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TRADE OPENNESS AND INTERNATIONAL FRAGMENTATION OF PRODUCTION IN THE EUROPEAN UNION: THE NEW DIVIDE?

by Paolo Guerrieri* and Filippo Vergara Caffarelli**

Abstract

This paper analyses the relationship between international fragmentation of production, trade openness and global export performance in the European Union from 2000 to 2009. As most trade models featuring international production sharing show, the higher the level of fragmentation and related international openness the better the export performance of a country. Our econometric analysis confirms this hypothesis. We estimate an error correction model based on panel data on the EU Member States and find that inter-European fragmentation and openness significantly improve their long-run export performance. Policy implications could be that restrictive policies preventing firms from internationalizing production would weaken a country's position in global production networks, with long-term negative effects on domestic jobs and growth.

JEL Classification: F14, L23.
Keywords: international fragmentation of production, trade openness, export performance, European Union.

Contents

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1. Introduction

The international economic landscape dramatically changed in the last two decades. One of the dominant features of globalisation is the international fragmentation of production. Firms in the developed area have geographically fragmented their production, subcontracting an ever expanding range of activities from product design, to components, to assembly and also increasingly service activities. Firms are outsourcing and off-shoring in order to lower costs, acquire higher quality inputs and generally improve their competitiveness. And there are no yet serious signs that these trends are really receding as a consequence of the recent crisis.

In the past fifteen years international production sharing has received a lot of attention in Asia where international production networks have sprung up. However the European Union (EU) is no exception to this world trend. Intra-EU trade and cross border production further increased because of the EU accession of the relatively low-wage central and Eastern European economies whose involvement in the international production networks of the core countries in the EU has been widely documented in the literature. In the case of Europe international fragmentation is thus especially evident in intraregional European trade.

The international fragmentation of production has also been widely studied within a trade theoretic framework and in particular the link between trade openness, international fragmentation of production and export performance is well identified. Both in a Ricardian (Eaton and Kortum, 2002) and in a monopolistically competitive (Krugman, 1979) framework a high involvement in international outsourcing and a high level of imports (of intermediates) and of exports (of finished goods) could promote more efficient production levels. At the same time, it has been shown that barriers to trade could increase the overall cost of fragmented production technologies and facilitate (inefficient) domestic vertical integration.

In this paper we want to investigate the role of cross-border production within the EU in explaining the increasingly diverging export performance of European economies. In the background we have the clear evidence of a divide between Germany with the Eastern European economies on the one side and the other large EU countries

on the other. According to the OECD export performance index, between 2000 and 2008 merchandise exports of Germany, Czech Republic, Hungary, Poland, Slovakia and Slovenia grew on average faster than their destination markets, while the opposite occurred for France, Italy, Spain and the UK. As noted in Danninger and Joutz (2007), the establishment of regionalized production chains is a crucial determinant of Germany's increased export market share in the 2000s.

Using detailed quarterly data on intra-EU trade ranging from the early 2000s to the end of the dramatic recession in 2009, we estimate the relation between global export performance of the European countries, on the one hand, and intra-EU fragmentation of production and intra-EU trade openness, on the other. Our aim is to appreciate whether countries more involved in international production sharing and therefore more open to European partners are indeed better performers in the global export market.

Evidence from the most representative EU Member States appears to support such a relationship. Germany and its central and Eastern European partners are increasingly interconnected on the production side and open among each other. They all improved their global export performance.

In our econometric analysis we take into account the dynamic nature of the panel and estimate an error correction model for export performance. The results confirm the existence of a statistically significant relationship. Fragmentation and trade openness are both significant determinants of the global export performance of the EU Member States in the long run.

The rest of the paper is organized as follows. The next section outlines the framework of the analysis. Section 3 presents our measures of fragmentation, openness and export performance. Section 4 contains the econometric analysis and section 5 concludes.

