Empir Econ (2011) 40:839–854
DOI 10.1007/s00181-010-0365-8

Bilateral and regional trade elasticities of the EU

Natalya Ketenci · Idil Uz

Received: 21 April 2009 / Accepted: 15 January 2010 / Published online: 1 April 2010
© Springer-Verlag 2010

Abstract The traditional way of assessing the impact of currency depreciation and income on the trade balance has been to estimate the elasticity of trade volume to relative prices and income. The previous studies examine the problems associated with using aggregate data. The recent studies rely on bilateral data, yet another problem is that data for export and import prices are not available. Thus, this study proposes an alternative way of assessing the impact of currency depreciation by using the real exchange rate and the impact of income on bilateral trade. The models are applied between the EU and its major trading partners. Furthermore, the analysis includes the six major trading regions along side the eight major trading countries for 1980–2007, on the quarterly basis. This article uses the autoregressive distributive lag (ARDL) approach advocated by Pesaran and Pesaran (1997). Our results indicate a higher importance of income compared to the real exchange rate in defined bilateral export and import demand functions. In addition, the applied CUSUM and CUSUMSQ stability tests confirm the stability of estimated coefficients in most cases.

Keywords Bilateral trade elasticities · J-curve · Cointegration · Stability tests · European Union

JEL classification F14 · F31 · F43

N. Ketenci (✉) · I. Uz
Department of Economics, Yeditepe University, Kayisdagi 34755, Istanbul, Turkey
e-mail: nketenci@yeditepe.edu.tr

I. Uz
e-mail: idiluz@yeditepe.edu.tr

1 Introduction

The EU's trade policy is characterised above all by a commitment to multilateralism. Another important characteristic of the EU's trade policy is an ambitious set of preferences granted to developing countries, for example, trade relations between the EU and its former colonies or less developed countries as well as developing countries in Asia and Latin America. Many different tariff regimes coexist, but actually few tariffs are specific to a single country—one exemption is Turkey and its customs union with the EU. Also, a limited number of trade concessions, most of them under agreements with different countries, have been made.

This study investigates the trade relations between the EU and its major trading partners on a bilateral basis. The analysis includes eight countries and six regions. The countries are Canada, China, Japan, Norway, Russia, Switzerland, Turkey and the US. The regions are the new EU members, Bulgaria and Romania, and one candidate, Turkey (NMCs), the Central and Eastern European countries, the European Free Trade Area (EFTA), the North American Free Trade Area (NAFTA), the Association of Southeast Asian Nations (ASEAN), and the Dynamic Asian Countries (DAC) (see Appendix 1 for data). In 1990, as can be seen from (Table 1), 22.59% of exports and 25.28% of imports were from the selected countries and regions. In 2007, exports increased to 36.58% and imports were increased to 36.57%.

The elasticity approach to trade has been an important area for research. Price elasticity, in particular, has been the centre of focus for determining whether the Marshal–Lerner (ML) condition holds in the long run. A number of studies have followed the traditional approach and estimated import and export demand elasticities to determine whether the ML condition holds. See, for example, Kreinin (1967), Houthakker and Magee (1969), Khan (1974, 1975), Goldstein and Khan (1976), Goldstein and Khan (1978), Wilson and Takacs (1979), Haynes and Stone (1983), Warner and Kreinin (1983) and Bahmani-Oskooee (1986). The ML condition states that as long as the sum of the price elasticity of export and import demand functions exceeds unity, devaluation will improve the trade balance. Other studies have estimated trade elasticities for developing countries. For example, Bahmani-Oskooee and Niroomand (1998) tested long-run price elasticities and the ML condition for 30 developed and developing countries. Lal and Lowinger (2002) confirmed the existence of both short-run and long-run relationships between nominal exchange rate and trade balances for South Asia countries.

Table 1 Share of EU trade

	Percentage share of selected countries/regions in total EU trade			Percentage share of selected countries/regions in total extra-EU trade		
	Export	Import	Total trade	Export	Import	Total trade
2007	36.58	36.57	36.57	91.46	86.47	88.88
2000	32.55	34.30	33.43	86.67	83.79	85.16
1990	22.59	25.28	24.51	71.04	71.08	71.06

Source: Eurostat

One of the criticisms of these studies has been the use of aggregate trade data. The problem, called an "aggregation bias", is that a significant price elasticity with one trading partner could be more than offset by an insignificant elasticity (see Bahmani-Oskooee and Goswami 2004). While with one trade partner a country's trade balance can be improving with another it can be deteriorating (see Bahmani-Oskooee and Brooks 1999). Therefore, this necessitates studies on trade elasticities on a bilateral basis.

Some studies include bilateral trade between selected developed countries and different regions, such as that by Marquez (1990). Studies have been conducted on the bilateral trade between the US and one or more of its trading partners, for example, Cushman (1990), Haynes et al. (1996), Bahmani-Oskooee and Brooks (1999), Nadenichek (2000), and Bahmani-Oskooee and Ratha (2008). Other studies have examined the bilateral trade of one country other than the US. For example, studies have been done on bilateral trade in Canada as the base country with its trade partners by Bahmani-Oskooee et al. (2005); on bilateral trade in Sweden by Hatemi and Irandoust (2005) and Irandoust et al. (2006), and on bilateral trade in Japan by Harrigan and Vanjani (2003) and Bahmani-Oskooee and Goswami (2004). Fewer studies have analysed bilateral trade in developing countries beside those by Wang and Ji (2006) for bilateral trade in China, Liu et al. (2007) for bilateral trade in Hong Kong, and Bahmani-Oskooee and Kantipong (2001) for the case of Thailand.

According to the Commission, the EU is committed to ensure that the European economy is open to the world and competitive on the world stage. In doing this, it takes an active role in the WTO's multilateral negotiations together with bilateral agreements and devises specific trading policies with third countries and regional areas. The aim of this study is to estimate the elasticity of bilateral trade between the EU and its major trading partners. Our study shows whether the long journey on the way to economic and monetary integration has been accomplished and the EU, with 15 members, is considered as a single identity and the biggest trader in the international markets.

