European Exports and Outward Foreign Direct Investment: A Dynamic Panel Data Approach

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I. Introduction

Up to now, empirical research on bilateral economic relationships has mostly followed the lines of a gravity model either in its "classical" (Tinbergen 1962; Pöyhönen 1963; Linnemann 1966) or the now more accepted New Trade Theory-based formulation (Helpman 1987; Bergstrand 1985, 1989, 1990; Hummels and Levinsohn 1995; see Oguledo and MacPhee 1994 for an overview). However, more recent theoretical studies of multinationals and trade (Brainard 1993; Markusen and Venables 1998, 2000; and others) have found that the same exogenous factors are at work in determining trade and multinational activities, an aspect that has so far had little impact on the empirical analysis of bilateral economic relationships.[1]

Two caveats can be raised from an econometric point of view with respect to the results of most of the available empirical analyses on bilateral economic relations. First, only a few of the studies made use of the information in every available dimension of variation (i.e., cross-section and time, at the aggregate level). Country-specific effects could

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Remark: I wish to thank W. Kohler and M. Pfaffermayr for extensive discussions and valuable suggestions. I am grateful to P. Balestra, J. Baumgartner, C. Bellak, F. Breuss, J. Cantwell, F. Di Mauro, J. Fersterer, R. Winter-Ebmer, M. Wüger and participants of the 9th International Conference on Panel Data, Geneva 2000, and the 2nd Annual Conference of the European Trade Study Group, Glasgow 2000, for helpful comments. I especially thank an anonymous referee for his insightful comments.

[1] Exceptions are Brainard (1997), Carr et al. (1998), and Markusen and Maskus (1999a, 1999b), who analyzed exports and sales by American MNEs, focusing on the question of determinants, and Brenton et al. (1999), who used a traditional gravity approach to arrive at a conclusion about the domino effects of European integration on FDI.

have had a major influence, but were not tested for in many cases.[2] Secondly, only static specifications have been estimated. A dynamic treatment of the bilateral economic relationships, however, would allow a useful distinction between short-run and long-run relationships.[3]

This paper contributes to the empirical discussion of long-run relationships between bilateral exports and foreign direct investment (FDI). In line with recent theoretical work, the specifications presented here contain identical determining factors for both bilateral trade and multinational activities. Moreover, they are based on a dynamic bivariate panel framework. In this way, we are able to determine more accurately whether the activities by multinational (MNEs, i.e. their investments abroad) and national (exporting; NEs) enterprises are substitutes or complements when driven by changes in different exogenous determinants.

II. Theoretical Background

According to the pathbreaking work of Helpman and Krugman (1985) and Helpman (1987) for the 2×2×2 model of trade with product differentiation similar to Dixit and Stiglitz (1977), exports are determined by the bilateral sum of GDP, the relative country size and relative factor endowments. The larger overall bilateral GDP, the more similar the countries in terms of GDP, and/or the more different countries are in terms of relative factor endowments, the larger is the volume of bilateral trade (see also Hummels and Levinsohn 1995). Transport costs exhibit a negative impact on the volume of trade.

The more recent theoretical literature on trade and MNEs builds on similar model structures and assumes that multinational activity (and FDI) and exports are determined by the same factors (i.e., the above-mentioned Heckscher–Ohlin variables, transport costs and fixed set-up costs for foreign plants). In contrast to pure New Trade Theory, two different approaches are pursued, which differ in their hypotheses on the impact of the Heckscher–Ohlin variables on multinational activity.

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[2] Exceptions are Baldwin (1994), who used a random effects model and projected trade potentials, and Mátyás (1997), who explained bilateral export figures by a random and fixed effects panel approach. In this context, the contributions of Helpman (1987) and Hummels and Levinsohn (1995) fit in, who used panel models of bilateral trade to explain the share of intra-industry trade. Also Carr et al. (1998) and Markusen and Maskus (1999a, 1999b) should be mentioned here.

[3] This is not possible for simple first-difference analyses as those by Bayoumi and Eichengreen (1995).

The vertical model (Helpman 1984; Grossman and Helpman 1991; etc.) assumes that differences in relative factor endowments are the driving force behind the formation of MNEs. MNEs are low-wage seeking in this class of models, and headquarter activities can be locally separated from production facilities. This model is successful in explaining North-South MNE activity but not FDI between the developed countries. Similar to homogeneous trade models, similarity in country size is not a relevant determinant of MNE activity from this model's perspective. The incentive to run a multinational firm stems mostly from differences in relative factor endowments and the relative abundance of labor (or low-skilled labor) abroad (see also Markusen and Maskus 1999a, 1999b for a discussion of this issue). Consequently, exports and multinational activity are complementary with respect to differences in relative factor endowments from a vertical model's point of view.

In contrast, the horizontal model underpins the importance of the trade-off between proximity to the market and concentration of production facilities (Brainard 1993; Carr et al. 1998; Markusen and Venables 1998, 2000; Egger and Pfaffermayr 2000). The decision of how to enter a market is mainly driven by the trade-off between transportation costs and fixed costs of setting up a foreign plant abroad. In contrast to the vertical model, similarity in country size affects multinational activity similar to exports in the New Trade Theory models. In other words, exports and multinational sales (FDI) are complements with respect to changes in the similarity of country size according to this literature. The importance of differences in relative factor endowments is less pronounced.

In sum, a discussion of the effects of growing similarity undertaken by the endowment-based literature on proximity and concentration leads us to less general conclusions, as theoretical results also depend on trade and investment impediments. Conveniently, general equilibrium and empirical analyses have found that decreases in transportation costs should be associated with higher exports and that increases in plant-specific fixed costs lead to less MNE activities (less FDI in our context: see Brainard 1997; Brenton et al. 1999).

