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Trade and Foreign Direct Investment: New Theoretical Approach and Empirical Findings for US Exports and European Exports

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Summary: Trade theory, in the context of economic globalization, is not fully convincing because so far foreign direct investment has not been considered explicitly. The workhorse of modern empirical trade analysis is the gravity model, that however, has only a limited basis in terms of precise derivation of the gravity equation; it is not particularly clear why the domestic GDP figure should be in the export equation. Taking a look at a simple model with two countries producing under Coob Douglas technology we consistently derive that exports depend positively both on the foreign GDP and the GDP of the home country. The empirical error correction model (ECM) approach presented for Germany's export volume to the US, and for US exports to Germany, give clear evidence that there is a positive effect on the real exchange rate, the foreign GDP and the home GDP – more specifically the ratio of home GDP to foreign GDP – on export quantity. US exports to France, Italy, the Netherlands and Spain also produced similar results. The direct real exchange rate elasticities found are – in a standard perspective – higher than in traditional approaches; but it is shown that the elasticity is a positive function of the relative size of the foreign market and the composite export elasticity is below unity or close to unity. Moreover, the new export equation introduced here is also a basis for refined gravity modeling; Mundell Fleming models should also be adequately re-specified. As regards the euro crisis it seems fairly clear that the fiscal multipliers for countries with inward vs. outward FDI look different from the traditional multiplier models.

Zusammenfassung: Im Hinblick auf die wirtschaftliche Globalisierung ist die Handelstheorie nicht überzeugend, da ausländische Direktinvestitionen nicht explizit betrachtet werden. Das Zugpferd einer modernen empirischen Handelsanalyse ist das Gravitationsmodell, das jedoch nur eine begrenzte Basis in Bezug auf die Herleitung der Gravitationsgleichung hat; es ist nicht eindeutig, warum der Wert der inländischen BIP in der Exportsgleichung sein sollte. Wird ein einfaches Modell mit zwei Ländern betrachtet, die unter der Cobb-Dougas Produktionstechnologie arbeiten, folgert daraus, dass die Exporte sowohl von dem ausländischen BIP als auch von dem BIP des Heimatlands positiv abhängen. Der empirische Fehlerkorreturmodell (ECM)-Ansatz, vorgestellt für Deutschlands Exportwert in die USA, und für die US-Exporte in Deutschland, belegt eindeutig, dass sich ein positiver Effekt auf den realen Wechselkurs, auf den ausländischen BIP und auf dem inländischen BIP – genauer gesagt das Verhältnis des inländischen BIP zum ausländischen BIP – und auf Exportmengen ergibt. US-Exporte nach Frankreich, Italien, den Niederlanden und Spanien haben ähnliche Ergebnisse erzielt. Die gefundenen direkten realen Wechselkurselastizitäten sind aus Standard-Sicht höher als in traditionellen Ansätzen; jedoch zeigt sich, dass die Elastizität eine positive Funktion der relativen Größe des ausländischen Markts ist, die zusammengefasste Export-Elastizität liegt unter der Einheit oder nahe der Einheit. Weiterhin ist die hier neu eingeführte Export-Gleichung auch eine Grundlage für ein überarbeitetes Gravitationsmodell, Mundell-Fleming-Modelle sollten auch angemessen neu festgelegt werden. Was die Euro-Krise anbelangt, erscheint es ziemlich eindeutig, dass die fiskalischen Multiplikatoren für Länder mit Direktinvestitionszuflüssen im Gegensatz zu Direktinvestitionsabflüssen anders als die in einem herkömmlichen Multiplikatormodell aussehen.

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1. Introduction

The theoretical and empirical analysis of trade is a key element of International Economics. As regards the export of goods and services a traditional approach will focus on the role of the real exchange rate and foreign gross domestic product where a long debate has focused on the issues of whether or not the short-term or at least the long run real exchange rate elasticity exceeds unity: According to the familiar Marshall-Lerner condition the sum of the absolute export elasticities must exceed unity if a real depreciation is to bring about an improvement of the trade balance. Among the many interesting studies one may point to the bilateral trade study of Bayoumi (1999) who puts the focus on 21 industrialized countries. Mann/Pluck (2007) consider sectoral US export functions looking at bilateral trade with 31 countries in four sectors in the period 1980-2003. Colacellli (2008) considers different sectors, as well as both high and low income countries, showing that for high income countries the estimates that exist for a unity elasticity are largely corroborated; and similarly for the standard view of below unity findings for developing countries – and, surprisingly, the elasticities for differentiated sectors are higher than for homogenous goods.