2. Framework of the analysis

International fragmentation of production[1] (IFP) occurs when some phases of a multi-stage production process are located abroad, keeping others and the overall coordination in the home country. This relocation may involve the supply of components, the provision of services or the assembly of final products. There are two main tasks that countries participating in international production sharing networks may perform: producers of intermediates or assemblers of final goods. In general countries may also locate in intermediate positions along the international value chain (e.g., producing intermediates in some sectors and assembling final goods in others, or producing and exporting "assembled intermediates" using imported inputs).

Production fragmentation can clearly take place only among countries that are open to trade and foreign investment as international outsourcing takes the form of investment (initially) and trade (subsequently) among participating countries. It generates particularly trade in intermediate inputs and products, which can sometimes cross border several times before being incorporated into a final good that can be sold domestically or abroad.

Baldwin (2006) argues that the actual globalisation process occurs at the level of the firms, which can fragment their production stages and/or delocalise tasks because of lower communication and coordination costs. The adoption of a fragmented production process enables firms to benefit from lower production costs and is aimed at increasing the efficiency and international competitiveness of the final-good producers, hence their export performance. The empirical literature confirms that a growing share of international trade consists of intermediate inputs.

Such reasoning has been clearly shown in a formal theoretical framework. Models of production sharing belong to different branches of the (international) economics literature. For a survey see, among others, Breda et al. (2007), Guerrieri and Vergara Caffarelli (2005) and the book edited by Arndt and Kierzkowski (2001).

[1] In the literature various terms are used to refer to a substantially unique phenomenon: international fragmentation of production (Jones and Kierzkowski, 1990), vertical specialisation (Hummels et al., 1998), global production sharing (Feenstra, 1998), international outsourcing (Grossman and Helpman 2002), international production networks (Ernst and Guerrieri, 1998). We use these terms interchangeably.

Industrial-Organization models of fragmentation such as Burda and Dluhosch (2002), Grossmann and Helpman (2002) and Jones and Kierzkowski (2001) directly link the extent of fragmentations (hence imports of intermediates) with the scale of production and of exports. In this framework firms engage in vertical specialization and open up internationally in order to lower (marginal and average) production costs and increase their competitive edge in final-good markets. At a microeconomic level the existence of the relationship we hypothesize is hence theoretically confirmed.

In the Krugman-style new trade theory literature firms compete monopolistically (Dixit and Stiglitz, 1977) both at home and abroad. Amiti (2005) explicitly introduces an intermediate-good sector and shows that for certain parameter values there exists an equilibrium with fragmentation. Moreover in her model larger exports require larger imports of intermediate goods establishing also in this context the proportional relationship going from production sharing and international openness to exports. Moreover a similar relationship also holds in Ricardian models, such as Yi (2003). This indicates that the existence of the link from fragmentation and openness to export performance is not due to imperfection in the competition structure.

Few empirical studies address the issue of the link between export performance and international production fragmentation. As mentioned above, Danninger and Joutz (2007) find that regionalized production was a key determinant of Germany's improved export performance. Bas and Strauss-Kahn (2011) analyze firm level data on French exporters and conclude that an increase in the set of imported input varieties increased significantly the number of exported varieties. Kasahara and Lapham (2006) develop and estimate a model which accounts for both imports of intermediates and exports of final goods and uncover the existence of strong import and export complementarities in Chile.

We are hence confident that the relationship we are exploring is theoretically sound and on these grounds we will focus our empirical analysis on verifying the theoretical assumption that European fragmentation and openness significantly and positively affect the export performance of the EU Member States.

The phenomenon of IFP has been extremely important in Asia where international production networks have literally exploded over the past two decades and

has also gained increasing importance in intra-EU trade with the accession of relatively low-wage central and Eastern European economies. We want to appreciate the extent of this participation of the Member States in transnational production sharing and openness and how these two factors affect the European countries' global export performance.