From the industrial economist's point of view, the relationship between trade and multinational activities is even less clear-cut, since there are manifold reasons for going multinational. Dunning (1981) in particular suggests in his framework of ownership, location and internalization (OLI) that a distinction should be made between the reasons for ownership, resource-based and local-market oriented investment (location), and the internalization of information and knowledge with-

in firms and across borders. Motives for multinationalization could therefore differ in their effects on the relationship between trade and multinational activities. Similarly, trade replacements are also possible in the long run.

From the industrial economics literature on FDI we know that the motives for going multinational and whether foreign subsidiaries are using foreign-produced inputs or intermediates imported from their parent produce different conclusions about the relationship between trade and FDI (Koizumi and Kopecky 1980). Basically, this goes beyond the static models of Markusen and Venables (1998, 2000), but we could associate adjustment processes and direct relationships between trade and FDI with short-run phenomena, which can be accounted for by including lagged exports and FDI in each equation. From the investment literature we know that the presence of adjustment costs leads to sluggish adjustments of capital stocks (Lucas 1967).[4] Such costs impede the immediate adjustment to the new equilibrium after a shock for both NEs and MNEs, leading to short-run situations apart from the (long-run) steady state, something that general equilibrium models do not usually tell us about (an exception is Koizumi and Kopecky 1980). Additionally, adjustment costs and linkage effects together allow for the possibility of a non-monotonicity of adjustment in the relationship between exports and FDI: they might exhibit a complementary relationship following a shock in the short run, which along the adjustment process could be outweighed by linkage effects between exports and stocks of FDI. Hence, there is a possibility for short-run complementarity and long-run substitution or vice versa, which depends on the associated parameters of the dynamic system.

Most of the empirical literature is built upon partial equilibrium models (see Swedenborg 1979; Caves 1996). More empirical evidence is available on the complementarity of trade and FDI, although some contributions also found substitutive relationships (Frank and Freeman 1978; Cushman 1988; for an overview, see Caves 1996). Complementarity is found, among others, by Lipsey and Weiss (1981, 1984), Blomström and Kokko (1994), Pfaffermayr (1996), and Brenton et al. (1999) at aggregate, industry and firm level. Swedenborg (1979) does not identify any significant and robust interrelationship between the

[4] Koizumi and Kopecky (1980) model adjustment costs for FDI and distinguish between short-run and long-run employment effects. Cushman (1988) assumes adjustment costs for FDI stocks and finds a substitutive relationship between FDI and exports (see also Mathieu 1995).

two. Svensson (1996) points out that distinguishing between final goods and intermediate goods exports is important: Foreign production replaces final goods exports and complements intermediate goods exports. However, he finds a negative net effect. In our case, we will not be able to decide in general whether the relationship is complementary or substitutive, but owing to the different exogenous determinants we need to analyze each for how they influence both exports and stocks of outward FDI in the long run.

III. The Econometric Model

Inclusion of the core variables mentioned above produces the following specification for the static case:

$$X_{ijt} = \alpha_0 + \alpha_1 GDT_{ijt} + \alpha_2 SIMI_{ijt} + \alpha_3 RLFAC_{ijt} + \alpha_4 RLTAX_{ijt} + \alpha_5 TCF_{ijt} + \gamma_{ij} + \delta_t + u_{ijt} \quad (1)$$

for exports and

$$F_{ijt} = \beta_0 + \beta_1 GDT_{ijt} + \beta_2 SIMI_{ijt} + \beta_3 RLFAC_{ijt} + \beta_4 RLTAX_{ijt} + \beta_5 TCF_{ijt} + \varepsilon_{ij} + \zeta_t + \upsilon_{ijt} \quad (2)$$

for FDI, respectively. Indices i, j refer to the country of origin and destination, respectively, of an economic activity; t accounts for the time period; X and F are exports and stocks of outward FDI. Only the exogenous determinants are included in the static case.

GDT expresses the sum of GDPs for the two countries i and j in period t, and *SIMI* indicates the similarity of size by the use of an index (see Section IV). *RLFAC* measures the difference in relative factor endowments between two countries. The remaining variables reflect export and investment impediments. *RLTAX* is the relative corporate tax rate between the exporting (i) and the importing country (j). This variable must be interpreted as influencing both the fixed and the variable costs. It is not an FDI-impeding variable, but we should think of corporate taxes as generally affecting a firm's short-run profits. A ceteris paribus increase in corporate tax rates at home does not necessarily lead to higher outflows of FDI if the latter are financed from retained profits. *TCF* is the transport cost variable. γ_{ij} (ε_{ij}), and δ_t (ζ_t) are the country-pair and time-specific fixed effects. The latter comprehensively account for cycle effects affecting Europe as a whole. This is relevant, since the period under study covers the first years of the European Single Market, which has been accompanied by a vivid stimulation of intra-

European FDI flows. For more details on data generation, see the next section.

To formulate (1) and (2) dynamically, we propose adding lagged endogenous variables to both equations, reasoning that the past should exert a major influence on current exports or FDI. Additionally, lagged exports and FDI should enter the equations transversely, to capture their relationship along the adjustment path, motivated by possible forward and/or backward linkages between the two (see Caves 1996).

