
CPI	1*	LR, SIC	0	0	0	0	1.01	2.05	4.60	0.51	1st-order	-0.264*
	2		1	1	1	1	0.92	2.28	5.00	0.35	No	-0.500***
	3		1	2	0	1	1.03	1.98	4.50	0.12	1st-order	-0.297**
	4	AIC	1	3	1	1	1.11	1.89	4.10	0.01	No	-0.222
PPI	1*	SIC	0	0	0	0	0.67	3.04	6.19	0.70	1st-order	-0.247*
	2		1	1	1	1	0.33	3.27	7.75	0.45	No	-0.611***
	3		1	3	1	1	0.39	3.20	7.48	0.07	No	-0.537**
	4	LR, AIC	1	2	1	1	0.71	2.84	6.04	0.01	No	0.278
Exports of goods according to the general system												
CPI	1	SIC	0	0	0	0	6.96	-1.39	-16.70	0.58	1st-order	-0.059
	2*	LR	2	3	0	3	7.98	-1.99	-21.80	0.29	No	-0.094
	3	AIC	1	3	0	0	3.11	-8.66	2.49	0.09	No	-0.058**
PPI	1		0	0	0	0	2.72	4.16	3.09	0.70	No	-0.100
	2*	LR, SIC	0	1	0	0	1.84	4.88	7.10	0.33	No	-0.236**
	3	AIC	1	3	0	1	1.43	4.94	9.02	0.10	No	-0.274
Exports of goods according to the normal system												
CPI	1*	SIC	0	3	0	0	14.80	-6.41	-54.60	0.57	1st-order	0.018
	2		2	3	1	1	2.99	2.09	1.07	0.17	No	-0.170**
	3	LR	3	3	1	1	2.33	2.79	4.16	0.07	2nd-order	-0.390***
	4	AIC	3	3	3	3	1.03	4.57	10.20	0.00	No	0.223
PPI	1		0	0	0	0	7.50	0.79	-19.20	0.73	1st-order	0.008
	2*	SIC	1	1	1	1	1.73	3.60	7.20	0.18	No	-0.208***
	3		1	3	1	1	1.23	3.75	9.50	0.06	No	-0.604***
	4	LR, AIC	3	3	1	1	0.39	4.39	13.30	0.01	No	-0.292

To provide a comparison for the results of the Johansen cointegration technique, the results of the Engle-Granger method are presented below in Table 4. Although the estimated trade elasticities are at reasonable levels and carry the correct signs in most cases, the presence of cointegration is strongly rejected even at the 10% level of significance. As an upshot, the presence of a long-run relationship between REER and trade flows can be dismissed in the traditional demand equation set-up.

Table 4. Imports and exports according to the Engle-Granger method

REER	Price elast.	Income elast.	Const	ADF	REER	Price elast.	Income elast.	Const	ADF
Total Import of goods and services					**Total Export of goods and services**				
CPI	0.13	2.11	-11.78	-3.19	CPI	-0.57	4.01	11.90	-2.00
PPI	-0.01	2.19	-12.00	-2.05	PPI	-0.43	3.72	11.22	-2.61
Import of goods according to the general system					**Export of goods according to the general system**				
CPI	0.52	2.94	-15.17	-0.82	CPI	-0.44	6.16	17.60	-1.65
PPI	-0.28	3.39	-15.86	-1.47	PPI	-0.81	6.25	19.21	-1.63
Import of goods according to the normal system					**Export of goods according to the normal system**				
CPI	0.02	2.62	-9.93	-2.22	CPI	-0.50	4.88	17.44	-1.76
PPI	-0.39	2.74	-9.24	-1.75	PPI	-0.57	4.70	17.74	-2.14

Notes: * Critical value for the ADF at 10% level is –3.45, which is based on the asymptotic distribution and is taken from Maddala (1998).

4. Alternative Specifications of Import and Export Demand Functions

The cointegration analysis of the traditional demand curve was unable to establish any meaningful long-run relationship between the different measures of trade flows and the real exchange rate. This result could be explained on theoretical as well as on statistical grounds. The following section addresses some of the problems with the standard approach by modifying and extending earlier work.