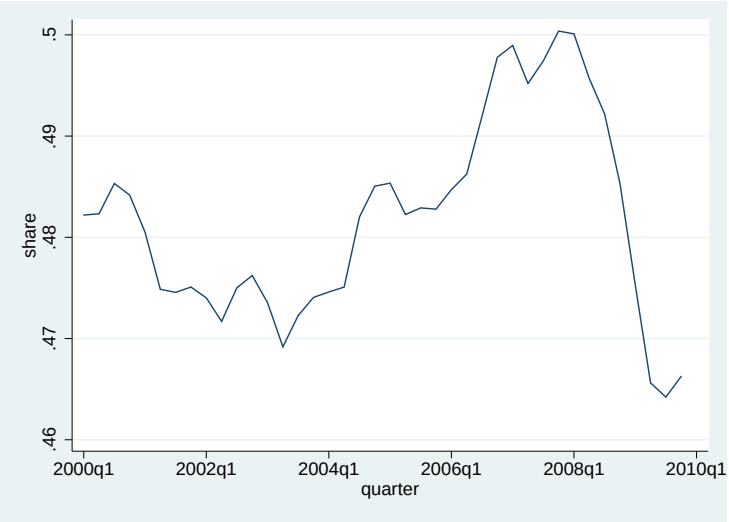
In the case of Western European firms and countries their late involvement in international production sharing – in comparison with the frontrunners, mainly US and Japan – determined the geographical concentration of their international outsourcing activities in the central and Eastern parts of the continent.[2] By transferring part and/or some production phases to Eastern Europe in the wider context of fragmentation processes taking place at the European and global level, Western European firms could maintain their competitive positions on a global scale and continue to expand their domestic markets. Nowadays most countries belonging to those transnational production networks are members of the European Union. Hence intra-EU fragmentation is for EU Member States a very good approximation of global fragmentation.[3]

Yeats (1998) and Hummels et al. (2001) have used trade in intermediate inputs or in parts and components to proxy for global production sharing. Consequently we expect trade in intermediates to be very important and increasing within the EU. Indeed intermediate goods account for almost one half of the internal trade in the EU. Figure 1 depicts the share of parts and components in the trade among the current 27 EU Member States from 2000Q1 to 2009Q4.

The share of intermediates was already high in 2000 confirming that production fragmentation was already in place. After experiencing a decline during the "growth pauses" in 2001 and 2003, trade in parts and components peaked up reaching a 50% share in the end of 2007. The beginning of the recession in early 2008 and the acute phase of the financial crisis determined a significant drop in the trade of intermediate goods which showed signs of stabilization only in the end of 2009.

[2] See De Benedictis and Tajoli (2008), Kaminski and Ng (2005) and Guerrieri and Vergara Caffarelli (2005), among others.
[3] Indeed over the observation period EU internal trade of intermediate goods accounts on average to more than two thirds of total (internal and external) intermediate trade of the European countries.

Figure 1: Share of intermediates in intra-EU trade



Source: Authors' calculations based on Eurostat data.
Note: centred five-term moving averages.

The share of parts and components in trade is however only an imperfect measure of IFP, since this phenomenon involves more than the purchase of a particular type of good. In the next section we introduce our measure of international production sharing together with the other indices which will be used throughout this paper.

3. Measurement

There is no single measure of fragmentation.[4] We employ a variant of the Revealed Comparative Advantage index introduced by Balassa (1965) in order to capture the *overall* involvement of a country into (intra-EU) production sharing both in case the country plays the role of the producer and exporter of intermediate goods and in the case it assembles (and exports) final goods using imported intermediates. Our measure thus captures both roles a country can take in the international division of labor.[5] Also it accounts for intermediate imports in final-good assembling countries in a better manner than alternative measures such as the family of indices introduced by Lafay (1992).[6]

[4] Iapadre (2001) surveys the most commonly used measures. See also Amador et al. (2011), Dean et al. (2011), Hummels et al. (2001) and Hummels et al. (1998).
[5] This is an important innovation with respect to the existing literature (such as Amador et al. 2011, and Iapadre, 2001) which mainly focused on producers (and exporters) of intermediates.
[6] Lafay indices are based on the balance of trade in intermediate goods which is an appropriate accounting practice when the interest of the analysis lies in measuring the net contribution of each country belonging to the international production chain. This implies that imports of intermediates are considered with the