However, the model does not work with the fixed effects estimator presented, because the lagged endogenous determinant correlates with the error term. This leaves the estimator biased and inconsistent in typical panels with large cross-sections and short time series.[5] Arellano and Bond (1991) suggest transforming the model either in orthogonal deviations or in first differences to eliminate the fixed effects and run it by using the Hansen (1982) two-step generalized method of moments (GMM) estimator.[6] In either type of transformation, the endogenous variables in levels with a lag two or higher are suitable instruments to overcome the estimation problem.[7] Here, the model will be transformed in first differences and read:

$$DX_{ijt} = \alpha_0 + \alpha_1 DX_{ij(t-1)} + \alpha_2 DF_{ij(t-1)} + \alpha_3 DGDT_{ijt} + \alpha_4 DSIMI_{ijt} + \alpha_5 DRLFAC_{ijt} + \alpha_6 DLTAX_{ijt} + \alpha_7 DTCF_{ijt} + \delta_t + u_{ijt} \quad (3)$$

$$DF_{ijt} = \beta_0 + \beta_1 DX_{ij(t-1)} + \beta_2 DF_{ij(t-1)} + \beta_3 DGDT_{ijt} + \beta_4 DSIMI_{ijt} + \beta_5 DRLFAC_{ijt} + \beta_6 DLTAX_{ijt} + \beta_7 DTCF_{ijt} + \zeta_t + \upsilon_{ijt}. \quad (4)$$

The cross-effects are not modeled contemporaneously, on the following grounds: To start with, it seems more plausible to assume that it takes some time for investments to occur in the production process. Hence, FDI is included in the export equation as a lagged variable. On the other hand, investors may look at export performance before entering a market, so that it will again take some time until investment projects are undertaken. Therefore, today's FDI projects should – if at all – be related to yesterday's rather than today's exports.

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[5] See Baltagi (1995) and Sevestre and Trognon (1995) for the treatment of and the literature on this bias.

[6] Thereby, one gets rid of all time-invariant influences. Examples of time-invariant determinants are distance, endowments with natural resources, etc.

[7] The absence of second-order serial correlation of the residuals and the satisfaction of the moment equations are necessary conditions.

It should be noted that parameters α_i and β_i only represent short-run influences on the dependent variables. Both equations should indicate a positive influence of lagged endogenous exports and FDI ($1>\alpha_1>0$; $1>\beta_2>0$). There is no clear prior about the cross-effects of yesterday's exports (FDI) on today's FDI (exports). In line with the above (static) models of trade and multinationals, we will define exports and FDI as being complementary with respect to a change in an exogenous variable if, in the long run, they evolve in the same direction after such a change in the determinant. Due to parameter signs for the lagged endogenous variable, the cross-effects between exports and FDI, and the short-run parameters of the exogenous variables together determine the long-run relationship between the two – which is not directly obvious from the short-run estimation results. For instance, α_2, $\beta_1>0$ (<0) alone would not imply a complementarity (substitution) between exports and FDI for a shock in an exogenous determinant.

Principally, the static models of reference do only support the interpretation of the long-run equivalents of the estimated parameters which are presented below (indicated by a bar; see Footnote 8 for the derivation of the long-run influences): As mentioned above, $\bar{\alpha}_3$ ($\bar{\beta}_3$) and $\bar{\alpha}_4$ should exhibit a positive sign. As discussed above, the expected sign for $\bar{\beta}_4$ depends on the theoretical background. We would expect $\bar{\alpha}_5>0$ and do not have a clear prior for the impact of a change in relative factor endowments on FDI. Exports and stocks of outward FDI should be observed to face a substitutive relationship after an increase in the relative corporate tax rate ($\bar{\alpha}_6<0$ and $\bar{\beta}_6>0$).

The influence of transport costs should have opposite signs for exports and FDI, $\bar{\alpha}_7<0$ and $\bar{\beta}_7>0$: Higher bilateral transport costs represent an impediment of entering the foreign market via exports. They should therefore drive firms to invest abroad and serve the foreign market through locally active affiliates.

IV. Data

All variables are in logs. As far as possible, data cover the period 1986–1996 for bilateral relationships between the current 15 EU members. For reasons of availability, Belgium and Luxembourg were treated as a single country, so that only 14 countries are given.

1. Trade and FDI Data

Nominal bilateral exports in current dollars were taken from OECD *Statistics of Foreign Trade*. To obtain real exports at constant prices and

1995 dollars, the series were converted using export price indices (OECD *Economic Outlook*) and the corresponding exchange rate index (IMF *International Financial Statistics*) for each country.

Outward FDI stock data in current prices and dollars were taken from the OECD *International Direct Investment Statistics Yearbook*. Although it would be possible to employ a gravity-like model for FDI flows (Martín and Velàzquez 1997), it is more appropriate in our case to choose stocks rather than flows, as stocks are employed in the production process. Brainard (1997), following the theoretical background, used MNE sales in the host countries, but these are not reported for the set of countries and level of aggregation envisaged by us. Therefore, we apply FDI stocks, remembering their relationship with MNE sales. To get real data, we propose taking the reported values (book values of foreign assets) as a rough approximation of depreciated initial values. However, "real" stocks should consist of book values multiplied by a constant. Hence, book values could be used instead of them in the production function, taking into account that the estimated parameters should be smaller if we could use the "real" values for stocks of FDI (see Bellak 1996 and OECD 1999). This enables us to use the investment deflator (OECD *National Accounts*, Volume 1) in combination with the exchange rate index for all countries, in order to arrive at a proxy for real stocks of bilateral FDI. However, one should always bear in mind that the FDI variable is an approximation only, and that the coefficients for this variable need to be interpreted with care. The panel remains unbalanced, due to the availability of bilateral data on FDI. Bilateral outward FDI stock data are available for Germany, Italy, Austria, and Sweden over the period 1986–1996; for France and the United Kingdom between 1987 and 1996; for Finland (1992–1996) and for the Netherlands (1986–1995).