Areas of interest in this study are the determination of the short-run behaviour of the exchange rate movements on trade, testing whether the j-curve holds in the EU as a whole, and finally, testing the long-run relationship between trade and variables such as exchange rate and income. However, considering the European Union as a group of individual countries, it creates another aggregation problem. The purpose of our study is to investigate the tendencies and dynamics of the European Union's international trade with its major world partners and to examine how the trade of the European Union as a whole region in general is affected by foreign income and real exchange rates.

In addition, the expression 'exchange rate pass-through' is used generally to refer to the effects of exchange rate changes on one of the following: (1) import and export prices, (2) consumer prices, (3) investments and (4) trade volumes. Of these four topics, the primary focus is on the effect of exchange rate on import and export prices. Our model does not measure the exchange rate pass-through effect. We use values of export and import rather than price of import and export. Yet, it provides information about the exchange rate pass-through on import and export demand. The analysis starts with discussing model and methodology in Sect. 2. Then, in Sect. 3, we discuss the empirical results and in Sect. 4, we give a summary and make some concluding remarks.

2 Model and methodology

The theoretical background of trade elasticity starts with the simple trade balance equation where TB_j represents the trade balance between the EU and its trading partner, j. Let TB_j be the difference between the value of the EU's exports to country/region j and the value of its imports from country/region j. The bilateral trade balance could be measured either in terms of domestic currency, euro, or in terms of the currency of country/region j. Measuring the trade balance in terms of the currency of j, say the US$, the TB_j is formulated as follows:

$$\mathrm{TB}_j^{\$} = P_x^{\$} X_j - P_m^{\$} M_j \tag{1}$$

where $P_x^{\$}$ is the EU's export price in US$, $P_m^{\$}$ is the EU's import price in US$, X_j is the EU's export volume to trading partner j and M_j is the EU's import volume from country/region j. Depreciation of the euro in terms of the US$ lowers the EU's export price in US$, thereby expecting that this will stimulate the EU's export volume to the US. However, the effect of depreciation of the currency on the value of export depends on whether the US demand for the EU goods is elastic. On the other hand, depreciation of the euro and its effect on the $P_m^{\$}$ depends on how large a trading partner is for the EU. If it is small, then there will be no change in $P_m^{\$}$, considering import demand as inelastic.

One of the problems in estimating bilateral trade in Eq. 1 is the lack of data on export and import prices on a bilateral basis. Alternatively, export values (or inpayments) and import values (or outpayments) are used to determine the currency and income changes are effective in changing a country's/region's inpayments and outpayments. Then, the equations become as follows:

$$\log X_{j,t} = a_0 + a_1 \log \left(\frac{P_j e}{P} \right)_t + a_2 \log Y_{j,t} + \varepsilon_{1,t} \tag{2}$$

$$\log M_{j,t} = b_0 + b_1 \log \left(\frac{P_j e}{P} \right)_t + b_2 \log Y_t + \varepsilon_{2,t} \tag{3}$$

In Eqs. 2 and 3, X and M are the values of export and import, respectively. P_j is the price for the jth country/region, e is the nominal bilateral exchange rate represented in national currency per foreign currency and P_t is domestic price level. Finally, Y is the domestic output and Y_j is the foreign output at period t. In (2), it is expected that a_2 has a positive sign, so that as the foreign economy grows so does the domestic export to foreign country/region. Similarly, a positive relationship between domestic output and demand for import from foreign country/region exists. In addition, an increase in real exchange rate, the depreciation of domestic currency, is expected to increase the value of exports and decrease the value of imports. Thus, a_1 is expected to have positive sign and b_1 is expected to have negative sign.

Models in Eqs. 2 and 3 are used to analyse the long-run relationship and dynamic interactions among the variables of trade empirically. However, to incorporate the short-run dynamics, the model has been estimated by using the bounds testing (or Autoregressive Distributed Lag, ARDL) approach to cointegration, developed by Pesaran and Pesaran (1997). Reasons for the ARDL are as follows: first, it is simply allowing cointegration relationship once the lag order of the model is identified. Second, it does not require a unit root test therefore it is applicable irrespective of whether the regressors in the model are purely stationary $I(0)$, purely non-stationary $I(1)$ or mutually cointegrated. So, the methodology of ARDL theoretically does not require a unit root test. See, for example, Pesaran and Pesaran (1997); Pesaran and Shin (1999), Atkins and Coe (2002),Pesaran et al. (2001), and Narayan and Narayan (2006). Finally, the test is relatively more efficient in small samples or finite sample data sizes. The procedure, however, will crush in the presence of I(2) series (integrated of order 2).

The ARDL approach involves two steps for estimating the long-run relationship (Pesaran et al. 2001). The first step is to examine the existence of a long-run relationship among all of the variables in an equation. The second step is to estimate the long-run and short-run coefficients of the same equation. We run the second step only if we find a cointegration relationship in the first step. This study uses a more general formula of the error correction model (ECM). In error-correction models, the long-run multipliers and short-run dynamic coefficients improve the model as follows:

$$\Delta \log X_{j,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_{1,i} \Delta \log X_{j,t-i} + \sum_{i=0}^{p} \alpha_{2,i} \Delta \log \text{RER}_{t-i} + \sum_{i=0}^{p} \alpha_{3,i} \Delta \log Y_{j,t-i} + \delta_1 \log X_{j,t-1} + \delta_2 \log \text{RER}_{t-1} + \delta_3 \log Y_{j,t-1} + \varepsilon_{1,t} \quad (4)$$

$$\Delta \log M_{j,t} = \beta_0 + \sum_{i=1}^{p} \beta_{1,i} \Delta \log X_{j,t-i} + \sum_{i=0}^{p} \beta_{2,i} \Delta \log \text{RER}_{t-i} + \sum_{i=0}^{p} \beta_{3,i} \Delta \log Y_{t-i} + \lambda_1 \log M_{j,t-1} + \lambda_2 \log \text{RER}_{t-1} + \lambda_3 \log Y_{t-1} + \varepsilon_{2,t} \quad (5)$$

where X and M are the values of export and import, respectively. Real Exchange Rate (RER) is calculated by $(P_t e / P^*_{j,t})$, where $P_{j,t}$ is the price for the country/region j, e is the nominal bilateral exchange rate represented in the national currency per euro and P_t is the domestic (EU 15) price level. Y is the real GDP in the EU and Y_j, represents foreign GDP. The coefficients α_2 and β_2 show the short-run effects of real depreciation on exports and imports, respectively. The coefficients δ_2 and λ_2, however, show the long-run effects of real depreciation on exports and imports, respectively. Finally, p is the number of lags, α_0 and β_0 are drifts, ε_1 and ε_2 are white noise errors.