As regards the discussion about price elasticities in trade one may emphasize that taking into account the role of foreign direct investment (FDI) can clearly raise the elasticity of exports with respect to the real exchange rate (Welfens, 2012); the main point here is that taking into account FDI makes it necessary to draw a distinction between gross domestic product (*Y*) and gross national income (*Z*) and exports are, of course, proportionate to national income: Since - with α* denoting the share of the capital stock in country 1 owned by foreign investors and ß the share of profits in GDP, * foreign variables and *q** the real exchange rate - the straightforward calculation of $Z = Y(1-\alpha*\beta)+\alpha\beta*Y*q*$ (α is the share of the foreign capital stock owned by investors from country 1 in the simple two country perspective chosen here). Hence, if exports and imports are no longer considered to be proportionate to GDP, but to GNP, the real exchange rate enters the trade equation in an additional dimension which is related to the real value of profits accruing from abroad.

There are several interesting traditional trade studies where our analysis has a strong focus on transatlantic exports. As regards Germany’s exports, an influential study is from Belke, Goecke and Guenther (2009) who consider hysteresis within a new framework of regression analysis that is used to identify critical ranges of exchange rate changes beyond which real export will react. While trade is increasingly taking place in a world of liberalized capital flows and growing foreign direct investment, respectively, not much theoretical analysis has been presented on export functions in the context of open economies with foreign direct investment – this is the field in which the subsequent analysis will provide new insights and present interesting empirical findings. While we can show that the long run real exchange rate elasticities for both the US and Germany exceed unity there is another interesting factor which is new: Based on the theoretical approach presented one should expect that the ratio of the domestic market size to the foreign market size will have a positive impact on real exports and this can indeed be corroborated for both Germany and the US.

The theoretical approach emphasizes that exports, in an economy with foreign direct investment inflows and FDI outflows, should not be assumed to be proportionate to the gross domestic product of the partner country but clearly to gross national product (GNP) which is gross domestic product (GDP) plus net income accruing from abroad. If we consider a case of asymmetric FDI with FDI flowing only to the foreign country (2) then foreign GNP will be smaller than GDP while the source country's GNP will have a GNP which is higher than GDP since net dividends will accrue from country 2. Under certain conditions it can, however, be shown that adequate use of domestic GDP figures and foreign GDP figures allows to analytically and empirically cover a setup with inward FDI and outward FDI.

Part of our analysis is indirectly related to the familiar gravity equation modelling. As regards empirical trade analysis gravity equation modelling, as pioneered by Tinbergen (1962) and developed by Bergstrand (1985) from the theoretical perspective, has become a standard approach which basically states that exports from country i to country j should be a negative function of distance and a positive function of both i's gross domestic product and of j's domestic product (Y and Y^*, respectively, in the simple context of a two country setup). Some additional theoretical arguments have been developed to derive the gravity equation such as the AvW gravity model (ANDERSON/VAN WINCOOP, 2003) but it can be shown – as is done subsequently – that the dependence of real exports on Y and Y^* can also be derived in the specific context of foreign direct investment inflows and foreign direct investment outflows, respectively. Thus we propose a new theoretical basis for trade analysis and one may argue that this is an important analytical step in a world economy with increasing economic globalization and foreign direct investment, respectively. In the context of the EU-US transatlantic trade and investment partnership negotiations it also will be interesting to take a closer look at the empirical findings for transatlantic exports.

In Section 2 the theoretical analysis is presented, Section 3 presents the empirical results for US exports to Germany and some other EU countries; and for German exports to the US. Section 4 suggests some important conclusions. One key insight is that in the presence of FDI, exports are a positive function of Y^*, the real exchange rate q^* and the ratio of $\frac{Y}{q^* Y^*}$, which can be interpreted based on size of the home market relative to the foreign market. We not only present a new theoretical approach but also come up with empirical results for transatlantic trade and finally suggest adequate refinements for both macroeconomic modelling and for gravity modelling.

2. An Export Function for an Open Economy with Foreign Direct Investment

The traditional approach for the analysis of exports is to assume that the quantity exported $X^r = f(q^*, Y^*)$ where the impact of the real exchange rate q^* ($q^* := \frac{eP^*}{P}$ where e is the exchange rate in price notation and P the price level) and of foreign real gross domestic product Y^* on real export is positive. However, in the context of foreign direct investment for the export function, one should consider the fact that real exports can be specified as follows:

$$X^r = x(q^*)Z^* \tag{1}$$

where Z^* is gross national income (WELFENS, 2011). If real exports are indeed proportionate to foreign gross national income, Z^*, one has to consider what the link between Z and real gross domestic product Y and the foreign GDP Y^* is. Let us denote the share of the capital stock (K) owned in country 1 by α* and the share of the foreign capital stock (K^*) by investors from country 1 by α we get the following expression for Z^* (with β denoting the share of profits in country 1 and β* denoting the share of profits in country 2; such shares are consistent with competition in each country and a Cobb Douglas function $Y = K^{\beta} L^{(1-\beta)}$ in country 1 – L is labor and $0 < \beta < 1$ – and $Y^* = K^{*\beta^*} L^{*(1-\beta^*)}$ in country 2:

$$Z^* = Y^*(1-\alpha\beta^*) + \alpha^*\beta \frac{Y}{q^*}; \tag{2}$$

Let us specify – with positive parameters x and η – a simple export function:

$$X^r = xq^{*\eta} Z^* \tag{3}$$

Using the definition of Z^* we therefore get:

$$X^r = xq^{*\eta-1} Y^*(1-\alpha\beta^*)q^* + x\alpha^*\beta Y q^{*\eta-1} \tag{4}$$

We can restate the equation as follows:

$$\left(X^r / q^{*\eta-1}\right) = xY^*(1-\alpha\beta^*)q^* + \alpha^*\beta Y \tag{5}$$

Disregarding the distance variable this equation is consistent with the gravity equation as both the real GDP of the exporting country and of the importing country are in the equation with a positive sign. We can rearrange this equation as follows:

$$\left(X^r / q^{*\eta-1}\right) / \left(xY^* q^*(1-\alpha\beta^*)\right) = 1 + \alpha^*\beta Y / \left(Y^* q^*(1-\alpha\beta^*)\right) \tag{6}$$

Considering that $\ln(1+z)$ is approximately equal to z – for z being close to zero – one may consider a country where $\alpha^*\beta Y / \left(Y^* q^*(1-\alpha\beta^*)\right)$ is close to zero and it also is assumed that $\alpha\beta^*$ is close to zero so that we can write as an approximation:

$$\ln X^r + (1-\eta)\ln q^* - \ln Y^* - \ln q^* - \ln x + \alpha\beta^* = \alpha^*\beta Y / \left(Y^* q^*(1-\alpha\beta^*)\right) \tag{7}$$

$$\ln X^r = (\ln x - \alpha\beta^*) + \eta \ln q^* + \ln Y^* + \left(\alpha^*\beta / (1-\alpha\beta^*)\right)\left(Y / (Y^* q^*)\right) \tag{8}$$

Note that from a European export perspective $Y / (Y^* q^*)$ is nominal home GDP in € relative to nominal foreign GDP expressed in €. Thus we have obtained an equation for the export function which can be easily implemented empirically where we expect η to be positive, while the coefficient for Y^* should be unity; also the coefficient for $Y / (Y^* q^*)$ is positive. Note that the elasticity of real exports with respect to the real exchange rate is a given by:

$$\frac{d \ln X^{r}}{d \ln q^{*}} = \eta - \left(\alpha^{*} \beta / \left(1 - \alpha \beta^{*}\right)\right)\left(Y / \left(Y^{*} q^{*}\right)\right) \qquad (8')$$

Hence the elasticity of exports with respect to q^* are a positive function of the relative size of the foreign market and a negative function of α* and α. A higher share of cumulated foreign direct investment at home and abroad will effectively reduce the elasticity of exports with respect to the real exchange rate. For a small open economy defined here as $Y/(Y^{*} q^{*})$ approaching zero – read: Y^* is very big relative to Y – the elasticity of exports with respect to the real exchange rate is η. Besides this special case, it holds that the overall elasticity of exports with respect to q^* thus has to be calculated for each country separately from the empirical results shown subsequently in the respective tables.

A potential problem is that α and α*, respectively, are a function of q^* if one follows FROOT/STEIN (1991) who have emphasized the role of imperfect capital market for FDI and international mergers & acquisitions, respectively; as α* is a positive function of q^* and α is a negative function of q^* the coefficient for $Y/(Y^{*} q^{*})$ might not be constant and this could make the empirical analysis cumbersome – but the subsequent test statistics do not suggest problems here.

It should be emphasized that the new approach presented here is based on careful theoretical analysis. To the extent that our results reinforce elasticity optimism in international trade we can simply state that the reality in the OECD countries selected does not provide evidence for the seemingly critical pessimism about the reaction of exports with respect to the real exchange rate. Our findings do not exclude that in a North- South perspective where exports of newly industrializing countries often are intermediate imports for goods to be exported by the respective OECD countries – in such a North-South perspective import elasticities might be rather low and as a mirror result export elasticities could also be fairly low.