2. Country Size and Factor Data

In line with Helpman (1987) and Hummels and Levinsohn (1995) country size is represented by the inclusion of overall bilateral country size ($GDT_{ijt} = GDP_{it} + GDP_{jt}$) and an index of similarity in country size (*SIMI*). The latter was introduced by Helpman (1987) and is defined as follows:

$$SIMI_{ijt} = \ln\left[1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)^2\right], \quad (5)$$

with $0 \leq SIMI \leq 0.5$, giving the extreme bounds of maximum difference and similarity in size. GDP and the respective deflator figures were collected from the OECD *National Accounts*, Volume 1, and converted into real values.

Capital stocks were developed according to a simple perpetual inventory method:

$$K_t = (1-\delta) K_{t-1} + GFCF_t, \tag{6}$$

with K representing the capital stock, δ being the real depreciation rate of 5 percent for all countries and years ($\delta = 0.05$), and $GFCF$ as the gross fixed capital formation (OECD *National Accounts*, Volume 1). In line with Hummels and Levinsohn (1995), capital stocks were set to a value 250 percent of real GDP for all countries in one year (1995). It was not possible to do this for the starting point of the data (1986), as the panel is not balanced and time series for some countries begin after 1986. The capital stock values of all the other years were then calculated using the above-mentioned perpetual inventory technique. In order to get real values of the required type, GFCF was converted using the investment and exchange rate deflators.

For equations with just two endowment factors, capital-labor ratios were calculated, so that the countries' working population was included as a variable (OECD, *STAN Database*). In the corresponding equation, the commonly used absolute difference in relative factor endowments (Helpman 1987) was included in the specification, which is given as

$$RLFAC_1 = \left| \ln \frac{K_{jt}}{N_{jt}} - \ln \frac{K_{it}}{N_{it}} \right|, \tag{7}$$

with $0 \leq RLFAC_1$. With regard to different levels of education (school enrollment), enrollment numbers from the OECD *Education Statistics 1985–1992*, *Education at a Glance* (several years) and the UNESCO *Statistical Yearbook* for each country and year were used. In one case, the relation between low-skilled people (primary education) and high-skilled people (the sum of persons with secondary and tertiary education) was used to approximate the skill composition of the work force. This could, of course, be biased by the fact that better educated people (with at least secondary school enrollment) are more successful in getting jobs. With three factors of production, on the other hand, *RLFAC* has to be refined by using a different distance measure. Here, an angular vector distance measure is applied to obtain a new variable which

represents differences in relative factor endowments:

$$RLFAC_2 = \ln \frac{(K_{it} \cdot K_{jt}) + (H_{it} \cdot H_{jt}) + (L_{it} \cdot L_{jt})}{\sqrt{(K_{it})^2 + (H_{it})^2 + (L_{it})^2}\ \sqrt{(K_{jt})^2 + (H_{jt})^2 + (L_{jt})^2}}, \tag{8}$$

with $-\infty \leq RLFAC_2 \leq 0$, and K, H, L expressing real capital stocks, higher educated (at least secondary school enrollment) and lower educated persons in heads. The maximum distance between endowment vectors of two countries is due to orthogonality and given as $RLFAC_2 = -\infty$. Identical relative factor endowments are then vectors which are (if at all) of different lengths, $RLFAC_2 = 0$. The same was done for the four-factor measure ($RLFAC_3$), where, in addition to physical capital, the three types of enrollment were entered as a different factor, and again $-\infty \leq RLFAC_3 \leq 0$. The latter was applied as it represents the lowest level of aggregation for available skill data at country level. In order to decompose $RLFAC_2$ and to test for different signs of differences in the relative endowment of physical capital to low-skilled labor and human capital to low-skilled labor two differences are calculated according to $RLFAC_1$:

$$KLS = \left| \ln \frac{K_{jt}}{L_{jt}} - \ln \frac{K_{it}}{L_{it}} \right| \tag{9}$$

$$HLS = \left| \ln \frac{H_{jt}}{L_{jt}} - \ln \frac{H_{it}}{L_{it}} \right|. \tag{10}$$

The two variables are used in one of the export and FDI specifications instead of $RLFAC_2$.

3. Other Variables

Transport costs in most studies are proxied by distance numbers between two countries' capitals. However, as it is clear that distances do not vary over time, an attempt should be made to find a substitute, considering in particular that decreasing trade costs should show some relevance for increasing integration. To get a measure to this effect, we followed the line of Geraci and Prewo (1976) and others, applying the relationship between mirror data from the importing country (c.i.f.) and free on board (f.o.b.) values reported by the exporting country. Naturally, this is only a proxy, because of the well-known limitations of trade data (see Brainard 1997). On the other hand, our sample of countries should not be affected by problems resulting from statistical conveniences, since we

Table 1: *Descriptive Statistics: Average Annual Percentage Change of Relevant Variables, 1986–1996 (all variables in real terms at constant prices and USD 1995)*

Country	FDI from EU countries	Imports from EU countries	Share of low-skilled people	Share of high-skilled people	Real capital/ labor ratio	Transport costs	Corporate tax rates	Real GDP per capita
Belgium-Luxembourg	7.33	–2.55	–1.19	1.13	1.59	–0.43	–0.38	2.03
Denmark	9.91	–1.34	0.98	–0.79	0.42	0.20	0.00	1.57
Germany	7.66	1.14	1.88	–0.95	3.05	–0.50	–1.45	1.55
Finland	3.77	–6.19	–0.74	0.58	3.98	–0.72	0.00	1.11
France	8.99	–0.83	–0.75	0.65	2.39	–0.12	–3.97	1.37
UK	12.46	0.19	–0.86	0.63	1.01	–0.96	–3.27	1.94
Ireland	31.68	11.47	–1.84	2.14	0.47	–1.90	0.00	5.67
Italy	8.13	–1.60	–1.07	0.80	2.35	–1.03	3.71	1.71
Netherlands	22.19	0.30	0.05	–0.04	2.46	–3.50	–3.11	1.99
Austria	3.63	–5.80	0.96	–0.52	4.23	1.06	–2.21	1.87
Portugal	22.71	7.29	–3.63	4.80	3.89	–1.76	0.00	3.37
Sweden	20.90	–1.39	0.25	–0.22	1.57	–1.01	0.00	0.71
Spain	8.48	8.28	–1.55	1.23	3.56	1.36	0.59	2.64

focus only on EU member states. It should be mentioned that these problems could be entirely avoided if we could use c.i.f. and f.o.b. values reported by the same country (Brainard 1997). This is, however, possible only for the United States, which is not helpful in this context. Average corporate tax rates were taken from Mennel and Foerster (1997).