Two main lines of criticism have emerged from the literature. The first one comes from the theoretical level arguing that the standard demand equation does not take into account supply factors, not to mention the changes in variety and quality of goods (Driver and Wren-Lewis, 1999). The remedy for these problems is not easily found. A frequently used solution is to include a proxy for the supply and quality factors in the demand equation. In this study, the FDI stock variable is included in the export equation to control for the innovation and quality change in exports.

The second criticism claims that the log-linear specification of the demand equation in levels is unable to identify price and income elasticities, although they are not absent (Marquez, 1999). The solution to this problem is to use variables in first differences rather than in levels. This approach is followed by modelling trade equations using the autoregressive distributed lag (ARDL) model.

Starting with the former, the results of the cointegration analysis with FDI stock are presented in Table 5. Unfortunately, no significant improvements in the results have emerged. Although the sign of the price elasticity of demand for exports is more often in line with the theory than it was before the inclusion of FDI stock, there is still no statistically significant cointegration vector. In addition, the sensitivity of the results to changes in the number of lags is still high. Looking at the subset of the significant cointegration vectors with a theoretically correct sign of at least one parameter[8], the price elasticity of demand for exports ranges from -0.07 to -8%, while the income elasticity differs from 1.6 to 19%.

Table 5. Cointegration of the export demand equation with FDI stock

REER	Lags	Criteria	Coint. rank				Price elast.	Income elast.	FDI stock	J-B (prob)	LM Auto-correlation	Adjust. param.
			Trace		Max							
			5	1	5	1						
Total exports of goods and services												
CPI	1	SIC*	0	0	0	0	-0.67	6.37	-8.0E-06	0.2204	No	-0.295
	2		2	1	2	1	-0.19	5.28	-6.4E-06	0.0627	No	-1.250***
	3	LR, AIC	4	3	4	0	-0.16	5.31	-6.4E-06	0.0041	No	-0.968
PPI	1	SIC, LR*	0	0	0	0	0.19	5.18	-6.4E-06	0.5708	1st-order	-0.296
	2		2	1	1	1	-0.07	5.01	- 6.0E-06	0.0843	No	-1.070***
	3		3	2	2	2	0.82	-3.47	2.21E-05	0.0031	2nd-order	-0.118*
	4	AIC	4	4	4	4	0.06	7.13	-1.4E-05	0.0002	1st-order	-0.030
Exports of goods according to the general system												
CPI	1	ALL*	0	0	0	0	-1.96	12.27	-1.80E-05	0.4020	No	-0.212
	2		2	1	0	0	-8.19	19.27	-2.4E-05	0.0807	No	0.068
PPI	1	SIC*	0	0	0	0	-2.12	11.7	-1.9E-05	0.4716	No	-0.122
	2	LR	2	0	0	0	-1.85	7.78	-6.4E-06	0.1071	No	-0.398
	3	AIC	4	2	1	1	11.0	-58.9	0.00022	0.0022	No	0.033
Exports of goods according to the normal system												
CPI	1	SIC*	0	0	0	0	10.5	0.79	-1.1E-05	0.6042	1st-order	0.034
	2		2	1	1	1	4.40	2.16	-3.37E-06	0.0323	No	-0.083
	3	LR	3	3	3	1	2.52	2.23	1.35E-06	0.0017	No	-0.440***
	4	AIC	3	3	3	3	14.5	-41.6	0.0001	0.0001	No	-0.057***
PPI	1	LR, SIC*	0	0	0	0	17.1	-7.00	-2.0E-05	0.6245	1st-order	0.009
	2		2	1	1	1	3.13	2.91	1.42E-06	0.0360	No	-0.110
	3		3	2	3	2	1.43	1.60	7.33E-06	0.0008	No	-0.476***
	4	AIC	4	3	4	1	-0.40	12.2	-2.4E-05	0.0001	No	0.032

Another failed attempt to identify significant trade elasticities gives rise to some doubts about the usefulness of cointegration analysis in the underlying work and signals a need for alternative methods. General practice before the elaboration of the cointegration framework was to transform the underlying nonstationary variables into stationary series and then proceed with the standard estimation and inference procedures. Although this approach could result in the loss of relevant long-term information, it has the virtue of simplicity. In light of the short time-series and the resulting problems in the cointegration analysis, this approach is worth considering. In the following, the "general to specific"

[8] Requiring both parameters to be with correct sign, the price elasticity is still in the same range, while the income elasticity ranges from 5 to 19%.

procedure to the stationary autoregressive distributed lag (ARDL) model of trade flows is employed[9].