3. Empirical Evidence

The empirical implementation is straightforward. Our main concern in this empirical analysis is equation 8. The empirical implementation thus is

$$\ln X^{r} = \gamma_0 + \gamma_1 \ln q^{*} + \gamma_2 \ln Y^{*} + \gamma_3 \left[\frac{YP}{eP^{*} Y^{*}}\right] + \varepsilon \qquad (9)$$

We can test whether or not γ_2 is different from zero, but we also can test whether or not γ_2 is different from unity.

This equation can also be written as:

$$\ln\left(X_t^{r}\right) = \gamma_0 + \gamma_1 \ln\left(e_t \frac{P_t^{*}}{P_t}\right) + \gamma_2 \ln Y_t^{*} + \gamma_3 \left[\frac{Y_t}{\left(e_t \frac{P_t^{*}}{P_t}\right) Y_t^{*}}\right] + \varepsilon_t$$

where $X_t^r = \frac{X_t}{P_t}$; X_t^r denotes real export from the reporter country to the partner country; X_t denotes export from reporter country to partner country; P_t denotes GDP deflator of the reporter country; P_t^* denotes GDP deflator of the partner country; Y_t^* denotes real GDP of the partner country; Y_t denotes real GDP of the reporter country; and e_t denotes exchange rate. We use quarterly data from the first quarter of 1999 to the fourth quarter of 2012. Export figures are collected from the reporter country database[1]. In other words, Germany's export to the U.S. statistics are collected from Eurostats database, meanwhile export of the U.S. to Germany statistics are collected from BEA database. Other variables are taken from Eurostats database.

One of the main issues in time series analysis is a unit roots problem. We first conduct stationary test for all variables in equation 10. Augmented Dickey Fuller (ADF) is conducted in both the level and the first difference. The results suggest that all variables have a unit root in the level, but all variables are stationary in the first difference. These imply that a standard regression model that uses level data results in spurious regression problems. One of the alternative models for non-stationary data is Error Correction Model/ECM (YUSUF/EDOM, 2007; HACHICHA, 2003; TAMBI, 1999). ECM requires variables that have the same order of integration and should be co-integrated (BANERJEE, ET.AL, 1993; ENDERS, 2003). ECM allows us to estimate both short-run elasticity and long-run elasticity. Engle-Granger Co-integration test suggests all variables are cointegrated at the 5 percent level (see Appendix 1).

Since we have I (1) variables and all variables are co-integrated, we estimate the one-step ECM, hence:

$$\Delta \ln\left(X_t^r\right) = \gamma_0 + \gamma_1 \Delta \ln\left(e_t \frac{P_t^*}{P_t}\right) + \gamma_2 \Delta \ln Y_t^* + \gamma_3 \Delta \left[\frac{Y_t}{\left(e_t \frac{P_t^*}{P_t}\right) Y_t *}\right]$$

$$-\gamma_4 \left[\ln\left(X_{t-1}^r\right) - \gamma_5 \ln\left(e_{t-1} \frac{P_{t-1}^*}{P_{t-1}}\right) - \gamma_6 \ln Y_{t-1}^* - \gamma_7 \left\{\frac{Y_{t-1}}{\left(e_{t-1} \frac{P_{t-1}^*}{P_{t-1}}\right) Y_{t-1}^*}\right\}\right] + \varepsilon_t$$

where γ_1, γ_2, γ_3 and represent short run elasticity and γ_5, γ_6, γ_7 and denote long run elasticity.

[1] The U.S. Export statistics to Germany, France, Italy, and the Netherlands are taken from the US Bureau of Economic Analysis (BEA) Database while the U.S. Export statistics to Spain is taken from Eurostats database due to data limitation.

Table 1: Bilateral trade between Germany and the US

Variable	Germany's Export to the U.S.			The U.S. Export to Germany		
	Short Run (coefficient / s.e)	Long Run (coefficient / *(SE_{vc})*/{SE_{pv}})	Long Run - IV- (coefficient /[SE_{iv}])	Short Run (coefficient / s.e)	Long Run (coefficient / *(SE_{vc})*/{SE_{pv}})	Long Run - IV- (coefficient /[SE_{iv}])
$ln\left(e_t \frac{P_t^*}{P_t}\right)$	2.583050*** (0.892875)	2.398413 *(1.8031)* **{0.378766}*****	2.398409 [1.803108]	0.683182 (0.942363)	0.31417 *(0.954557)* **{0.161873}***	0.314174 [0.889579]
$ln\,Y_t^*$	4.589179*** (1.275325)	2.058761 *(0.937544)*** **{0.168286}*****	2.058760 [0.937543]**	2.619864** (0.82038)	1.99963 *(0.479817)**** **{0.120494}*****	1.999632 [0.510956]***
$\left[\frac{Y}{\left(e\frac{P_t^*}{P_t}\right)Y^*}\right]$	9.389481** (3.698670)	7.964456 *(8.942507)* **{1.796574}*****	7.964446 [8.942495]	0.098832 (0.198196)	-0.097367 *(0.236685)* **{0.042007}****	-0.097365 [0.221721]
$\frac{\partial \ln X_t^r}{\partial \ln q_t^*}$	0.540838	0.666144		0.235362	0.755352	
R-square	0.458667			0.433956		
Adj R-square	0.378043			0.349651		

***** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent**

Table 1 shows the results of ECM for two cases (equations), namely Germany's export to the U.S. and export of the U.S. to Germany. We also conduct serial LM correlation test and White test in order to check the possibilities of autocorrelation and heteroskedasticity problems. In several equations, the standard error is corrected by using the Newey-West method since the test suggests an autocorrelation problem. It is important to note that in the one-step ECM, the standard errors for the long-run elasticity are not provided in the regression results. Thus, we employ several procedures to generate the standard error for the long run elasticity. Three types of the standard error are presented in the Table, hence the standard error based on variance-covariance (SEvc) and the standard error based on Bewley Transformation which is calculated by using proxy variable (SEpv) and Instrument Variable estimation (SEiv) (see Appendix 2). Generally, the standard error based on Bewley Transformation is always smaller than other two measurements. The results suggest that the impact of real exchange rate on Germany's export to the U.S. is different from zero both in the short run and in the long run. The estimated coefficients suggest that the long run exchange rate elasticity is smaller than the short run elasticity. Interestingly, both estimated coefficients are above unity. One should consider the impact of the real exchange rate on real export not only from the first independent variable, but also from the third independent variable. As previously mentioned in equation (8'), the impact of the real exchange rate on real export should be calculated as $\eta - (\alpha * \beta / ((1-\alpha\beta *)))(\overline{Y} / (\overline{Y * q *}))$.

Therefore, since the coefficients of both the first and third independent variables are significant, the short run exchange rate elasticity is equal to 0.54 in the case of the Germany's export to the U.S.. Moreover, the long run exchange rate elasticity is slightly higher, as much as 0.67.

Table 2: Bilateral trade between France and the US

Variable	France's Export to the U.S.			The U.S. Export to France		
	Short Run (coefficient / s.e)	Long Run (coefficient / (SE_{vc})/$\{SE_{pv}\}$)	Long Run - IV- (coefficient /$[SE_{iv}]$)	Short Run (coefficient / s.e)	Long Run (coefficient / (SE_{vc})/$\{SE_{pv}\}$)	Long Run - IV- (coefficient /$[SE_{iv}]$)
$ln\left(e_t \frac{P_t^*}{P_t}\right)$	3.180742*** (0.88961)	2.211792 (2.542551) {0.550895}***	2.211799 [2.766074]	2.434272*** (0.674172)	4.32029 (2.484499)* {1.323838}***	4.320289 [2.440352]*
$ln Y_t^*$	4.350591*** (1.550539)	0.293871 (0.976826) {0.211649}	0.293870 [1.186958]	0.533555 (1.34895)	0.358352 (0.876427) {0.466995}	0.358352 [0.981789]
$\left[\frac{Y}{\left(e\frac{P_t^*}{P_t}\right)Y *}\right]$	14.10228*** (5.151011)	9.542964 (16.17591) {3.504834}***	9.542986 [17.46881]	0.394316*** (0.107918)	0.682313 (0.399496)* {0.212867}***	0.682314 [0.391541]*
$\frac{\partial \ln X_t^r}{\partial \ln q_t^*}$	0.883325	0.657138		0.066155	0.222568	
R-square	0.458712			0.364879		
Adj R-square	0.378095			0.270287		

***** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent**

In the short run, an increase of real GDP of the partner country is expected to raise export value both in the case of Germany's export to the U.S and export of the U.S. to Germany. Similar to the real exchange rate, the impact of partner country's real GDP is expected to be smaller in the long run relative to the short run. In the gravity model, the partner country's real GDP is also known as the demand capacity variable. Lastly, the impact of our new variable in the case of Germany's export to the U.S, the reporter's nominal GDP relative to the partner's nominal GDP, is expected to be positive and statistically significant in both the long run and in the short run. However, the coefficient is not different than zero in the case of the U.S.' Export to Germany.