Our main concern from Eqs. 4 and 5 is to obtain an estimate of α_2 and β_2 coefficients which express the short-run dynamics of real exchange rate, and to obtain an estimate of δ_2 and λ_2 coefficients as the long-run effects of real exchange rates, and δ_3 and λ_3 coefficients as the long-run effects of trading partners' incomes on export and import values, respectively. It is expected that signs of α_2 and δ_2 coefficients are positive, explaining by this positive relationship between the depreciation of domestic currency and export values in the short run and long run, respectively. At the same time as depreciation of domestic currency decreases value of imports in the short run and long run, we expect that signs of β_2 and λ_2 coefficients are negative. Finally, it is expected that estimates of δ_3 and λ_3 coefficients have positive signs in the long run, showing by this that growing foreign economy increases domestic export to those countries, and a growing domestic economy has a growing demand for imports.

The ARDL approach is used to establish whether the dependent and independent variables in each model are cointegrated. The null of no cointegration, i.e., $H_0 : \delta_1 = \delta_2 = \delta_3 = 0$ and $H_0' : \lambda_1 = \lambda_2 = \lambda_3 = 0$, are tested against the alternative of $H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq 0$ and $H_1' : \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq 0$. So, we look at the ARDL bounds testing approach to estimate these equations by ordinary least square (OLS) test in order to test for the existence of the coefficients of the lagged variables.

We have to conduct a Wald-type (F-test) coefficient restriction test, which entails testing the above null hypotheses H_0 and H_0'. Pesaran et al. (2001) computed two sets of asymptotic critical values for testing cointegration. The first set assumes variables to be I(0), the lower-bound critical value (LCB) and the other I(1), upper bound critical value (UCB). If the F-statistic is above the UCB, the null hypothesis of no cointegration can be rejected irrespective of the orders of integration for the time series. Conversely, if the test falls below the LCB the null hypothesis cannot be rejected. Finally, if the statistic falls between these two sets of critical values, the result is inconclusive.

Since the results of the F-test are sensitive to lag lengths, we follow Bahmani-Oskooee and Goswami (2004) and Bahmani-Oskooee and Ratha (2008) in applying various lag lengths in the model. However, as Pesaran and Pesaran (1997, 305) argue, variables in regression that are 'in first differences are of no direct interest' to the bounds cointegration test. Thus, a result that supports cointegration at least at any one lag structure provides evidence for the existence of a long-run relationship. Alternatively, Kremers et al. (1992); Banerjee et al. (1998) and Bahmani-Oskooee and Brooks (1999) have demonstrated that in an ECM, a significant lagged error-correction term is a relatively more efficient way of establishing cointegration. So, the error correction term can be used when the F-test is inconclusive.

Lastly, following Nielsen (2004), we avoid using any dummy in the autoregressive model. According to Nielsen (2004), the best results are obtained for the case where the cointegration rank is initially determined in a model with no dummies.

3 Empirical results

In this section, we report the estimation results of error-correction models (4) and (5) between the EU and its major trading partners, which are eight countries, Canada, China, Japan, Norway, Russia, Switzerland, Turkey, and the US; and six regions, the NMCs, the CEECs, the EFTA, the NAFTA, the ASEAN, and the DACs. Equations (4) and (5) were estimated using the ARDL approach to determine whether the dependent and independent variables in each model are cointegrated. As Bahmani-Oskooee and Brooks (1999) showed in their study, the results of F-test are sensitive to lag lengths. Therefore F-tests were applied for each first differenced variable by changing the lag lengths from 0 to 10. The results of these estimations are reported in the Table 2.

Table 2 The results of the F-test for cointegration among variables

Partner country/region	Lag length										
	0	1	2	3	4	5	6	7	8	9	10
Panel A: bilateral export demand equation											
Turkey	10.54	2.47	2.97	1.14	2.89	2.61	2.07	1.69	1.63	1.99	2.25
Norway	8.52	2.25	2.42	0.78	1.95	1.81	1.89	1.44	1.53	1.68	2.55
Switzerland	10.78	6.49	1.83	3.12	5.06	6.56	3.41	3.55	4.64	3.39	2.83
Russia	1.20	1.33	0.18	0.16	0.36	0.07	0.27	0.20	0.50	0.42	0.59
Canada	8.97	4.75	3.74	7.64	4.08	3.35	3.48	2.91	3.55	3.19	3.06
United States	24.22	13.90	10.18	13.99	6.34	7.80	7.14	8.60	8.07	5.29	6.43
China	5.16	4.05	2.27	2.14	2.72	3.01	3.69	4.40	3.46	3.60	3.49
Japan	7.40	4.73	5.03	6.09	1.09	1.36	1.77	1.67	1.38	0.92	1.17
CEEC	0.76	1.46	2.42	2.13	0.68	0.90	1.14	2.41	1.67	1.79	0.99
NMC	2.37	2.14	0.97	1.12	1.27	1.50	1.55	1.89	1.01	1.45	1.78
EFTA	12.48	1.83	2.40	2.65	3.30	2.78	2.84	2.45	1.55	0.94	1.14
NAFTA	4.37	5.13	4.70	5.49	1.31	1.40	2.55	2.81	2.03	1.40	1.78
ASEAN	2.15	2.97	3.57	4.17	4.89	4.24	3.04	1.94	1.04	0.81	0.64
DAC	6.11	2.77	3.73	1.84	2.12	2.03	1.56	1.46	1.03	0.70	1.08
Panel B: bilateral import demand equation											
Turkey	11.15	13.67	4.49	4.28	1.70	1.21	1.16	1.31	1.81	2.39	2.78
Norway	3.97	2.54	2.65	1.60	2.86	2.27	3.00	1.39	2.13	2.22	3.09
Switzerland	10.64	9.10	6.60	9.20	5.02	3.99	2.62	2.75	3.30	3.69	2.07
Russia	87.54	4.93	1.75	1.24	1.81	1.09	1.52	1.48	1.43	1.35	1.25
Canada	9.55	3.98	4.91	3.49	3.49	4.15	3.72	3.57	3.24	2.78	2.66
United States	8.75	4.17	4.04	17.04	9.36	10.01	4.91	5.80	3.36	2.32	2.18
China	8.49	4.42	5.48	4.27	4.35	3.73	4.06	3.01	2.77	2.85	2.27
Japan	3.84	5.36	8.47	26.84	6.55	4.70	5.22	6.84	2.92	4.38	4.01
CEEC	2.81	1.85	2.81	2.22	2.16	1.15	1.61	1.94	3.16	1.87	3.04
NMC	3.14	1.93	1.52	2.15	2.15	2.09	3.13	3.48	3.75	4.01	2.95
EFTA	13.95	5.61	5.58	1.66	3.15	3.42	3.18	1.92	4.37	4.28	4.85
NAFTA	2.73	0.75	1.32	0.55	2.07	1.27	1.75	1.29	2.04	2.21	3.00
ASEAN	1.48	0.90	0.57	0.39	0.95	0.92	0.99	1.59	0.90	1.07	1.30
DAC	4.06	3.51	3.40	5.42	3.35	2.06	2.32	2.96	2.20	2.40	2.95

