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

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Abstract

This paper implements a panel data approach for studying the determinants of and relationships between bilateral economic activities in terms of 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 obtain answers 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.

Key words: gravity equation, panel econometrics
JEL: C33, F14, F15, F23

1 Introduction[1]

First attempts to explain bilateral economic relationships - or more precisely volumes of trade - were made about 35 years ago in the tradition of Issac Newton's law of gravity (Tinbergen, 1962; Poeyhoenen, 1963; Linnemann, 1966). Since then, theoretical and empirical research has proliferated. The former was driven by two issues: First, factors of trade resistance and impediments (transportation costs) were shown to be compatible with expenditure-based models (Anderson, 1979; Bergstrand, 1985 and 1989). Secondly, the aspect of bilateral relationships in a multilateral world was underpinned by models supplied by the New Trade Theory (Helpman, 1987; Bergstrand, 1990; Hummels & Levinsohn, 1995).

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Empirical progress was based mainly on the former, motivated by the fact that many specifications of the gravity type were found to explain bilateral trade volumes rather well (see Oguledo & MacPhee, 1994 for an overview). However, in spite of its empirical succes, reservations from the theoretical side could not be eliminated: it was repeatedly criticised that most of the tested equations were ad hoc specifications (Leamer & Levinsohn, 1995) derived not from a specific but from any plausible model of trade (Deardorff, 1998) which reduced the degree of interest awarded to this type of research at the economic policy level.

Former empirical research was concerned almost solely with trade relations. But more recent theoretical studies of multinationals and trade have found that the same exogenous factors are at work in determinig trade and multinational activities, an aspect that has so far had little impact on the empirical analysis of bilateral economic relationships[2].

Two caveats can be raised from an econometric point of view with respect to the results of most empirical analyses. First, only a few of these 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 have been a major influence, but were not tested for in many cases[3]. 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[4].

This paper aims to make a contribution 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. Working from a dynamic bivariate panel framework, it studies the long-run relationships between exports and stocks of outward FDI. 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 sub-

[2]Exceptions are Brainard (1997), who analysed exports and sales by American MNEs, focussing 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.

[3]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 & Levinsohn (1995) fit in, who used panel models of bilateral trade to explain the share of intra-industry trade.

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

stitutes or complements in terms of changes in different exogenous determinants.

Below, a summary is given of the theoretical background for the empirical setup. The next section develops specifications, while section 4 reports on the construction of variables and the sources of data. Section 5 presents the estimation results, followed by the conclusions arrived at in section 6.

2 Theoretical Background

Most of the theoretical progress in incorporating the theory of the multinational firm into the New Trade Theory was achieved only in recent years. Research in the field concentrated on the so-called proximity-concentration trade-off. Two approaches were pursued. First, game theory models were used to endogenize market structures, i. e. to explain the presence of MNEs by reasoning along an economies-of-scale and oligipolistic market structures line (Horstmann & Markusen, 1992; Brainard, 1993). Secondly, research returned to the endowment-based model. The presence of either MNEs or NEs or both within the framework of monopolistic competition was shown to be driven by a mix of factors such as the link between plant and firm-specific fixed costs, costs of transportation, relative factor endowments and relative country size (Markusen & Venables, 1996 and 1998; Egger & Pfaffermayr, 2000). Although general conclusions from the analyses of the latter type are scarce, due to the complexity of models, the specifications in section 3 will include the relevant variables from this research.

Clearly, some particular variables can be found in every endowment-based study of bilateral trade (see Helpman, 1987, or Hummels & Levinsohn, 1995). These are country size (relative and absolute bilateral economic space) and differences in relative factor endowments. A look at the more recent literature on trade and MNEs informs us that two more variables should be of great importance: they are export- and investment-impeding factors. The formers are associated with the costs of transportation, the latter with fixed costs and entry barriers (see Markusen & Venables, 1996 and 1998; Brainard, 1997; etc.).

Obviously, the well-known trade and multinational models tell us only about the (mostly static) steady-state. Nevertheless, most endowment-based setups show that multinational activities and trade enjoy a complementary relationship in the long-run after a change in similarity of size or relative factor endowments[5]. We would expect a positive influ-

[5] This conclusion follows from the endowment-based models developed in the tradition of Markusen (1983), Helpman (1984), Grossman & Helpman (1991), and Brainard (1993), see Pfaffermayr (1996) for an overview.

ence of increased bilateral economic space on both exports and FDI. Increasing similarity in terms of country size should be associated with a positive change of bilateral exports (see also Helpman, 1987). The same would hold true for FDI in a world without trade and investment impediments (as in Helpman, 1984). In the more recent theory on proximity and concentration, however, the effects of changes in relative size on FDI are not so clear. Markusen & Venables (1998) show that, due to the dominance of corner solutions (either only MNEs or only NEs are active) the effects on the number or the sales of MNEs might differ due to different levels of the transportation cost parameter. On the other hand, Egger & Pfaffermayr (2000) show that increasing c.p. the size of a country relative to the other would always imply a positive change in the volume of outward FDI of that country.