In this paper we also ran the model for other four European countries, namely France, Italy, the Netherlands and Spain. Generally, we find similar results on those four countries in terms of the expected sign. However, we should note that the R-square on the regression models are quite low (less than 0.50). Moreover, the elasticities of exchange rate are substantially larger than traditional export model - here exceeding unity. Again, we should also consider the impact of exchange rate through the third independent variable. By using equation (8'), our estimation suggests that the short run and the long run exchange rate elasticity are equal to 0.89 and 0.66 respectively in the case of export of France to the U.S. The results are also similar for the Netherlands but not for Italy. The short run exchange rate elasticity is slightly higher than unity, as much as 1.02.

Table 3: Bilateral trade between Italy and the US

Variable	**Italian Export to the U.S.**			**The U.S. Export to Italy**		
	Short Run (coefficient / s.e)	**Long Run (coefficient / *(SE$_{vc}$)*/{SE$_{pv}$})**	**Long Run - IV- (coefficient /[SE$_{iv}$])**	**Short Run (coefficient / s.e)**	**Long Run (coefficient / *(SE$_{vc}$)*/{SE$_{pv}$})**	**Long Run - IV- (coefficient /[SE$_{iv}$])**
$\ln\left(e_t \frac{P_t^*}{P_t}\right)$	4.70394*** (1.332887)	2.544384 *(1.200655)*** **{0.743744}***	2.544384 [0.992053]**	1.39903* (0.759693)	1.365453 *(0.473396)**** **{0.195778}***	1.365452 [0.589031]**
$\ln Y_t^*$	4.624734* (2.359962)	1.921579 *(1.048901)** **{0.649741}***	1.921579 [0.901951]**	3.083503*** (0.998534)	0.76778 *(0.98845)* **{0.408784}***	0.767780 [0.975188]
$\left[\frac{Y}{\left(e\frac{P_t^*}{P_t}\right)Y^*}\right]$	27.57893*** (8.517175)	10.85716 *(8.519529)* **{5.277414}****	10.85717 [7.272540]	0.151062 (0.09592)	0.134633 *(0.090016)* **{0.037227}***	0.134633 [0.098473]
$\frac{\partial \ln X_t^r}{\partial \ln q_t^*}$	1.02240	1.09505		1.103376	0.983376	
R-square	0.420069			0.353807		
Adj R-square	0.333696			0.257565		

***** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent**

Table 2 presents bilateral trade model between France and the United States. In terms of France's export to the U.S., the results suggest that all coefficients are positive and statistically significant at 1 percent in the short run. However, foreign real GDP is not significant in the long run, even if it still has positive coefficient. Similar empirical evidence is also found in the export model of Italy and The Netherlands which is shown in Table 3 and Table 4. All coefficients are positive (as we expected based on the theoretical framework) but the significances are mixed across countries. Another important finding that should be further discussed is the magnitude of elasticities in the long run relative to the short run. One may expect that long run elasticity is always larger than short run elasticity. However, our empirical findings show that this is not always the case. Bredin and Fountas (2002) also found similar results on Irish merchandise exported to the EU.

Table 5 shows the estimated coefficient for bilateral trade between Spain and the U.S. Generally, the results are similar to other countries except for long run elasticity of our third independent variable (nominal home GDP in € relative to nominal foreign GDP expressed in €). Unlike the results for other European countries, our third independent variable has a negative sign and is statistically significant in the long run. Moreover, the differences between Spain-US bilateral trade model and other European countries bilateral trade model can also be seen on the short run exchange rate elasticity in the case of the U.S.' Export to Spain. It has a negative sign and is statistically significant.

Table 4: Bilateral trade between The Netherlands and the US

Variable	The Netherland Export to the U.S.			The U.S. Export to the Netherland		
	Short Run (coefficient / s.e)	Long Run (coefficient / *(SE_{vc})*/{SE_{pv}})	Long Run - IV- (coefficient /[SE_{iv}])	Short Run (coefficient / s.e)	Long Run (coefficient / *(SE_{vc})*/{SE_{pv}})	Long Run - IV- (coefficient /[SE_{iv}])
$\ln\left(e_t \frac{P_t^*}{P_t}\right)$	2.474268*** (0.819151)	1.50772 *(0.608419)**** {0.443175}***	1.507719 [0.616536]**	1.777832** (0.741122)	1.439353 *(2.226617)* {0.640046}**	1.439353 [2.359145]
$\ln Y_t^*$	5.91716*** (1.467287)	3.689446 *(0.316462)**** {0.230512}***	3.689445 [0.384403]***	3.182179*** (1.024814)	3.490409 *(0.713972)**** {0.205233}***	3.490411 [0.995506]***
$\left[\frac{Y}{\left(e\frac{P_t^*}{P_t}\right)Y^*}\right]$	37.44144** (15.85833)	17.67258 *(13.44092)* {9.790421}*	17.67258 [12.35121]	0.085329** (0.032746)	0.068961 *(0.113763)* {0.032701}**	0.068960 [0.115477]
$\frac{\partial \ln X_t^r}{\partial \ln q_t^*}$	0.650260	0.646778		0.06595417	0.055851	
R-square	0.507945			0.281429		
Adj R-square	0.43466			0.174407		

***** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent**

That short term price elasticity in several cases is higher than the long run price elasticity could point to the fact that 1999 to 2012 was a phase of increasing capacity utilization in the EU and the US – until the onset of the recession in 2008/09. The ratio of the domestic market size to the foreign market size is significant in all cases considered; in some cases, however, only in the short-run and in some cases only in the long run. In the case of France both the long run impact and the short run impact are significant. Interestingly, US exports' price elasticity in trade with France has higher long-term price elasticity than in the short run. Finally, one should note that the definition of the relative size of the domestic market to the foreign market generally lets us expect that the approximation suggested in the theoretical part should be fairly good for European exports going to the US while the approximation for US exports to EU countries might be less adequate.

As regards the particular results for trade between Spain and the US it should be noted that there is evidence for a structural break in Spanish exports to the US after the massive US and international recession in 2008/09 (see appendix). Given the fact that services exports play a particular role for transatlantic trade, with respect to trade between Spain and the US and France and the US it is obvious that the structure of trade could affect the parameters estimated.

Table 5: Bilateral trade between Spain and the US

Variable	Spanish Export to the U.S.			The U.S. Export to Spain		
	Short Run (coefficient / s.e)	**Long Run (coefficient / *(SE$_{vc}$)*/{SE$_{pv}$})**	**Long Run - IV- (coefficient /[SE$_{iv}$])**	**Short Run (coefficient / s.e)**	**Long Run (coefficient / *(SE$_{vc}$)*/{SE$_{pv}$})**	**Long Run - IV- (coefficient /[SE$_{iv}$])**
$ln\left(e_t\frac{P_t^*}{P_t}\right)$	4.151216*** (0.966775)	-0.003163 *(0.677266)* {0.536570}	-0.003163 (0.704607)	3.181589* (1.611815)	4.00965 *(1.44847)**** {0.968475}***	4.009650 [1.448470]***
lnY_t^*	1.027154 (2.600223)	2.73312 *(0.41306)**** {0.327250}***	2.733124 (0.531433)***	4.922183 (3.366138)	1.74853 *(0.788009)**** {0.485734}***	1.748530 [0.788009]**
$\left[\frac{Y}{\left(e\frac{P_t^*}{P_t}\right)Y^*}\right]$	39.23002*** (11.43985)	-10.51017 *(8.574401)* {6.793138}	-10.51017 (7.468144)	0.299333** (0.117731)	0.32769 *(0.104019)**** {0.069403}***	0.327691 [0.104019]***
$\frac{\partial \ln X_t^r}{\partial \ln q_t^*}$	0.92508	0.86116		-0.32564	0.17017	
R-square	0.502082			0.445727		
Adj R-square	0.427924			0.363175		

***** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent**

With respect to the role of the real exchange rate for current account adjustment, it should be noted that any static view (with CA denoting the current account) on dCA/dq* is misleading not only with respect to the necessary distinction between the short run and the medium term adjustment. It also means to overlook the important adjustment channel that an improvement of the current account can occur, not only on the basis of exporting more of a given set of tradable products and of exporting additionally by exporting additional product categories from the initial range of products produced; an important element could also be the creation of product innovations which are then exported – possibly within a product cycle approach. The relevance of this innovation export channel might be related to rising foreign direct investment inflows, namely to the extent that higher FDI inflows go along with a transfer of technology that is relevant for product innovations (here product innovations should be defined with respect to the respective exporting country; not in a global economy perspective). The innovation export channel should be relevant for countries with high per capita income since this should generally stimulate product diversification and should generate pressure for product innovations. Data on the role of product innovations could be taken from innovation surveys – e.g. provided by the European Commission for EU countries – or from strong increases in relative export unit values (say, there is a strong increase in the export unit value of key sectors relative to the export unit value of a benchmark country which could be the US).

4. Conclusions

We have shown that the traditional export function used in both textbooks and many empirical approaches is doubtful and should be refined to include both the foreign GDP and home GDP, where the argument for the latter is related to inward foreign direct investment and the role of GNP, respectively; indeed, exports as well as imports are proportionate to gross national product. Moreover, one also should take into account that consumption is also proportionate not to GDP but to GNP (WELFENS, 2011) and the implications for stabilization policy analysis are considerable. Clearly, an extension of the analysis could be panel data analysis based on the new export function.