In particular our index is the ratio between country *i*'s share of intermediate trade (imports plus exports) on total trade and the share of intermediates in the EU internal trade, minus one:

$$RCA(\text{trade})_{i,t} = \frac{\sum_{j \in EU} \left(X^{\text{Int}}_{i,j,t} + M^{\text{Int}}_{i,j,t}\right) \Big/ \sum_{j \in EU} \left(X^{\text{Tot}}_{i,j,t} + M^{\text{Tot}}_{i,j,t}\right)}{\sum_{i,j \in EU} \left(X^{\text{Int}}_{i,j,t} + M^{\text{Int}}_{i,j,t}\right) \Big/ \sum_{i,j \in EU} \left(X^{\text{Tot}}_{i,j,t} + M^{\text{Tot}}_{i,j,t}\right)} - 1 \qquad (1)$$

where *i* and *j* are the EU Member States, *t* is the quarter, *X* exports, *M* imports and the superscripts *Int* and *Tot* refer to intermediate and total (excluding commodities) trade flows respectively. In order to minimize the effect of price volatility of energy and agricultural commodities on trade value, these goods have been excluded from total trade, as in Buono and Vergara Caffarelli (2011).

The index takes positive values if the share of intermediates in country *i*'s EU trade is higher than the share of intermediates in the EU internal trade, negative values in the opposite case. For positive values the index shows that the country is relatively specialized in the trade of intermediate goods, despecialised otherwise.

Figure B1 in Appendix B depicts the $RCA(\text{trade})_{i,t}$ index for the 27 EU Member States in the period 2000Q1-2009Q4. Most Member States display a positive sample average $RCA(\text{trade})_{i,t}$. Only 9 Member States appear little involved in intra-EU production fragmentation: Cyprus, Denmark, Greece, Ireland, Italy, Lithuania, Luxemburg, the Netherlands and the UK. Among them Italy experiences the second largest (percentage) decrease in vertical specialization and Luxemburg the largest. Notably from the beginning to the end of the observation period the index for Germany is the fastest increasing over time among all the Member States. From Figure B1 the effect of the global crisis on the scope of intra-EU fragmentation is unclear: some countries appear to reduce their involvement, some seem to increase it and others are apparently not affected.[7]

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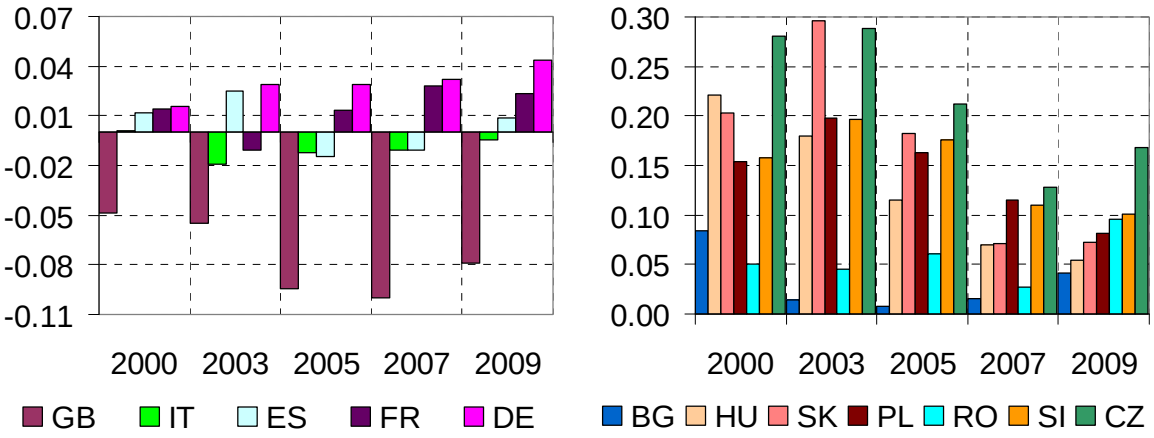
negative sign and hence they reduce the value of the indices. However large intermediate imports are an indication of high overall involvement in transnational production sharing.