Growing differences in relative factor endowments on the (overall but not intra-industry) export side are commonly associated with higher exports due to gains in specialisation. According to Helpman (1984), this also holds true for multinational activities in the two-factor model. Markusen and Venables (1998) show that the effect of a c.p. change of relative endowments depends on which type of firms is active initially. Neither Helpman (1984) nor Markusen & Venables (1998) provide us with an answer regarding the effects on FDI, as their MNEs supply only headquarter services but not capital to their foreign operations. Considering a linear relationship between MNE sales and FDI, this would point at similar effects in terms of their sign of a greater similarity between two countries in terms of relative relative factor endowments on both trade and FDI for empirical analysis albeit MNEs do not explicitely serve the foreign market with capital in these models[6]. Egger & Pfaffermayr (2000), however, show that c.p. changes in relative endowment of labour, physical and human capital imply different effects on (exports and) FDI. By modelling the role of physical and human capital and the reasons for going multinational, we would thus arrive at different conclusions about the effects of a change in relative endowment.

[6]Basically, trade theory tells us more about MNE sales than about their capital-serving nature by way of FDI. Most of the theoretical contributions do not associate capital flows across borders with the process of multinaionalisation at all. Therefore, multinational sales would be the more proper variable from a theoretical point of view, but they go unreported in most countries. On the other hand, capital outflows and inflows are relevant variables in their own right from a political economist's point of view. Bearing in mind the linear relationship between MNE sales and FDI (foreign owned capital stocks) we will interpret the theoretical conclusions so as to get a broader basis for the hypotheses. It should be noted that a few general equilibrium models do distinguish between the headquarter-serving and the capital-serving nature of multinationals. Examples are Markusen & Venables (1998) and Egger & Pfaffermayr (2000).

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 which in many cases produce corner solutions for firm types (either MNEs or NEs are active).

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). The higher corporate tax rates are, the smaller should be the volume of exports and FDI, mainly the result of shrinking firm sizes. Note that the numbers of NEs and MNEs normally depend only on factor endowments. Thus, an increase in relative corporate tax rates would not result in a change in the numbers of firms in either country, but only in a change of short-run profits, wages and firm sizes. We would therefore expect to decrease both exports and FDI. Hence, capital should be less likely to flow out when corporate tax rates of the home country increase relative to the host country.

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 internalisation (OLI) that a distinction should be made between the reasons for ownership, resource-based and local-market oriented investment (location), and the internalisation of information and knowledge within firms and across borders. Motives for multinationalisation could therefore differ in their effects on the relationship between trade and multinational activities. Similarly, trade replacements are also possible in the long-run.

In order to obtain empirical answers regarding the long-run relationship between exports and FDI, we need to include two additional variables in each equation. From the investment literature we know that the presence of adjustment costs leads to sluggish adjustments of capital stocks (Lucas, 1967)[7]. Such costs impede the immediate adjustment to the new equilibrium after a shock for both NEs as well as MNEs, leading to short-run situations off-side the (long-run) steady-state, something that general equilibrium models do not usually tell us about (an exception is Koizumi & Kopecky, 1980).

From the industrial economic literature on FDI, on the other hand,

[7]Koizumi & 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).

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 & Kopecky, 1980). Basically this goes beyond the static models of Markusen & Venables (1996, 1998), 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.

More empirical evidence is available on the complementarity of trade and FDI, although some contributions also found substitutive relationships (Frank & Freeman, 1978; Cushman, 1988; for an overview see Caves, 1996). Complementarity is found i.a. by Lipsey & Weiss (1981, 1984), Blomström & Kokko (1994), Pfaffermayr (1996), and Brenton et al. (1999) at aggregate, industry and firm level. 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 analyse each for how they influence both exports and stocks of outward FDI in the long-run.

3 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

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

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. In order to capture the long-run influences, 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 4). $RLFAC$ 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 variable costs. We should think of corporate taxes as affecting a firm's short-run profits. The model of Egger & Pfaffermayr (2000) shows that an increase in the corporate tax rate of the parent country would lower both exports and FDI delivered by that country. TCF is the transport cost variable. γ_{ij} (ε_{ij}), and δ_t (ζ_t) are the country-pair and time-specific fixed effects. For more details on data generation see the next section .