As all the variables are I(1), the analysis is carried out with the data in first difference form. The results of the "general to specific" modelling of trade flows with a maximum lag of four are presented in Appendix 3. The results from the import demand equation indicate that the long-run elasticity of REER is either insignificant or carries a theoretically incorrect sign. The income elasticity of demand for imports lies in the range of 1–2.3% and is significant in most of the models. As a general conclusion, REER is unlikely to play an important role in the determination of long-term import flows.

The results for the export demand equation are more in line with theory. As expected, the explanatory power of REER is the highest in the case of the narrowest measure of exports. In this case, both trade elasticities are statistically significant and have correct signs. However, the magnitude of income elasticity is estimated to be over 4%, which is considered to be relatively high[10].

The remaining results are less satisfactory. As for total exports, price elasticity stays below 0.5%, while income elasticity is around 6–7%. Excluding services and considering only the export of goods increases the price and income elasticities to the corresponding levels of 1–1.5% and 10–11%. As a conclusion, while the estimation results provide some evidence in favour of the significant price elasticity of demand for exports, an unreasonably high income elasticity reduces the reliability of the results.

5. Granger Causality Analysis

The analysis above demonstrated that the long-run impact of REER on trade flows was statistically insignificant, being independent on the method and specification of the model employed. Yet, the latter does not rule out the possibility of the short-run relationship between REER and trade flows.

To find out whether REER has the power to have an impact on trade flows in the short run, the Granger causality test is employed. The idea behind this test is to check whether the changes in REER precede the changes in trade flows. For REER to Granger cause changes in trade flows, two conditions have to be satisfied: 1) REER should Granger cause trade flows; 2) trade flows should not Granger cause REER. The second condition is necessary to eliminate the possibility of a third factor simultaneously causing the changes in REER and trade flows.

[9] A general model is turned to the final model by sequentially imposing statistically insignificant restrictions on the last lags of all the right-hand-side variables. Thus, there might be some insignificant variables in the final model. While the latter results in the loss of efficiency, it helps to avoid data mining.

[10] The usual range for income elasticity is from 2.0 to 4.0% (Riedel, 1988). The unconventionally high income elasticity could be the result of the omitted variable bias. Given that a relevant supply side factor is missing and there is a positive correlation between the missing supply factor and income variable, the estimate of income elasticity is biased upwards.

An important point behind the Granger causality test is the stationarity assumption of the time series under consideration. The stationarity analysis above suggests that all the possible versions of REER as well as export and import equation variables are I(1). In this situation, the Granger causality test can be applied to the data in first difference given that the underlying nonstationary series are not cointegrated (Granger, 1988)[11]. As the earlier cointegration analysis implies no cointegration, the Granger causality test is applied to the first difference of the logarithm of the variables, ie to the growth rates of the underlying variables.

The results of the bivariate causality test[12] with two and four lags are presented below in Table 6. One can conclude that REER_PPI performs better than REER_CPI. More surprisingly, REER_PPI seems to have the potential to predict changes in the broadest and narrowest measure of exports and imports, but has no power to do so in the case of the intermediate measure. In addition, as the causality seems to run from the REER to the trade flows and not vice versa in most of the cases, the possibility of the common factor causing changes in the REER and trade flows seems unlikely.