Note: unrestricted intercept no trend (3.17–4.14) at 90% significance level, (3.79–4.85) at 95% significance level.

As can be seen from Table 2, almost in all cases the F-statistics demonstrate at least one lag structure that supports cointegration relations between variables. For example, in the results of the bilateral export demand equation for the US, there is evidence of cointegration for every chosen lag from 0 to 10, while for Turkey and Norway only 0 lag application presents cointegration relations. On the other hand, in the results of the bilateral export demand function for Russia, the CEECs and the NMCs, no evidence of cointegration was found in imposing any lag length out of 10. Similarly, the bilateral import demand function for the CEECs, the NAFTA and the ASEAN did not provide any evidence for cointegration relations. Therefore, we cannot include Russia, the CEECs and the NMCs in the further estimations of the bilateral export demand equation and the CEECs, the NAFTA, the ASEAN in estimations of the bilateral import demand equation.

Now that we have justified the inclusion of lag-variables in the chosen countries and regions, we need to re-estimate Eqs. 4 and 5 and to employ the Akaike Information Criterion (AIC) in order to select the optimum lag length. For analyzing the effect of the J-curve, we present the short-run coefficients of the first differenced real exchange rate for both the bilateral export demand function in the first panel and the bilateral import demand function in the second panel.

Table 3 shows that there is evidence of the J-curve in bilateral export demand function in the cases of Canada, China, Japan and NAFTA, where the first several lags carry negative coefficients followed by positive ones. However, in the other cases of the bilateral export demand function, no specific trends were found in the estimates of the short-run coefficients of the real exchange rate. Panel B reports the estimates of the short-run exchange rate coefficients for the bilateral import demand equation. Evidence of the existence of the J-curve phenomenon was not found, except in the case of Canada. In Canada, there is weak evidence that supports the J-curve phenomenon, where the first five lags carry negative coefficients followed by one positive lag. The lack of a specific pattern in the estimates of the short-run real exchange rate coefficients is in line with previous research (Rose and Yellen 1989; Bahmani-Oskooee and Ratha 2008; Halicioglu 2008). However, there are some studies where evidence of the J-curve was found as well as in the cases of some of the countries in this study. For example, Marwah and Klein (1996) found evidence of the J-curve in both the cases of the USA and Canada in the bilateral trade with their major trading partners. Bahmani-Oskooee and Kantipong (2001) examined the response of the bilateral trade to the exchange rate of Thailand as a developing country and its five largest trade partners. They found evidence of the J-curve only in the cases of USA and Japan.

In order to provide additional evidence of cointegration among the variables in Table 3, we report the coefficients of EC(−1) of the error-correction model. All coefficients of EC(−1) have expected negative sign and are highly significant in most cases, which provide additional conformation for cointegration relationships between variables. The exceptions are error-correction coefficients for cases of the EFTA and the DAC in the export demand function and Russia and the DAC in the import demand function. The magnitude of the speed of equilibrium adjustment is relatively high in most cases, which is in line with previous studies. The highest error correction coefficient appeared in the case of the United States, which means that about 68% of bilateral export disequilibrium is corrected every quarter by the real exchange rate. Consequently, steady state equilibrium can be reached in less than 6 months in the case of the bilateral trade of EU and the United States. However, in the case of the NAFTA, steady state equilibrium in bilateral export trade with EU can be re-established in about 3 years.

The coefficients obtained for the error correction term EC(−1) are as powerful as the F-test in the determination of cointegration. The significant and negative coefficients of EC(−1) provide evidence of cointegration and support the adjustment toward

Table 3 Short-run coefficient estimates of exchange rate and error-correction term