Since we are concentrating on fixed effects and dynamic panel data analysis, it is adequate to look at growth rates of variables rather than at levels. Table 1 presents average annual growth rates for different variables over the period 1986–1996. Both FDI stocks and imports are measured as outward stocks of FDI and exports from partner country statistics. More details about the panel coverage for FDI stocks are provided above.

V. Empirical Results

The first stage comprises the estimations for the static fixed effects (equations 1 and 2; see Table 2). Obviously, the fixed country-pair effects account for a lot of information which is expressed by a rather high value for the corresponding likelihood ratio statistic. The high values for the Hausman chi-squared statistic in both equations confirm that group effects should better be modeled as fixed effects. Nevertheless, the remaining information, after wiping out country-pair and time-specific effects, leaves us with mostly significant parameter estimates. It should be noticed that no lagged endogenous effects and cross-effects of FDI on exports and vice versa are included, so that the static equations only contain determinants from the static theoretical models. The parameter for relative corporate tax rates shows the opposite sign of what was expected from theory. One possible reason could be that the adjustment process cannot be modeled in the static case. We will therefore turn to the dynamic specifications (equations 3 and 4).

In order to evaluate the sensitivity of the dynamic regression results with respect to different formulations of the difference in relative factor endowments variable (*DRLFAC*), four specifications of the export and FDI equation respectively are estimated. As reported in Tables 3 and 4, the hypothesis that first-difference residuals are second-order serially correlated can be rejected in all specifications. This is a necessary condition for valid instrumentation and can be seen from the robust test for second-order serial correlation as well as from the two-step Sargan statistic. The reported Sargan test statistics show that the hypothesis that all moment restrictions are satisfied for all dynamic specifications is not rejected at the 5 percent significance level. There seems

Table 2: *Determinants of Intra-EU Exports and Outward FDI Stocks, 1986–1996 (unbalanced fixed effects panel regression results (levels in logs))*

Variable[a]	Export		Foreign direct investment (FDI)	
	α	std. error	β	std. error
Sum of bilateral GDPs (*GDT*)	2.451	0.243**	4.572	1.124**
Similarity in country size (*SIMI*)	1.407	0.119**	1.506	0.551**
Relative factor endowments ($RLFAC_2$: *K, HS, LS*)	0.791	0.086**	–1.210	0.399**
Relative average corporate tax rates (*RLTAX*)	–0.047	0.022**	0.221	0.103**
Transport cost factor (*TCF*)	–0.262	0.047**	–0.115	0.220
Constant	–43.849	6.772**	–105.505	31.366**
	p-value		*p*-value	
Statistics (N=86; T=11)				
Observations	827		827	
Adj. R^2	0.996		0.957	
Standard error of the estimate	0.095		0.442	
Time effects[b] (11)	45.65	0.000**	65.44	0.000**
Country-pair effects[b] (86)	3,420.48	0.000**	2,184.00	0.000**
Hausman[c] (5)	68.21	0.000**	25.34	0.000**

[a] Degrees of freedom in parentheses. – [b] Likelihood ratio test, testing the restriction of joint zero parameters for the respective fixed effects. – [c] Asymptotically distributed as χ^2. – ** significant at 5 percent.

to be no severe problem of over-identification of the moment restrictions. However, if the moment restrictions were not valid (not satisfied) this would imply that the hypothesis of the model and the instrumentation which have led to the restrictions might have been incorrect.

In all specifications for both exports and stocks of outward FDI, the lagged endogenous variables show that adjustment costs play a significant role and are of approximately equal size for both exports and FDI. The estimation results confirm that, within the EU and across the observed period, outward FDI (exports) for most specifications shows a very small positive (negative) impact on exports (FDI) in the short run, which is not different from zero at common levels of significance. As

Table 3: *Determinants of Intra-EU Exports, 1988–1996*
(dynamic panel regression results (first differences; dependent variable is export))