Table 6. The bivariate causality test between REER and trade flows

Null Hypothesis: REER does not Granger cause Exports-Imports (F-test)					
	REER	**Imports**		**Exports**	
		2 lags	4 lags	2 lags	4 lags
Goods and services	CPI	**0.076**	0.289	0.181	0.217
	PPI	**0.018**	0.159	0.177	**0.071**
Goods	CPI	0.270	0.295	0.553	0.570
	PPI	0.159	0.235	0.605	0.550
Goods in normal trade	CPI	0.128	0.289	0.134	0.255
	PPI	**0.063**	0.269	**0.054**	**0.022**
Null Hypothesis: Exports-Imports does not Granger cause REER (F-test)					
	REER	**Imports**		**Exports**	
Goods and services	CPI	0.841	0.741	0.972	0.835
	PPI	0.906	0.562	0.878	0.513
Goods	CPI	0.911	0.756	0.965	0.536
	PPI	0.962	0.778	0.917	0.248
Goods in normal trade	CPI	0.891	0.565	0.671	**0.009**
	PPI	0.974	0.565	0.448	**0.027**

11 In the case of cointegration, an inclusion of the error correction term is required in the analysis of Granger causality.

12 The bivariate Granger causality test in the case of import and l lags is the following: $IMP_t = \alpha_0 + \alpha_1 IMP_{t-1} + ... + \alpha_l IMP_{t-l} + \beta_1 REER_{t-1} + ... + \beta_l REER_{t-l}$, where all the variables are expressed in growth rates. The null hypothesis that REER does not Granger cause IMP is the following: $\beta_1 + ... + \beta_l = 0$, which is tested using F-statistics.

To reduce the possibility of spurious causality due to the omission of other important variables, the relevant number of lags of income variables (GDP and FGDP) was included as explanatory variables to the Granger causality test. The results of this analysis are presented in Table 7. It can be concluded that REER_PPI still performs better than REER_CPI, confirming the results obtained from the bivariate Granger causality analysis. However, this conclusion is not robust as it is highly conditional on the lag length. Considering 4 lags in the import and 2 lags in the export equation, it can be concluded that no REER had impact on any measure of trade flows.

Table 7. The multivariate causality test between REER and trade flows

Null Hypothesis: REER does not Granger cause Exports-Imports (F-test)					
	REER	**Imports**		**Exports**	
		2 lags	4 lags	2 lags	4 lags
Goods and services	CPI	0.1070	0.4384	0.1261	0.1065
	PPI	**0.0200**	0.2685	0.1330	**0.0138**
Goods	CPI	0.2894	0.5578	0.4440	0.7316
	PPI	0.1564	0.2853	0.3169	0.6324
Goods in normal trade	CPI	0.2015	0.5228	0.2792	0.5472
	PPI	**0.0906**	0.3093	0.1110	**0.0399**
Null Hypothesis: Exports-Imports does not Granger cause REER (F-test)					
	REER	**Imports**		**Exports**	
Goods and services	CPI	0.6921	0.8841	0.6174	0.5389
	PPI	0.9891	0.7341	0.7237	0.4360
Goods	CPI	0.5887	0.9244	0.7387	0.8874
	PPI	0.7214	0.7247	0.7551	0.3494
Goods in normal trade	CPI	0.4998	0.8561	0.9903	**0.0362**
	PPI	0.8189	0.8702	0.9280	0.1286

Conclusions

The empirical results cast some doubt on the usefulness of the internal-external balance approach to the equilibrium exchange rate. As for various measures of imports, the Johansen as well as the Engle-Granger cointegration analysis indicated clear lack of long-run relationships between import flows and the REER. The results from the export demand function could not reject the existence of cointegration in some of the cases, but the incorrect sign of the price elasticity of demand for exports allowed to dismiss the results. In addition, further extensions and modifications suggested in the literature led to some improvements in the export demand equation, but did not change the main conclusion of the earlier findings. The Granger causality test found some support for the presence of the short-run effect of the REER_PPI on trade flows. Based on this empirical evidence, it can be concluded that there is a secondary role for REER in achieving a sustainable position of external balance.