[7] It is possible to appreciate that there was a statistically significant reduction in the fragmentation levels during the crisis. The effect is estimated by means of a panel regression of the $RCA(\text{trade})_{i,t}$ index on country fixed effects, quarterly dummies and a dummy for the crisis (from 2008Q3 to 2009Q3). The details are available upon request.

Figure 2 presents the fragmentation levels of some European countries during the past decade. Among the "old" Member States, Germany stands out clearly as an outlier. At the beginning of the observation period Germany's involvement in European fragmentation was similar to France and Spain and higher than Italy and especially the UK. In 2007 Germany participation in IFP appears almost two times higher than its initial level and notwithstanding the crisis it further increased in 2009. Conversely both in 2007 and in 2009 the other old Member States are on average less vertically specialized than in 2000, especially because of the poor performance of the UK and also, but to a lesser extent, of Italy and Spain. In the pre-crisis period France seemed to be the only one able to replicate Germany's fragmentation involvement (figure 2, left panel).

Figure 2: Fragmentation within the EU: selected countries



Source: Authors' calculations on Eurostat data.
Note: yearly averages of quarterly indices.

During the 2000-2009 period central and Eastern European Countries (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia) somehow moderated their comparative advantages in the trade of intermediate goods. Their involvement in transnational production sharing remains however clearly evident from the data (figure 2, right panel).

To measure intra-EU openness we apply the usual trade openness index to intra-EU trade flows so to capture the internal degree of openness of the Member States'

economies. Hence we compute the index as the ratio between total internal trade of each Member State and its GDP:

$$Open_{i,t} = \sum_{j \in EU} \left(X_{i,j,t}^{\mathrm{Tot}} + M_{i,j,t}^{\mathrm{Tot}} \right) \Big/ Y_{i,t} \qquad (2)$$

where *i* and *j* are the EU Member States, *t* is the quarter, *X* exports, *M* imports, *Y* GDP and the superscript *Tot* refers to total trade (excluding agricultural and energy commodities). Figure B2 in Appendix B presents the intra-EU openness of the Member States in the period of observation (2000Q1 to 2009Q4).

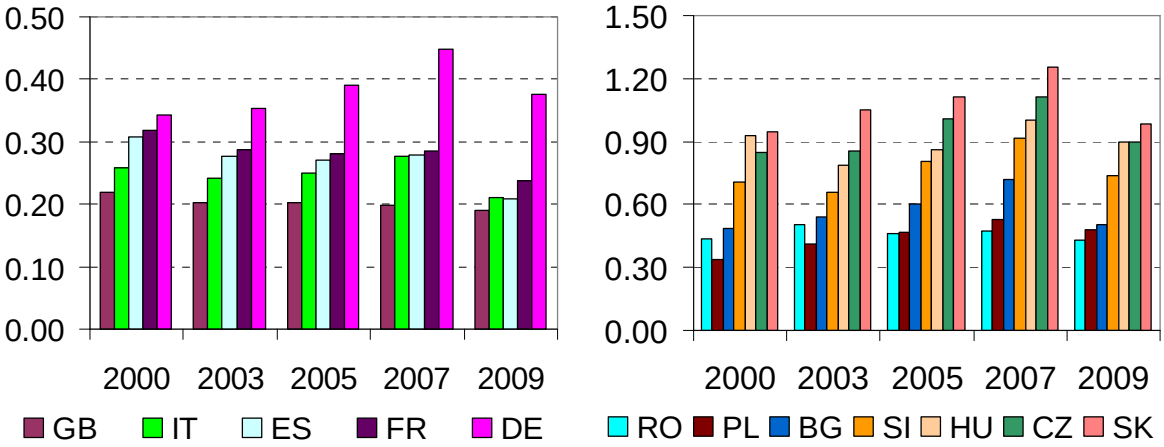
As expected smaller-sized countries appear relatively more open to internal trade than larger Member States. However size appears not to be a crucial determinant of the dynamics of openness: 8 countries display an increase in their degree of openness toward their EU partners: Bulgaria, Cyprus, Czech Republic, Germany, Lithuania, Netherlands, Poland, Slovenia and Slovakia. In all other Member States the index of openness decreases between 2000Q1 and 2009Q4.[8]