Partner country/region	Lag length 0	1	2	3	4	5	6	7	8	9	10	EC(−1)
Panel A: bilateral export demand equation												
Turkey	0.04 (0.14)	0.06 (0.13)	0.23* (0.13)	0.05 (0.14)	0.08 (0.14)	0.02 (0.14)	−0.04 (0.13)	0.26* (0.13)	−0.10 (0.13)	0.19 (0.13)	−0.08 (0.13)	−0.19* (0.09)
Norway	0.02 (0.29)	0.19 (0.26)	−0.79* (0.26)	0.28 (0.27)	0.11 (0.26)	0.42 (0.26)	−0.16 (0.26)	−0.61* (0.28)	0.55* (0.28)			−0.15* (0.07)
Switzerland	−0.002 (0.03)	0.09* (0.04)	0.05 (0.04)	0.07* (0.04)	0.07* (0.03)	0.10* (0.04)	−0.04 (0.03)	0.07* (0.03)	0.08* (0.03)			−0.34* (0.10)
Canada	−0.06 (0.13)	−0.60* (0.14)	−0.27* (0.14)	−0.1 (0.14)	0.04 (0.14)							−0.14* (0.06)
United States	−0.31* (0.09)	0.07 (0.15)	0.02 (0.13)	−0.09 (0.13)	0.24* (0.12)	0.20 (0.12)	0.18 (0.11)	0.22* (0.11)				−0.68* (0.14)
China	−0.40* (0.20)	−0.003 (0.19)	−0.06 (0.19)	0.02 (0.19)	0.33* (0.19)							−0.19* (0.08)
Japan	−0.24* (0.10)	−0.19* (0.11)	−0.11 (0.11)	−0.05 (0.11)	−0.14 (0.11)	0.19* (0.11)						−0.12* (0.07)
EFTA	0.06 (0.17)	−0.11 (0.18)	−0.25 (0.18)	−0.08 (0.18)	0.10 (0.17)	0.30* (0.17)	0.004 (0.18)	−0.19 (0.19)	−0.03 (0.19)	0.21 (0.18)		−0.13* (0.08)
NAFTA	−0.16* (0.05)	−0.14* (0.06)	−0.06 (0.06)	−0.04 (0.05)	0.11* (0.05)	0.08 (0.05)	0.02 (0.05)					−0.08* (0.03)
ASEAN	−0.04 (0.12)	−0.31* (0.12)	−0.04 (0.12)	−0.06 (0.12)	0.01 (0.12)	0.02 (0.11)	−0.05 (0.11)	−0.002 (0.11)	0.18 (0.11)			−0.10 (0.06)
DAC	−0.24* (0.07)	−0.18* (0.10)	−0.06 (0.10)	−0.13 (0.10)	−0.12 (0.09)	0.03 (0.10)	0.04 (0.09)	−0.12(0.09)	−0.10 (0.09)	−0.10 (0.08)		−0.08 (0.07)
Panel B: bilateral import demand equation												
Turkey	−0.05 (0.08)	0.01 (0.09)	0.07 (0.09)	0.17* (0.09)	0.05 (0.09)	−0.08 (0.09)	0.07 (0.08)	0.01 (0.08)	0.01 (0.08)	−0.07 (0.07)	0.17* (0.07)	−0.19* (0.09)
Norway	−1.60*(0.47)	0.47 (0.49)	0.14 (0.46)	−0.63 (0.45)	0.34 (0.46)	0.17 (0.44)	−0.05 (0.45)	−0.80 (0.49)	0.97* (0.47)			−0.19* (0.08)
Switzerland	−0.06*(0.04)	0.04 (0.04)	−0.01 (0.04)	0.09* (0.04)	0.03 (0.03)	0.05 (0.03)						−0.21*(0.07)
Russia	0.24 (0.23)	0.37 (0.27)	−0.40 (0.26)	0.30 (0.25)	0.05 (0.21)	0.04 (0.19)	0.32* (0.16)					−0.13 (0.08)
Canada	−0.30*(0.14)	−0.33* (0.14)	−0.12 (0.15)	−0.26* (0.15)	−0.08 (0.15)	0.17 (0.15)						−0.31* (0.09)
United States	−0.44*(0.09)	−0.48* (0.11)	−0.62* (0.12)	−0.64* (0.14)	0.08 (0.15)	−0.09 (0.13)	0.13 (0.12)					−0.10*(0.06)
China	−0.05 (0.08)	−0.14* (0.08)	−0.08 (0.08)	0.03 (0.08)	−0.01 (0.07)	0.14* (0.07)	0.06 (0.07)	−0.19* (0.08)	0.01 (0.08)	0.12 (0.08)		−0.22*(0.08)
Japan	−0.30* (0.08)	−0.13 (0.09)	−0.04 (0.09)	−0.14 (0.09)	0.06 (0.09)	0.14 (0.09)	0.11 (0.09)	0.06 (0.10)	0.12 (0.10)	0.16* (0.09)	−0.03 (0.09)	−0.09* (0.05)
NMC	0.07 (0.04)	−0.05 (0.05)	0.04 (0.05)	0.05 (0.05)	0.04 (0.05)	0.02 (0.05)	0.08* (0.04)	0.06 (0.04)	−0.08* (0.04)			−0.12*(0.04)
EFTA	−0.66* (0.25)	0.29 (0.26)	−0.03 (0.25)	−0.16 (0.24)	0.04 (0.24)	0.51* (0.24)	0.05 (0.25)	−0.41(0.26)	0.82* (0.25)			−0.36* (0.09)
DAC	−0.03 (0.07)	−0.16* (0.08)	−0.06 (0.08)	−0.08 (0.08)	−0.02 (0.08)	0.04 (0.08)	0.02 (0.08)	−0.03 (0.07)	0.01 (0.07)			−0.07 (0.07)