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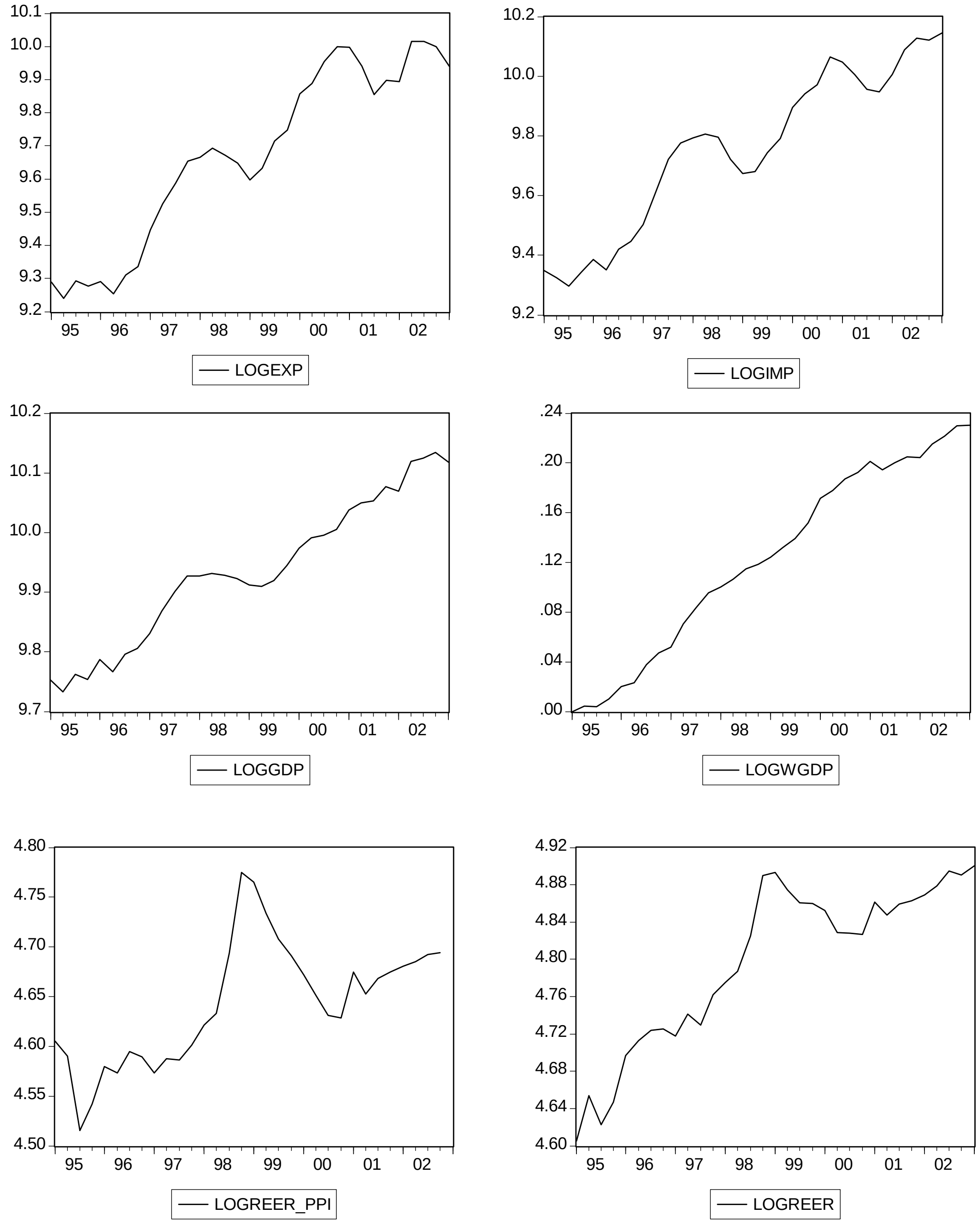
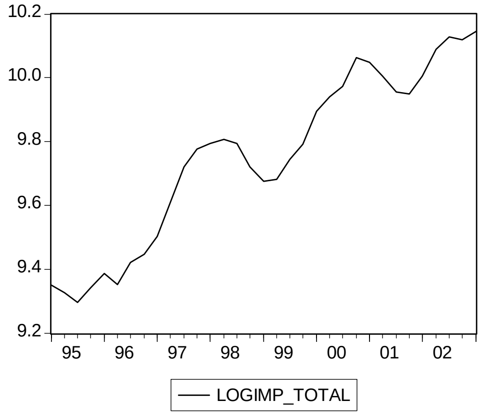
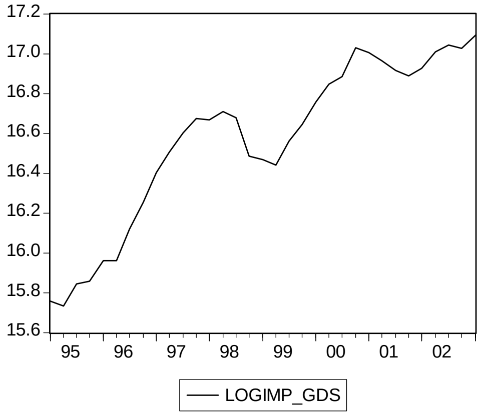
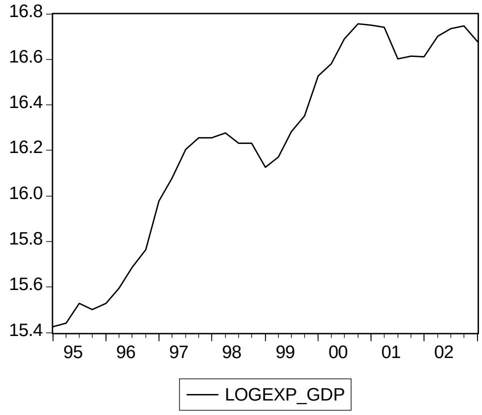
Appendix 1. Import and export demand variables