To formulate equations (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[8]. Arellano & 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 generalised method of moments (GMM) estimator. In either type of transformation, the endogenous variables in levels with a lag two or higher are suitable instruments to overcome the estimation problem[9]. Here, the model will be transformed in first differences and read:

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

$$\begin{aligned} DF_{ijt} = {} & \beta_0 + \beta_1 DX_{ij(t-1)} + \beta_2 DF_{ij(t-1)} + \beta_3 DGDT_{ijt} + \beta_4 DSIMI_{ijt} \\ & + \beta_5 DRLFAC_{ijt} + \beta_6 DRLTAX_{ijt} + \beta_7 DTCF_{ijt} + \delta_{2t} + u_{2ijt} \end{aligned} \quad (4)$$

The cross-effects are not modelled contemporaneously, on the following grounds: To start with, it seems more plausible to assume that

[8] See Baltagi (1995) and Sevestre & Trognon (1995) for the treatment of and the literature about this bias.

[9] The absence of second oder serial correlation of the residuals and the satisfaction of the moment equations are necessary conditions.

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.

It should be notet 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. However, $\alpha_2, \beta_1 > 0$ (< 0) alone would not imply a complementarity (substitution) between exports and FDI for a shock in an exogeneous 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 below for the derivation of the long-run influences): As mentioned above, $\overline{\alpha}_3$ ($\overline{\beta}_3$) and $\overline{\alpha}_4$ should indicate a positive sign. As discussed above, the expected sign for $\overline{\beta}_4$ depends on the theoretical background. We would expect $\overline{\alpha}_5 > 0$ 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 complementary relationship after an increase in the relative corporate tax rate ($\overline{\alpha}_6 < 0$ and $\overline{\beta}_6 < 0$).

The influence of transport costs should have opposite signs for exports and FDI, $\overline{\alpha}_7 < 0$ and $\overline{\beta}_7 > 0$: Greater 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.

4 Data

All variables are in logs. As far as possible, data cover the period of 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.

4.1 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 (Martìn & 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, which should be a linear function of 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.

4.2 Country Size and Factor Data

In line with Helpman (1987) and Hummels & 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:

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

with $0 \leq SIMI \leq 0.5$, giving the extreme bounds of maximum difference and similarity in size. GDP and the respective deflator num-

bers 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:

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

with K representing the capital stock, δ being the real depretiation rate of 5% 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 & Levinsohn (1995), capital stocks were set to a value 250% 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 polpulation was included as a variable (OECD, STAN Data). In the corresponding equation, the commonly used absolute difference in relative factor endowments (Helpman, 1987) was included in the specification, which is given as:

$$RLFAC_1 = \mid \ln \frac{K_{jt}}{N_{jt}} - \ln \frac{K_{it}}{N_{it}} \mid \tag{7}$$

with $0 \leq RLFAC_1 \leq 1$. With regard to different levels of education (school enrolment), enrolment 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 (primary education) and high skilled (the sum of secondary and tertiary enrolled persons) was used to compute the skill composition of the work force. This could, of course, be biased by the fact that higher enroled people are more successful in getting jobs. With 3 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:

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

with $-\infty \leq RLFAC_2 \leq 0$, and K, H, L expressing real capital stocks, higher educated (at least secondary school tier) and lower educated persons in heads. The maximim distance between endowment vectors of two countries is due to orthongonality 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 enrolment 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 unskilled labor and human capital to unskilled labor two differences are calculated according to $RLFAC_1$:

$$KLS = \mid \ln \frac{K_{jt}}{L_{jt}} - \ln \frac{K_{it}}{L_{it}} \mid \tag{9}$$

$$HLS = \mid \ln \frac{H_{jt}}{L_{jt}} - \ln \frac{H_{it}}{L_{it}} \mid \tag{10}$$

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

4.3 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 & 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 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 US, which is not helpful in this context. Average corporate tax rates were taken from Mennel & Foerster (1997).

5 Empirical Results

The first stage comprises the estimations for the static fixed effects (equations 1 and 2; see Table 1). 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 modelled 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 and cross-effects of FDI on exports and vice versa are included, so that the static equations should represent the long-run relationship. The parameter for relative corporate tax rates shows the opposite sign than was expected from theory. One possible reason for that could be that the adjustment process cannot be modelled in the static case. We will therefore turn to the dynamic specifications (equations 3 and 4).