Note: Standard errors are in parenthesis. Asterisk means significant at 5% level

Table 4 Long-run coefficient estimates

Partner country/region	Constant	LogRER	LogY
Panel A: bilateral export demand equation			
Turkey	−2.44* (1.03)	0.07 (0.07)	0.56* (0.24)
Norway	−0.05 (0.06)	−0.08 (0.12)	0.13* (0.07)
Switzerland	−1.81* (0.97)	−0.08* (0.03)	0.58* (0.25)
Canada	−1.10* (0.63)	−0.12* (0.06)	0.27* (0.14)
United States	−8.54* (1.74)	−0.64* (0.13)	1.68* (0.34)
China	−0.40* (0.19)	−0.07 (0.05)	0.25* (0.10)
Japan	−1.86 (1.14)	−0.09 (0.06)	0.39* (0.23)
EFTA	−0.53 (0.33)	0.01 (0.08)	0.20* (0.12)
NAFTA	−0.78* (0.40)	−0.04 (0.03)	0.16* (0.08)
ASEAN	−0.45 (0.28)	0.02 (0.07)	0.14 (0.10)
DAC	−0.45 (0.33)	−0.07 (0.10)	0.15 (0.12)
Panel B: bilateral import demand equation			
Turkey	−5.46* (3.11)	−0.07 (0.05)	0.88* (0.49)
Norway	−3.63* (1.52)	−0.42 (0.25)	0.69* (0.29)
Switzerland	−1.26 (1.16)	−0.03 (0.03)	0.30 (0.21)
Russia	−2.91* (1.42)	−0.34 (0.21)	0.56* (0.27)
Canada	−3.51* (1.07)	−0.09 (0.06)	0.66* (0.20)
United States	−0.65 (0.69)	0.10* (0.04)	0.15 (0.14)
China	−10.50* (3.62)	0.02 (0.02)	1.64* (0.57)
Japan	−0.12 (0.43)	−0.02 (0.05)	0.08 (0.09)
NMC	−5.43* (1.63)	−0.05* (0.02)	0.86* (0.26)
EFTA	−4.84* (1.38)	−0.25* (0.12)	0.94* (0.27)
DAC	−0.83 (1.46)	0.13* (0.08)	0.12 (0.25)

Note: Standard errors are in parentheses. Asterisk means significant at 5% level

the steady state equilibrium in the model. Therefore, even though the results of the F-test in Table 2 do not provide any evidence of cointegration for Russia, CEECs and NMCs in the bilateral export equation and for the CEECs, NAFTA and ASEAN in the bilateral import equation, we imply the second stage of estimations for these countries as well. After imposing the optimum lag length on each first differenced variable using AIC, we estimate models (4) and (5) again for the excluded countries. The estimates of the coefficients of EC(−1) for these countries were not found significant in any case except for that of the CEECs in the bilateral import function. The error correction coefficient was found negative and significant, which confirms the existence of cointegration in the bilateral import trade between the EU and the CEECs, where trade disequilibrium can be adjusted by real exchange rate in more than one and a half years.

Cointegration relations between the variables of bilateral import and export functions are due not only to the strong relations between trade and real exchange rate, but also due to significant relations between EU import and EU income and between EU export and partners' income. Table 4 indicates that the long-run elasticity of trade partners' income in the case of the bilateral export function and the long-run elasticity of the EU's income in the case of the bilateral import function carry the expected positive sign in all cases. In addition, in most cases of bilateral export and import equations income coefficients are highly significant except for the ASEAN and the DAC in the bilateral export equation and Switzerland, the United States, Japan and the DAC in the case of the bilateral import equation. Almost all countries' long-run income elasticities are reported as inelastic, but the magnitude of change is much greater than in real exchange rate elasticities. However, the United States' income is shown to be elastic in the EU's bilateral export trade and the EU's income is reported as elastic in the bilateral import trade with China. It appears that demand is the main determining factor in bilateral export and import functions and may be more significant than real exchange rate.

Due to the lack of data for import and export prices on a bilateral level, trade volumes cannot be employed in the model. For that reason, we cannot estimate trade flow elasticities for determining the ML condition in our model. Therefore, in our article, we follow Bahmani-Oskooee and Goswami (2004) to try to establish direct link between a country's value of export and import and real exchange rate on the bilateral basis. However, we can use the long-run elasticity of the real exchange rate as a proxy of price elasticity for determining the existence of the ML condition. The reported results of long-run coefficient estimates do not provide any empirical evidence that the ML condition holds in the long-run with any considered trading partner because the real exchange rate elasticities in all cases are too low. From Panel A of Table 4 it can be seen that only in three cases, Turkey, the EFTA and the ASEAN, does the long-run elasticity of the real exchange rate carry the expected positive sign; however, it is not significant. While in the cases of Switzerland, Canada and the United States real exchange rate is significant, but with unexpected negative sign, which illustrates the adverse effect of the currency depreciation on the bilateral export in the long run between the EU and the above-mentioned trade partners. In the B Panel, bilateral import function, it can be seen that in two cases the long-run coefficients of the real exchange rate carry the expected negative sign and significant, indicating that real depreciation of the euro decrease European imports from the NMC and the EFTA, while in the cases of the United States and DAC, the adverse effect is observed. However, the real exchange rate elasticities are too low to make a conclusion about the significant effect of currency depreciation on bilateral trade. It can be concluded that the EU's exports and imports are insensitive to exchange rate movements. Alternatively, the results are also consistent with the literature of exchange rate pass-through that studies the response of export and import demand to exchange rate changes. The studies show that the exchange rate pass-through coefficients vary both in region and/or countries and time (Krugman 1987; and Menon 1995).

Table 5 shows some diagnostic statistics such as the Lagrange Multiplier (LM) to check for the serial correlation among the residuals of presented models. The Jarque–Bera statistic is used to test the normality of the residuals, White's test is applied to check the heterosckedasticity of the residuals and finally, Ramsey's RESET statistics to check the functional misspecification of each model. For example, the LM test is significant only in two cases out of 22, which are the EFTA in the bilateral export function and Japan in the bilateral import demand equation. The RESET statistic shows that

Table 5 Diagnostic statistics

Partner country/region	Adj R^2	LM[a]	Normality[b]	Heterosckedasticity[c]	RESET[d]
Panel A: bilateral export demand equation					
Turkey	0.81	0.63	4.00	1.37	2.34
Norway	0.74	0.36	1.07	1.12	0.07
Switzerland	0.80	0.64	0.25	0.88	0.08
Canada	0.62	0.92	0.20	0.60	0.00003
United States	0.77	0.66	3.01	1.00*	3.76
China	0.58	1.13	52.81*	1.62*	0.05
Japan	0.51	0.38	3.15	1.19	0.20
EFTA	0.81	4.57*	0.94	1.07	0.80
NAFTA	0.66	0.58	28.25*	0.98	0.65
ASEAN	0.65	1.03	2.00	1.44	3.03
DAC	0.67	1.38	3.72	0.65	2.03
Panel B: bilateral import demand equation					
Turkey	0.71	0.98	0.68	1.14	1.64
Norway	0.33	0.56	17.18*	0.55	5.56*
Switzerland	0.85	1.53	3.60	0.92	1.08
Russia	0.91	0.33	190.99*	2.52*	8.52*
Canada	0.68	0.40	4.38	1.07	3.45
United States	0.86	1.39	3.48	1.21	0.46
China	0.78	0.95	3.82	0.96	0.21
Japan	0.78	2.39*	8.05*	0.78	0.06
NMC	0.44	1.28	285.69*	1.10	0.32
EFTA	0.71	1.43	1.22	1.13	0.09
DAC	0.58	1.89	7.65*	0.75	3.89*