Variable[a]	(X1)		(X2)		(X3)		(X4)	
	α	std. error	α	std. error	α	std. error	α	std. error
Lagged exports (DEX_{-1})	0.624	0.032**	0.704	0.031**	0.642	0.032**	0.539	0.031**
Lagged FDI ($DFDI_{-1}$)	0.000	0.003	–0.001	0.004	0.000	0.003	0.001	0.004
Sum of bilateral GDPs (*DGDT*)	0.535	0.149**	0.190	0.147	0.378	0.139**	0.578	0.140**
Similarity in country size (*DSIMI*)	0.347	0.110**	0.197	0.111*	0.319	0.107**	0.316	0.100**
Relative factor endowments ($DRLFAC_1$: *K/L*)	0.007	0.004*	–	–	–	–	–	–
Relative factor endowments ($DRLFAC_2$: *K, HS, LS*)	–	–	–0.448	0.093**	–	–	–	–
Relative factor endowments ($DRLFAC_3$: *K, E1, E2, E3*)	–	–	–	–	–0.065	0.018**	–	–
Capital/low-skilled ratio (*DKLS*: *K/LS*)	–	–	–	–	–	–	0.177	0.029**
High-skilled/low-skilled ratio (*DHSLS*: *HS/LS*)	–	–	–	–	–	–	–0.147	0.021**
Relative corporate tax rates (*DRLTAX*)	–0.124	0.011**	–0.140	0.013**	–0.131	0.011**	–0.127	0.011**
Transport cost factor (*DTCF*)	–0.224	0.023**	–0.231	0.024**	–0.223	0.024**	–0.229	0.026**
Constant	0.037	0.007**	0.044	0.007**	0.039	0.006**	0.040	0.007**
	p-value		*p*-value		*p*-value		*p*-value	
Statistics (N=86; T=9)[b]								
Observations	655		655		655		655	
R-squared[c]	0.31		0.26		0.31		0.36	
Standard error of the estimate[c]	0.06		0.06		0.06		0.05	
Overidentification[d] (44)	58.14	0.075	56.47	0.098	55.04	0.123	55.36	0.117
Serial correlation 1st order[e] (86)	–4.33	0.000**	–4.58	0.000**	–4.46	0.000**	–4.32	0.000**
Serial correlation 2nd order[e] (86)	–1.60	0.055	–1.60	0.054	–1.59	0.056	–1.66	0.048
Time effects[f] (9)	2,502.7	0.000**	2,734.6	0.000**	2,794.8	0.000**	2,050.7	0.000**
Outlier effects[f] (9)	435.4	0.000**	560.7	0.000**	448.2	0.000**	782.0	0.000**

[a] Only two-step GMM estimation results are presented. DEX_{-1} and $DFDI_{-1}$ have been instrumented according to Arellano and Bond (1991). All exogenous variables enter the instrument set as usual. For explanations of different versions of *DRLFAC* (changes in the bilateral distance of relative factor endowments), see Section III. Parameter estimates for outlier dummies and fixed time effects are not presented in order to save space. – [b] Degrees of freedom are reported in parentheses. – [c] Calculated by the use of residuals from the one-step estimation. – [d] Two-step version of the Sargan (1958) test of over-identifying restrictions, asymptotically distributed as χ^2. – [e] Asymptotically distributed as a standard normal distribution. – [f] Wald tests for testing the restriction of joint zero parameters for the respective effects (fixed time and outlier effects), asymptotically distributed as χ^2. – ** significant at 5 percent, * significant at 10 percent.

Table 4: *Determinants of Intra-EU Stocks of Outward FDI, 1988–1996*
(dynamic panel regression results (first differences; dependent variable is foreign direct investment))

Variable[a]	(F1)		(F2)		(F3)		(F4)	
	β	std. error	β	std. error	β	std. error	β	std. error
Lagged exports (DEX_{-1})	–0.084	0.084	0.000	0.083	–0.060	0.090	–0.116	0.078
Lagged FDI ($DFDI_{-1}$)	0.692	0.023**	0.677	0.023**	0.673	0.023**	0.717	0.024**
Sum of bilateral GDPs (*DGDT*)	4.545	0.445**	3.889	0.439**	4.355	0.456**	4.555	0.408**
Similarity in country size (*DSIMI*)	2.229	0.189**	1.728	0.243**	2.144	0.196**	1.883	0.207**
Relative factor endowments ($DRLFAC_1$: *K/L*)	0.017	0.013	–	–	–	–	–	–
Relative factor endowments ($DRLFAC_2$: *K, HS, LS*)	–	–	–1.584	0.246**	–	–	–	–
Relative factor endowments ($DRLFAC_3$: *K, E1, E2, E3*)	–	–	–	–	–0.205	0.078**	–	–
Capital/low-skilled ratio (*DKLS*: *K/LS*)	–	–	–	–	–	–	0.487	0.110**
High-skilled/low-skilled ratio (*DHSLS*: *HS/LS*)	–	–	–	–	–	–	–0.250	0.081**
Relative corporate tax rates (*DRLTAX*)	0.011	0.038	–0.073	0.038*	–0.012	0.037	0.024	0.039
Transport cost factor (*DTCF*)	0.419	0.080**	0.438	0.082**	0.423	0.084**	0.469	0.080**
Constant	–0.078	0.034**	–0.036	0.032**	–0.070	0.033**	–0.082	0.029**
	p-value		*p*-value		*p*-value		*p*-value	
Statistics (N=86; T=9)[b]								
Observations	648		648		648		648	
R-squared[c]	0.21		0.18		0.18		0.22	
Standard error of the estimate[c]	0.31		0.31		0.31		0.31	
Overidentification[d] (44)	55.97	0.107	56.20	0.103	53.16	0.162	53.95	0.145
Serial correlation 1st order[e] (86)	–4.18	0.000**	–4.20	0.000**	–4.20	0.000**	–4.29	0.000**
Serial correlation 2nd order[e] (86)	–0.26	0.399	–0.26	0.396	–0.28	0.389	–0.34	0.365
Time effects[f] (9)	659.6	0.000**	537.5	0.000**	630.1	0.000**	650.0	0.000**
Outlier effects[f] (9)	149,947.2	0.000**	164,796.7	0.000**	273,722.7	0.000**	281,447.9	0.000**

[a] Only two-step GMM estimation results are presented. DEX_{-1} and $DFDI_{-1}$ have been instrumented according to Arellano and Bond (1991). All exogenous variables enter the instrument set as usual. For explanations of different versions of *DRLFAC* (changes in the bilateral distance of relative factor endowments), see Section III. Parameter estimates for outlier dummies and fixed time effects are not presented in order to save space. – [b] Degrees of freedom are reported in parentheses. – [c] Calculated by the use of residuals from the one-step estimation. – [d] Two-step version of the Sargan (1958) test of over-identifying restrictions, asymptotically distributed as χ^2. – [e] Asymptotically distributed as a standard normal distribution. – [f] Wald tests for testing the restriction of joint zero parameters for the respective effects (fixed time and outlier effects), asymptotically distributed as χ^2. – ** significant at 5 percent, * significant at 10 percent.