< Table 1 about here >

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 2 and 3, 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% significance level. There seems to be no severe problem overidentification 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.

< Table 2 and 3 about here >

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 already noted, this does not suffice to say whether they are complementary or substitutive. It might perhaps 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 explainable 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[10].

< Table 4 about here >

Table 4 provides information on the long-run effects of a c.p. shock in the various exogeneous 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% in an exogenous variable in period $(t-1)$ must be interpreted as a shock of α_i (β_i) % 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

[10] We can derive the associated multipliers for the shocks by the use of the $2x2$ 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 ($DX_t = DX_{t-1}$ and $DF_t = DF_{t-1}$) we simply can compute $M = (I - B)^{-1}$ where I is a $2x2$ identity matrix. Elements $m_{12} = \frac{\beta_1}{(1-\beta_2)(1-\alpha_1)-\beta_1\alpha_2}$ and $m_{21} = \frac{\alpha_2}{(1-\beta_{22})(1-\beta_{11})-\beta_{21}\beta_{12}}$ then are the multipliers for the long-run effect of a shock in exports on FDI (in FDI on exports, respectively). Elements $m_{11} = \frac{1-\alpha_1}{(1-\beta_2)(1-\alpha_1)-\beta_1\alpha_2}$ and $m_{22} = \frac{1-\beta_2}{(1-\beta_{22})(1-\beta_{11})-\beta_{21}\beta_{12}}$ 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 $(\alpha_i \cdot m_{11} + \beta_i \cdot m_{21})$ in exports and of $(\beta_i \cdot m_{22} + \alpha_i \cdot m_{12})$ in FDI, respectively.

size. This follows from the fact that, in all export equations, the coefficient of both $DGDT$ and $DSIMI$ is positive and the determinant of 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) but contradicts the theoretical findings of the model of Egger & Pfaffermayr (2000), where a c.p. increase in the larger country's size generally generates more outward FDI by that country.

The sign for the difference in 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 (enrolments) in specification 2 and 3 (X2-F2 and X3-F3) changes the sign as compared to specification 1. Yet, when we splitted 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 others. On the other hand, a higher diversity in the endowment of higher enrolled people in relation to less enrolled ones seems to reduce the incentive both to export and to invest abroad. The reason for this might be in the critical role that human capital (or higher school enrolment) and unskilled labor (or lower school enrolment) 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 3 factors.

Higher relative corporate tax rates in the exporting country exert pressure on the profits of both NEs and MNEs, which theoretically should result in lower exports and FDI from that country. This result is very robust for exports, but generally contradicted by the long-run effects on FDI. This was already found in the static estimations and could 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 lead us to expect a complementary relationship after a change in the relative corporate tax rate, but it was not confirmed by the long-run effects on outward FDI.

6 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 analysing trade flows by way of the gravity model. More recent theoretical work underpinned the role of multinationals and their activities interrelated with trade. Some of the empirical work thus looked at whether FDI (multinational sales) and trade are driven by the same determinants. This paper thus estimated specifications for bilateral intra-EU activities based on static general equilibrium models for endowment-based trade and multinationals, where trade and FDI are determined by the same factors.

The aim was to identify their long-term relationships caused by shocks in the 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, yet 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 was expected in theory. The same applied for both bilateral economic space (sums of GDPs) and similarity of country size in the export equation, but not directly for FDI, where

the underlying theories are not agreed. We found no clear effect of the variable which measures the distance in relative factor endowments between two countries. The result depends on which factors model is used: A substantial difference was identified in the effects of changes in differences between the human capital-unskilled labour ratios vis-à-vis physical capital-unskilled labour ratios. The estimation results pointed at a complementary relationship between FDI and exports because of increasing differences in relative factor endowments, although no gains from specialisation were indicated for some of the specifications.

In summary, substantial theoretical results were confirmed by the estimations. Some points are still inconclusive. There is empirical evidence of different influences of physical capital, unskilled and skilled labour endowments, which most of the theoretical work does not account for. Further theoretical and empirical analysis is needed in order to achieve better understanding and to identify the role of human capital, unskilled labour and physical capital within models on 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 for economic relations between industrialised countries and developing countries could be important, because of differences not only in the capital-to-labour ratio but also in the skilled-to-unskilled-labour ratio.