Note: Asterisk means significant at 5% level.
[a] Lagrange multiplier test of residual serial correlation for lag 4 with the null of no serial correlation
[b] Jarque–Bera statistic used for testing normality
[c] White's test is used with the null hypothesis of no heterosckedasticity
[d] Ramsey's RESET test using the square of the fitted values. Distributed as X^2 with 1 d.f.

only three models are misspecified out of 22, and they are Norway, Russia and DACs in the bilateral import demand function. Based on the diagnostic statistics reported in Table 5 in general it can be concluded that in the majority of the cases our models pass all diagnostic tests.

Finally, to ensure that our models pass the stability test we apply the CUSUM and CUSUMSQ tests proposed by Brown et al. (1975) to the residuals of the error-correction models (4) and (5). The graphical results of these tests are not presented here for brevity. The results summarized in Table 6 confirm the stability of the estimated coefficients in most cases. However, it appears that the plot of CUSUM statistics confirms stability in more cases than the plot of CUSUMSQ test. These results are in line with literature where the plot of CUSUMSQ reports more unstable results than the plot of CUSUM in these types of models. However, both the CUSUM and the

Table 6 Stability tests results

Partner country/region	CUSUM	CUSUMSQ	Partner country/region	CUSUM	CUSUMSQ
Panel A: bilateral export demand equation			Panel B: bilateral import demand equation		
Turkey	Unstable	Unstable	Turkey	Stable	Stable
Norway	Stable	Stable	Norway	Stable	Stable
Switzerland	Stable	Unstable	Switzerland	Stable	Unstable
Canada	Stable	Stable	Russia	Stable	Unstable
United States	Stable	Stable	Canada	Stable	Stable
China	Unstable	Unstable	United States	Unstable	Stable
Japan	Stable	Stable	China	Stable	Stable
EFTA	Stable	Unstable	Japan	Stable	Stable
NAFTA	Unstable	Unstable	NMC	Stable	Unstable
ASEAN	Stable	Stable	EFTA	Stable	Stable
DAC	Stable	Stable	DAC	Stable	Stable

CUSUMSQ tests indicate stability in 13 out of 22 cases. Where in the cases of Turkey, China and NAFTA in the bilateral export demand equation relationships are reported as unstable by both tests, the stability tests appear to be inconclusive in the cases of Switzerland and the EFTA in the bilateral export demand equation and in the cases of Switzerland, Russia, the United States and the NMC in the bilateral import demand equation.

4 Summary and conclusion

A wide range of studies have concentrated on the short-run and long-run effects of currency depreciation on the trade balance looking for evidence in the support of the J-curve effect and ML condition. Many studies have used aggregate data; however, in general, the literature does not provide any specific pattern in the short-run response of the trade balance to currency devaluation. However, studies where bilateral trade data were used provide enough evidence for the support of the positive long-run relation between exchange rate and trade balance (see Bahmani-Oskooee and Ratha 2004). Therefore recent studies, including our article, transformed their focus on the bilateral trade data.

In this article, we investigated the relations between the EU's import and export values and real exchange rate. Using the ARDL approach, we estimated each model between the EU and its main industrial trading partners, which are eight countries, Canada, China, Japan, Norway, Russia, Switzerland, Turkey and the US; and six regions, the NMCs, the EFTA, the NAFTA, the ASEAN and the DACs, which accounted for 88.88% of the total extra EU trade in 2007.

Due to the lack of evidence of cointegration in the cases of Russia, the CEECs and NMCs in the bilateral export demand function and in the cases of the CEECs, the NAFTA and the ASEAN in the bilateral import demand function we had to exclude these countries from the further estimations. From our estimates, we found evidence of the J-curve in the cases of Canada, China, Japan and the NAFTA in bilateral export demand function and in the case of Canada in the bilateral import function.

The estimation results show that the trade demand functions of the EU with 15 members provide similar characteristics with the trade demand functions of a single country. For example, it was found that the EU's exports and imports are insensitive to exchange rate movements (see also the case of Japan in a study by Bahmani-Oskooee and Goswami 2004). The magnitude of the exchange rate elasticities of export and import demand, however, are lower than those of a single country analysis (see Bahmani-Oskooee and Brooks 1999; Hatemi and Irandoust 2005). However, income appeared to be more significant in the long-run, indicating the greater importance of income compared to the real exchange rate in bilateral export and import demand functions. Finally, the applied stability tests confirmed the stability of estimated coefficients in most cases.

Appendix 1: data

This study examines trade relationships between the European Union and its 14 trade partners for the period 1980–2007 on a quarterly basis. The EU's trade partners, considered in this study, consist of eight countries and six regions. The countries studied as trade partners of the EU are Canada, China, Japan, Norway, Russia, Switzerland, Turkey and the United States. The regions are the NMC, new EU members and a candidate (Bulgaria, Romania and Turkey); the CEECs, Central and Eastern European countries[1] (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Serbia, Slovakia and Slovenia); the EFTA,[2] European Free Trade Area (Norway and Switzerland); the NAFTA, North American Free Trade Area (Canada, Mexico and the US); the ASEAN, Association of Southeast Asian Nations[3] (Brunei Darussalam, Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam); and the DACs, dynamic Asian Countries (Hong Kong, Korea, Malaysia, Singapore, Thailand and Taiwan).

The trade variables of the model are the values of the exports and imports of the European Union's 15 countries. All trade values are obtained from Eurostat. Exchange Rates are in national currency per ecu/euro. For Croatia, Bosnia-Herzegovina, Serbia and Slovenia, Yugoslavian dinar exchange rates are used for the period 1980Q1–1989Q1.