already noted, this does not suffice to say whether they are complementary or substitutive. It might perhaps lead to the conclusion that the impact on intra-firm trade caused by FDI is greater than the replacement effect from competition in serving the foreign market. We should note that the cross-effect of FDI on exports is relatively small compared to the opposite one. This should be explicable from the fact that FDI growth rates are, on average, much higher than those of exports. In order to obtain conclusions about the long-run effects of a shock in an exogenous variable we have to transform the parameter values into their long-run equivalents.[8]

Table 5 provides information on the long-run effects of a ceteris paribus shock in the various exogenous variables on exports and outward FDI. These effects depend not only on the short-run parameters estimated in the different specifications, but also on the multiplier which must be calculated from the coefficients of both the lagged endogenous variables and the cross-impacts of exports on FDI and vice versa. However, this leads to long-run effects which in all cases are greater than their short-run equivalents. As a rule, a shock of 1 percent in an exogenous variable in period $(t-1)$ must be interpreted as a shock of $\alpha_i(\beta_i)$ percent in growth of exports (FDI) in the same period. Hence, we have to calculate own and cross-effects of such a change to come up with the overall effects on both exports and FDI. Depending on the estimated parameter signs, own effects could be either reinforced or lowered by the cross-effects.

There is evidence that bilateral exports are an increasing function of positive dynamics in bilateral economic space and similarity of country size. This follows from the fact that, in all export equations, the coefficient of both *DGDT* and *DSIMI* is positive and the determinant of

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[8] We can derive the associated multipliers for the shocks by the use of the 2×2 parameter matrix $B=\begin{pmatrix}\beta_2 & \beta_1\\ \alpha_2 & \alpha_1\end{pmatrix}$. We should first notice that such a shock is equivalent to a simultaneous shock in exports and FDI in the same period. The effect on exports and FDI therefore comprises an own and a cross effect. Making use of the steady-state assumptions ($X_t=X_{t-1}$ and $F_t=F_{t-1}$) we simply can compute $M=(I-B)^{-1}$ where I is a 2×2 identity matrix. Elements $m_{12}=\beta_1/[(1-\beta_2)(1-\alpha_1)-\beta_1\alpha_2]$ and $m_{12}=\alpha_2/[(1-\beta_2)(1-\alpha_1)-\beta_1\alpha_2]$ then are the multipliers for the long-run effect of a shock in exports on FDI (in FDI on exports, respectively). Elements $m_{11}=(1-\alpha_1)/[(1-\beta_2)(1-\alpha_1)-\beta_1\alpha_2]$ and $m_{22}=(1-\beta_2)/[(1-\beta_2)(1-\alpha_1)-\beta_1\alpha_2]$ are due to the long-run own effects for FDI and exports because of the bivariate nature of the specifications. In sum, a shock in the exogenous variable i leads to a long-run change of $(\alpha_i m_{11}+\beta_i m_{21})$ in exports and of $(\beta_i m_{22}+\alpha_i m_{12})$ in FDI, respectively.

Table 5: *Long-Run Effects of Shocks in the Exogenous Variables on Exports (DX*) and FDI (DF*)*

Shock in error equivalent to 1 percent shock in:[a]	(X1), (F1)		(X2), (F2)		(X3), (F3)		(X4), (F4)	
	*DX**	*DF**	*DX**	*DF**	*DX**	*DF**	*DX**	*DF**
Sum of bilateral GDPs (*DGDT*)	1.432	15.391	0.617	12.732	1.049	13.951	1.291	16.780
Similarity in country size (*DSIMI*)	0.926	7.207	0.655	5.470	0.887	6.570	0.698	6.551
Relative factor endowments ($DRLFAC_1$: *K/L*)	0.019	0.051	–	–	–	–	–	–
Relative factor endowments ($DRLFAC_2$: *K*, *HS*, *LS*)	–	–	–1.487	–4.763	–	–	–	–
Relative factor endowments ($DRLFAC_3$: *K*, *E*1, *E*2, *E*3)	–	–	–	–	–0.180	–0.588	–	–
Capital/low-skilled ratio (*DKLS*: *K/LS*)	-	–	–	–	–	–	0.386	1.570
High-skilled/low-skilled ratio (*DHSLS*: *HS/LS*)	–	–	–	–	–	–	–0.319	–0.748
Relative corporate tax rates (*DRLTAX*)	–0.327	0.125	–0.471	–0.224	–0.365	0.032	–0.273	0.196
Transport cost factor (*DTCF*)	–0.590	1.529	–0.779	1.360	–0.619	1.411	–0.490	1.868
Roots of the bivariate polynomial:[b]								
z_1	1.44		1.42		1.48		1.40	
z_2	1.60		1.48		1.56		1.85	

[a] Long-run effects have been calculated by the use of the dynamic multipliers according to Footnote 8. – [b] According to Lütkepohl (1993) the dynamic processes are stable if the roots (z_1, z_2, i.e., the inverses of the eigenvalues) of their corresponding polynomials are greater than 1 in absolute value: $|z_1|, |z_2| > 1$.

the cross-effects does not outweigh own effects. The same holds true for stocks of outward FDI, which is in a line with the theoretical arguments forwarded by Helpman (1984) for MNEs in a "vertical model" as well as by Markusen and Maskus (1999b) for MNEs which follow the "horizontal model" or the "knowledge-capital model." It contradicts the theoretical findings of Egger and Pfaffermayr's (2000) model, where a ceteris paribus increase in the larger country's size generally generates more outward FDI by that country.