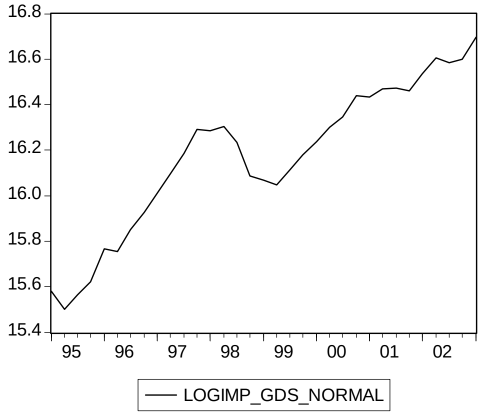


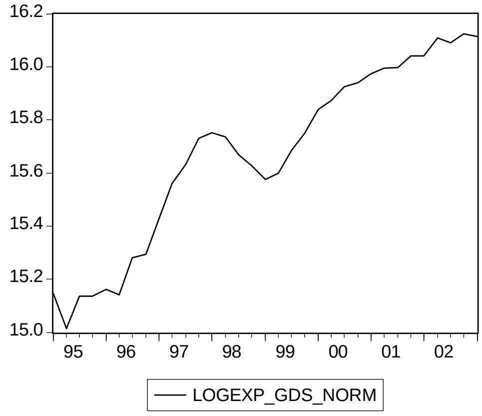
Appendix 2. The comparison of three different measures of exports and imports











Appendix 3. The results of ARDL model of import and export demand

The models with REER_CPI and three measures of imports								
Goods and services			Goods in the normal trade system			Goods in the general trade system		
Variables	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**
DLIMP(-1)	0.20	0.21	DLREER	-0.85	0.43	DLIMP_GDS(-1)	0.31	0.22
DLREER	-0.37	0.33	DLGDP	1.64	0.51	DLREER	-1.48	0.54
DLREER(-1)	-0.83	0.32	C	0.02	0.01	DLREER(-1)	-0.40	0.56
DLGDP	1.03	0.51				DLGDP	1.37	0.76
DLGDP(-1)	0.23	0.55				DLGDP(-1)	-0.65	0.85
C	0.02	0.01				C	0.04	0.02
Price elast	-1.50		**Price elast**	-0.85*		**Price elast**	-2.71*	
Income elast	1.58*		**Income elast**	1.64**		**Income elast**	1.03	
LM autocorr prob	0.99		LM autocorr prob	0.93		LM autocorr prob	0.32	
J-B normality prob	0.67		J-B normality prob	0.76		J-B normality prob	0.46	