Moreover, the empirical implementation of the export function which points to the role of the relative market size – the ratio of the nominal GDP to the foreign nominal GDP – has a powerful implication, namely that gravity equity modeling should be adjusted: The export function presented, augmented by a distance variable, should bring better results than traditional gravity equation modeling.

It is also noteworthy that even in a small open economy analysis exports cannot be treated as an exogenous variable as soon as there is (cumulated) FDI inflows. Moreover, in a world with FDI we clearly have more interdependency through trade than otherwise. Fiscal policy multipliers as well as monetary policy multipliers will differ from models without foreign direct investment.

As regards the difference between GDP and GNP one may point out that in a broader perspective undeclared interest income from abroad – tax dodging problems – seem to distort official statistics. The OECD tax analyses, and discussions among OECD countries, have pointed to problems here. It seems sensible to assume that the difference between GDP and GNP is larger than official data suggest.

As regards macroeconomic modeling, the Mundell-Fleming model – and related modeling approaches for flexible exchange rates – should be modified; and consumption naturally should be proportionate to disposable GNP (with τ denoting the income tax rate where we assume that profits accruing to foreign subsidiaries are not taxed in the host country while profits from subsidiaries abroad are taxed at the foreign income tax rate $\tau*$). Investment consists of a domestic component which is proportionate to the difference between the marginal product of capital and the real interest rate r; plus a foreign investment flows component which reflects the difference between the marginal product of capital at home and the marginal product of capital abroad; v and v' are positive parameters). The equilibrium condition for the goods market, the money market (with M denoting the stock of nominal money, P the price level and m the real demand for money; h and h' are positive parameters) and the foreign exchange market read for the case of a small open economy (with v"(r-r*) denoting real portfolio capital inflows; v" and x and x' are positive parameters):

(I)

$$Y = c(1-\tau)\left(Y(1-\alpha\beta*)+\alpha*\beta*Y*q*\right)+v\left(\beta\frac{Y}{K}-r\right)+v'\left(\beta\frac{Y}{K}-\beta*\frac{Y*}{K*}\right)+G$$

$$+\left\{xq*^{\eta}\left[\left(Y*(1-\alpha\beta*)+\alpha*\beta\frac{Y}{q*}\right)\right]+\frac{x'Y}{q*Y*}-q*\,jq*^{\eta*}\left(Y(1-\alpha*\beta)+\alpha\beta*Y*q*\right)-j'\frac{Y}{q*Y*}\right\}$$

(II) $\frac{M}{P}=\frac{hY}{h'r}$

(III)

$$v''(r-r*)+v'\left(\beta\frac{Y}{K}-\beta*\frac{Y*}{K*}\right)=jq*^{\eta*-1}\left(Y(1-\alpha*\beta)+\alpha*\beta Y*q*\right)+j'\frac{Y}{q*Y*}$$

$$-xq*^{\eta}\left(Y*(1-\alpha\beta*)+xq*^{\eta-1}\alpha*\beta Y\right)-\frac{x'Y}{q*Y*}$$

As can easily be seen, the role of foreign direct investment shows up through the parameters v' as well as α and $\alpha*$; recall that the export function's parameter x' in fact reflects both the parameters α, $\alpha*$ and β and $\beta*$. The size of the fiscal policy multiplier and the size of the monetary policy multiplier are both affected by foreign direct investment (see appendix for selected multiplier results). We have considered here the case of a small open economy and naturally one also may consider the case of a two-country model. Finally, the Marshall-Lerner condition now has to be modified compared to the standard wisdom that the sum of the two import elasticities in absolute terms should exceed unity if a real devaluation is to raise the export-import ratio; it is not difficult to adjust the modified Marshall Lerner condition stated by Welfens (2011) for the case of an economy with FDI. The modified Mundell-Fleming model – with foreign direct investment – has some interesting features that should be taken into account by policymakers (Welfens, 2013a); the slope of the balance-of-payments equilibrium can be zero, not only for the case of an infinite interest elasticity of capital flows but also for a specific set of cumulated FDI flows and certain FDI asymmetry patterns, respectively. There is every reason to go back to more traditional economic modeling provided that refinements in line with trade and FDI have been made. Moreover, as regards DSGE models there are caveats: The key assumption that error terms have a white noise pattern have not been translated into adequate consumption functions (Welfens, 2013b).

The new approach suggested and tested here lends itself to applications to all countries and to a new wave of gravity equation modeling. Policymakers and companies, as well as the general public, could thus get a better understanding of international trade dynamics and economic globalization.

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