CPI data are used for calculating Real Exchange Rates and they are obtained from the OECD website and from the National Statistical Departments of the considered countries and regions. All data are in log levels.

[1] Excluding Belarus, Moldavia, Russia and Ukraine.

[2] Excluding Iceland, Liechtenstein due to lack of data.

[3] Excluding Lao People's Democratic Republic and Myanmar due to lack of data.

References

Atkins FJ, Coe PJ (2002) An ARDL bounds test of the long-run Fisher effect in the United States and Canada. J Macroecon 24(2):255–266
Bahmani-Oskooee M (1986) Determinants of international trade flows: the case of developing countries. J Dev Econ 20:107–123
Bahmani-Oskooee M, Brooks TJ (1999) Bilateral J-curve between US and her trading partners. Weltwirtschaftliches Arch 135:156–165
Bahmani-Oskooee M, Goswami GG (2004) Exchange rate sensitivity of Japan's bilateral trade flows. Jpn World Econ 16:1–15
Bahmani-Oskooee M, Kantipong T (2001) Bilateral J-curve between Thailand and her trading partners. J Econ Dev 26:107–117
Bahmani-Oskooee M, Niroomand F (1998) Long-run price elasticities and the Marshall-Lerner condition revisited. Econ Lett 61:101–109
Bahmani-Oskooee M, Ratha A (2004) The J-curve: a literature review. Appl Econ 36(13):1377–1398
Bahmani-Oskooee M, Ratha A (2008) Exchange rate sensitivity of US bilateral trade flows. Econ Syst 32:129–141
Bahmani-Oskooee M, Goswami GG, Talukdar BK (2005) Exchange rate sensitivity of the Canadian bilateral inpayments and outpayments. Econ Model 22:745–757
Banerjee A, Dolado JJ, Mestre R (1998) Error-correction mechanism tests for cointegration in a single equation framework. J Time Ser Anal 19:267–283
Brown RL, Durbin J, Evans JM (1975) Techniques for testing the constancy of regression relations over time. J R Stat Soc B 37:149–192
Cushman DO (1990) US bilateral trade equations: forecasts and structural stability. Appl Econ 22: 1093–1102
Goldstein M, Khan M (1976) Large versus small price changes and the demand for imports. IMF Staff Papers 23:200–225
Goldstein M, Khan M (1978) The supply and demand for exports: a simultaneous approach. Rev Econ Stat 60:275–286
Halicioglu F (2008) The bilateral J-curve: Turkey versus her 13 trading partners. J Asian Econ 19:236–243
Harrigan J, Vanjani R (2003) Is Japan's trade (still) different? J Jpn Int Econ 17:507–519
Hatemi JA, Irandoust M (2005) Bilateral trade elasticities: Sweden versus her trade partners. Am Rev Polit Econ 3:38–50
Haynes SE, Stone JA (1983) Secular and cyclical responses of the US trade to income: an evaluation of traditional models. Rev Econ Stat 65:87–95
Haynes SE, Hutchison MM, Mikesell RF (1996) US-Japanese bilateral trade and the yen-dollar exchange rate: an empirical analysis. South Econ J 52:923–932
Houthakker HS, Magee S (1969) Income and price elasticities in the world trade. Rev Econ Stat 51:111–125
Irandoust M, Ekblad K, Parmler J (2006) Bilateral trade flows and exchange rate sensitivity: evidence from likelihood based panel cointegration. Econ Syst 30:170–183
Khan MS (1974) Import and export demand in developing countries. IMF Staff Papers 21:678–693
Khan MS (1975) The structure and behaviour of imports of Venezuela. Rev Econ Stat 57:221–224
Kreinin ME (1967) Spurious regression and residual-based tests for cointegration in panel data. J Econom 90:510–516
Kremers JJM, Ericsson NR, Dolado JJ (1992) The power of cointegration tests. Oxford Bull Econ Stat 54:325–348
Krugman P (1987) Pricing to market when the exchange rate changes. In: Arndt S, Richardson J (eds) Real financial linkages among open economies. MIT Press, Cambridge
Lal AK, Lowinger TC (2002) Nominal effective exchange rate and trade balance adjustment in South Asia countries. J Asian Econ 13:371–383
Liu L, Fan K, Shek J (2007) Hong Kong's trade patterns and trade elasticities. Hong Kong Monetary Authority working paper, March 21–31
Marquez J (1990) Bilateral trade elasticities. Rev Econ Stat 72:70–77
Marwah K, Klein LR (1996) Estimation of J-curve: United States and Canada. Can J Econ 29:523–539
Menon J (1995) Exchange rate pass-through. J Econ Surv 9(2):197–231
Nadenichek J (2000) The Japan-US trade imbalance: a real business cycle perspective. Jpn World Econ 12:255–271

Narayan PK, Narayan S (2006) Savings behaviour in Fiji: an empirical assessment using the ARDL approach to cointegration. Int J Soc Econ 33(7):468–480

Nielsen HB (2004) Cointegration analysis in the presence of outliers. Econom J 7:249–271

Pesaran MH, Pesaran B (1997) Working with Microfit 4.0: interactive econometric analysis. Oxford University Press, Oxford

Pesaran MH, Shin Y (1999) An autoregressive distributed lag modeling approach to co-integration analysis. In: Strom S (ed) Econometrics and economic theory in the 20th century: the Ragnar Frisch centennial symposium. Cambridge University Press, Cambridge

Pesaran MH, Shin Y, Smith RC (2001) Bounds testing approaches to the analysis of level relationships. J Appl Econ 16:289–326

Rose AK, Yellen JL (1989) Is there a J-curve? J Monet Econ 24:53–68

Wang J, Ji AG (2006) Exchange rate sensitivity of China's bilateral trade flows. BOFIT Discussion Papers 19

Warner D, Kreinin ME (1983) Determinants of international trade flows. Rev Econ Stat 65:96–104

Wilson JF, Takacs WE (1979) Differential responses to price and exchange rate influences in the foreign trade of selected industrial countries. Rev Econ stat 61:267–279