The models with REER_PPI and three measures of imports								
Goods and services			Goods in the normal trade system			Goods in the general trade system		
Variables	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**
DLIMP(-1)	0.19	0.21	DLREER_PPI	-0.630	0.297	DLREER_PPI	-1.09	0.37
DLREER_PPI	-0.05	0.25	DLGDP	2.087	0.488	DLGDP	2.28	0.61
DLREER_PPI(-1)	-0.64	0.25	C	0.009	0.011	C	0.02	0.01
DLGDP	1.17	0.55						
DLGDP(-1)	0.42	0.55						
C	0.00	0.01						
Price elast	-0.85		**Price elast**	-0.63*		**Price elast**	-1.09**	
Income elast	1.95*		**Income elast**	2.09**		**Income elast**	2.28**	
LM autocorr prob	0.88		LM autocorr prob	0.92		LM autocorr prob	0.53	
J-B normality prob	0.62		J-B normality prob	0.86		J-B normality prob	0.73	

The models with REER_CPI and three measures of exports								
Goods and services			**Goods in the normal trade system**			**Goods in the general trade system**		
Variables	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**
DLEXP(-1)	-0.53	0.22	DLREER	-1.43	0.38	DLEXP_GDS(-1)	0.02	0.20
DLEXP(-2)	-0.19	0.21	DLWGDP	5.55	1.57	DLREER	-1.22	0.54
DLEXP(-3)	-0.97	0.23	C	0.00	0.01	DLREER(-1)	-0.09	0.57
DLEXP(-4)	-0.84	0.28				DLWGDP	6.12	2.32
DLREER	0.35	0.41				DLWGDP(-1)	4.55	2.42
DLREER(-1)	-0.52	0.41				C	-0.03	0.03
DLREER(-2)	-0.53	0.47						
DLREER(-3)	-0.09	0.42						
DLREER(-4)	-0.80	0.39						
DLWGDP	2.59	1.58						
DLWGDP(-1)	6.12	1.96						
DLWGDP(-2)	6.35	2.19						
DLWGDP(-3)	5.89	2.03						
DLWGDP(-4)	4.32	1.99						
C	-0.09	0.03						
Price elast	-0.45*		**Price elast**	-1.43**		**Price elast**	-1.34	
Income elast	7.17**		**Income elast**	5.55**		**Income elast**	10.85**	
LM autocorr prob	0.81		LM autocorr prob	0.56		LM autocorr prob	0.91	
J-B normality prob	0.44		J-B normality prob	0.81		J-B normality prob	0.27	

The models with REER_PPI and three measures of exports								
Goods and services			**Goods in the normal trade system**			**Goods in the general trade system**		
Variables	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**	**Variables**	**Coeff**	**St. dev**
DLEXP(-1)	-0.46	0.25	DLEXP_NORM(-1)	-0.14	0.17	DLEXP_GDS(-1)	-0.08	0.19
DLEXP(-2)	-0.04	0.19	DLREER_PPI	-0.74	0.31	DLREER_PPI	-0.91	0.38
DLEXP(-3)	-0.86	0.24	DLREER_PPI(-1)	-0.53	0.34	DLREER_PPI(-1)	-0.45	0.44
DLEXP(-4)	-0.90	0.28	DLWGDP	4.47	1.66	DLWGDP	5.31	2.17
DLREER_PPI	0.24	0.38	DLWGDP(-1)	0.95	1.84	DLWGDP(-1)	5.89	2.30
DLREER_PPI(-1)	-0.49	0.38	C	0.01	0.02	C	-0.03	0.02
DLREER_PPI(-2)	-0.46	0.34						
DLREER_PPI(-3)	0.34	0.32						
DLREER_PPI(-4)	-0.59	0.35						
DLWGDP	0.97	1.71						
DLWGDP(-1)	5.34	1.88						
DLWGDP(-2)	6.06	2.00						
DLWGDP(-3)	5.28	1.91						
DLWGDP(-4)	4.24	2.09						
C	-0.08	0.03						
Price elast	-0.29		**Price elast**	-1.11**		**Price elast**	-1.26**	
Income elast	6.73**		**Income elast**	4.74*		**Income elast**	10.39**	
LM autocorr prob	0.48		LM autocorr prob	0.58		LM autocorr prob	0.89	
J-B normality prob	0.72		J-B normality prob	0.59		J-B normality prob	0.05	

Notes: 5% and 1% level of significance are denoted as * and ** respectively. The Breusch-Goldfrey Serial Correlation LM test autocorrelation test is carried out with 4 lags.