The sign for the difference in the relative factor endowments variable obviously depends on its definition. Using partly insignificant estimation results for exports, we find a clear positive influence for the first specification. This result again confirms Helpman's (1984) theoretical suggestions, according to which both exports and FDI should increase because of increasing specialization. As mentioned above, the theory for the sign in the FDI equation is not so clear-cut. Our empirical evidence shows that the inclusion of information on skills (enrollments) in specifications 2 and 3 (X2–F2 and X3–F3) changes the sign as compared to specification 1. Yet, when we split up employment into high-skilled and low-skilled workers and calculated the distances between both the physical capital/low-skilled and the high-skilled/low-skilled people endowments, we obtained different results. Increasing differences in the relation between physical capital endowment and low-skilled people endowment were found to increase both exports and FDI, in line with the arguments of Helpman (1984) and Markusen and Maskus (1999b) for vertical MNEs. On the other hand, a higher diversity in the endowment of better educated people in relation to less educated ones seems to reduce the incentive both to export and to invest abroad. This coincides with the results of models with horizontally oriented MNEs and the "knowledge-capital model" (Carr et al. 1998; Markusen and Maskus 1999b). The reason for this might be the critical role that human capital (or higher school enrollment) and low-skilled labor (or lower school enrollment) play with regard to innovation, production and growth, but also for the size and composition of demand. However, this is an empirical finding for which we do not have a broad theoretical basis as it can be discussed only within a theoretical framework which acts in a space of at least three factors.

Higher relative corporate tax rates in the exporting country may exert a pressure on the size of exporting firms, which theoretically should result in lower exports and higher FDI from that country. This result is very robust for exports, and in three out of four specifications the empirical evidence for the long-run effects on FDI at least does not con-

tradict our theoretical priors. This was already found in the static estimations and could additionally be related to the problem of special tax-related agreements in favor of MNEs. An increase in transport costs between two countries is held to be a classical impediment to exports, and it is confirmed in all specifications: we find that higher transport costs tend to reduce bilateral exports and increase bilateral outward FDI.

In sum, a clear substitutive relationship between exports and stocks of outward FDI after a change in the transport cost factor was indicated, as was expected from the theory. There is some sign of a complementary relationship after a shock in the growth rate of bilateral sums of GDPs and similarity in country size. Empirical evidence also shows a clear complementary relationship after changes in the distance between relative factor endowments (although some of the coefficients do not have the expected sign). The theory led us to expect a substitutive relationship after a change in the relative corporate tax rate, but it was not confirmed in a significant way by the long-run effects on outward FDI.

VI. Conclusions

Furnishing an explanation for bilateral economic relationships was one of the greatest successes of empirical trade economics in the last decade. Prominent attention was given to analyzing trade flows by way of the gravity model. More recent theoretical work has underpinned the role of multinationals and their interrelationship with trade. Some of the empirical work has thus looked at whether multinational sales and trade are driven by the same determinants and whether this works in the same direction. This paper has estimated specifications for bilateral intra-EU activities based on static general equilibrium models for endowment-based trade and multinationals, where trade and FDI (not multinational sales) are determined by the same factors.

The aim was to identify their long-term relationships according to different exogenous determinants. By formulating the model dynamically, it was possible to identify the role of adjustment costs for both bilateral exports and stocks of outward FDI, and to distinguish between short- and long-term influences of changes in the exogenous variables, which would not be possible in simple static specifications. A panel data approach was used to exploit information in the time and cross-section dimensions simultaneously.

The estimations do not point at any clear-cut and significant influence of the cross-effects between exports and stocks of outward FDI.

However, the respective short-term parameters, although generally very small, do exhibit mostly a positive sign for the influence of FDI on exports and a negative one for the inverse relationship. In neither specification are the effects different from zero at any convenient levels of significance.

The estimation results show that trade impediments influence both trade and FDI in a way which is expected from theory. The same applies to both bilateral economic space (sums of GDPs) and similarity of country size in the export equation, but not directly to FDI. The underlying theories do not yield a uniform expectation with respect to the latter. We find no clear effect of the variable which measures the distance in relative factor endowments between two countries. A substantial difference was identified in the effects of changes in differences between the human capital to low-skilled labor ratios vis-à-vis the physical capital to low-skilled labor ratios. The estimation results point at a complementary relationship between FDI and exports because of increasing differences in relative factor endowments, although no gains from specialization are indicated for some of the specifications.

To summarize, important theoretical results were confirmed by the estimations. But some points remain inconclusive. There is empirical evidence of different influences of physical capital, low-skilled and high-skilled labor endowments, which most of the theoretical work does not account for. As compared to other empirical research we do not find a clear support of a single theoretical model as the "horizontal" or the "knowledge-capital" model of the multinational enterprise in aggregate European exports and stocks of outward FDI. Further theoretical and empirical analysis is needed in order to achieve better understanding and to identify the role of human capital, low-skilled labor and physical capital within models of endowment-based trade and multinational activities. It would also be interesting to apply the empirical analysis to other country samples. Especially, differences in the influence of determinants of economic relations between industrialized countries and developing countries could be important, because of differences not only in the capital-to-labor ratio, but also in the high-skilled-to-low-skilled labor ratio.

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Abstract: European Exports and Outward Foreign Direct Investment: A Dynamic Panel Data Approach. – This paper implements a panel data approach for studying the determinants of and relationships between bilateral economic activities in terms of both trade and foreign direct investment between the EU member states. The familiar equation for testing the determinants of bilateral exports is reformulated to reflect recent theoretical work. It is specified as a dynamic panel data model designed to answer questions about their relationship according to changes in different exogenous determinants. Exports and stocks of outward FDI are found to be substitutes with respect to changes in transport costs and complements with respect to most of the other determinants. JEL no. C33, F14, F15, F23