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Table 1: Determinants of Intra-EU-Exports and Outward FDI-Stocks 1986 - 1996
Unbalanced Fixed Effects Panel Regression Results (Levels in logs)

Variable[1]	Export		Foreign direct investment	
	β	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[2] (11)	45.65	0.000 **)	65.44	0.000 **)
Country pair effects[2] (86)	3420.48	0.000 **)	2184.00	0.000 **)
Hausman[3] (5)	68.21	0.000 **)	25.34	0.000 **)

1) Degrees of freedom in parentheses. - 2) Likelihood ratio test, testing the restriction of joint zero parameters for the respective fixed effects. - 3) Asymptotically distributed as χ^2. - **) significant at 5 percent, *) significant at 10 percent.

Table 2: Determinants of Intra-EU-Exports 1988 - 1996

Dynamic Panel Regression Results (First differences; dependent variable is export)

Variable[1]	(X1)		(X2)		(X3)		(X4)	
	β	Std. error	β	Std. error	β	Std. error	β	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)[2]								
Observations	655		655		655		655	
R^2 [3]	0.31		0.26		0.31		0.36	
Standard error of the estimate[3]	0.06		0.06		0.06		0.05	
Overidentification[4] (44)	58.14	0.075	56.47	0.098	55.04	0.123	55.36	0.117
Serial correlation 1st order[5] (86)	-4.33	0.000 **)	-4.58	0.000 **)	-4.46	0.000 **)	-4.32	0.000 **)
Serial correlation 2nd order[5] (86)	-1.60	0.055	-1.60	0.054	-1.59	0.056	-1.66	0.048
Time effects[6] (9)	2502.7	0.000 **)	2734.6	0.000 **)	2794.8	0.000 **)	2050.7	0.000 **)
Outlier effects[6] (9)	435.4	0.000 **)	560.7	0.000 **)	448.2	0.000 **)	782.0	0.000 **)

1) Only two-step GMM-estimation results are presented. DEX_{-1} and $DFDI_{-1}$ have been instrumented aaccording to Arellano & Bond (1991). All exgogenous 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 3. Parameter estimates for outlier dummies and fixed time effects are not presented in order to save space. - 2) Degrees of freedom are reported in parentheses. - 3) Calculated by the use of residuals from the one-step estimation. - 4) Two-step version of the Sargan (1958) test of over-identifying restrictions, asymptotically distributed as χ^2. - 5) Asymptotically distributed as a standard normal distribution. - 6) 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 3: Determinants of Intra-EU-Stocks of Outward FDI 1988 - 1996

Dynamic Panel Regression Results (First differences; dependent variable is foreign direct investment)

Variable[1]	(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	0.085 **)	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	β	p-value		p-value
Statistics (N=86; T=9)[2]								
Observations	648		648		648		648	
R^2 [3]	0.21		0.18		0.18		0.22	
Standard error of the estimate[3]	0.31		0.31		0.31		0.31	
Overidentification[4] (44)	55.97	0.107	56.20	0.103	53.16	0.162	53.95	0.145
Serial correlation 1st order[5] (86)	-4.18	0.000 **)	-4.20	0.000 **)	-4.20	0.000 **)	-4.29	0.000 **)
Serial correlation 2nd order[5] (86)	-0.26	0.399	-0.26	0.396	-0.28	0.389	-0.34	0.365
Time effects[6] (9)	659.6	0.000 **)	537.5	0.000 **)	630.1	0.000 **)	650.0	0.000 **)
Outlier effects[6] (9)	149947.2	0.000 **)	164796.7	0.000 **)	273722.7	0.000 **)	281447.9	0.000 **)

1) Only two-step GMM-estimation results are presented. DEX_{-1} and $DFDI_{-1}$ have been instrumented aaccording to Arellano & Bond (1991). All exgogenous 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 3. Parameter estimates for outlier dummies and fixed time effects are not presented in order to save space. - 2) Degrees of freedom are reported in parentheses. - 3) Calculated by the use of residuals from the one-step estimation. - 4) Two-step version of the Sargan (1958) test of over-identifying restrictions, asymptotically distributed as χ^2. - 5) Asymptotically distributed as a standard normal distribution. - 6) 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: Long-Run Effects of Shocks in the Dependent Variables on Exports (ΔX^*) and FDI (ΔF^*)

	(X1), (F1)		(X2), (F2)		(X3), (F3)		(X4), (F4)	
Shock of 1 percent in[1]:	ΔX^*	ΔF^*	ΔX^*	ΔF^*	ΔX^*	ΔF^*	ΔX^*	ΔF^*
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, E1, E2, E3)	-	-	-	-	-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[2]:								
z_1	1.44		1.42		1.48		1.40	
z_2	1.60		1.48		1.56		1.85	

1) Long-run effects have been calculated by the use of the dynamic multipliers according to footnote 10. - 2) 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: $|z_1|, |z_2| > 1$.