Figure 3 presents the European openness of some Member States. Again Germany's degree of intra-EU openness increases significantly, while the other large Western European countries reduced the share of internal trade to GDP from 2000 to 2009 (figure 3, left panel). The average openness of the Eastern European countries, which was already higher than their Western partners, further increased during the same period (figure 3, right panel).[9]

As we already pointed out countries involved in transnational production sharing trade parts and components with their partners. Thus we expect the openness measure to capture some of the intra-EU fragmentation, although the correlation is far from being perfect as intermediate goods are roughly a half of total intra-EU trade.[10]

[8] One may also note that the crisis reduced the intra-EU openness. The effect is estimated with the same panel regression methodology as in the case of the IFP index. The details are available upon request.
[9] These trends are even clearer in the pre-global-crisis period comparing 2000 with 2007 (instead of 2009).
[10] Indeed the pair-wise correlation between the two indices in our sample is 0.41.

Figure 3: Intra-EU openness: selected countries



Source: Authors' calculations on Eurostat data.
Note: yearly averages of quarterly indices.

Finally we measure global export performance of the EU Member States with the respective share in the external (i.e., non-EU) exports of all the EU countries.[11] In this manner we can identify the relative strength of each Member State vis à vis the others. Moreover we can abstract from the impact of EU-wide trends and shocks such as the common trade policy, the emergence of China as large exporter as well as the fluctuation of oil and commodity prices.

Equation (3) below presents the formulation of the performance index:

$$Perf_{i,t} = \sum_{j \in W \setminus EU} X_{i,j,t}^{\text{Tot}} \Big/ \sum_{i \in EU, j \in W \setminus EU} X_{i,j,t}^{\text{Tot}} \qquad (3)$$

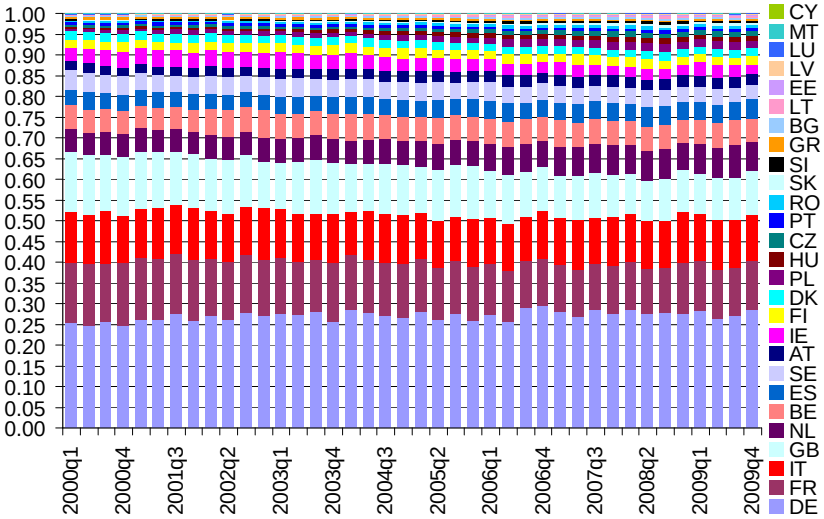
where i is the EU Member State, j the partner country, t the quarter, $W \setminus EU$ the whole world excluding the EU, X exports and the superscript Tot refers to total trade (as usual, excluding agricultural and energy commodities). Figure 4 depicts the evolution of the export performance index in the period 2000Q1 – 2009Q4.

The best performer over the whole period is Germany which accounts for more than 25% of EU exports. Other significant exporters are France, Italy, the UK, the Netherlands and Belgium whose average shares vary between 12% and 5%. While

[11] The OECD merchandise export performance index discussed in the Introduction is only available for some EU Member States (those which are also OECD Members) and with yearly frequency. We hence need to construct our quarterly measure of export performance for all European economies.

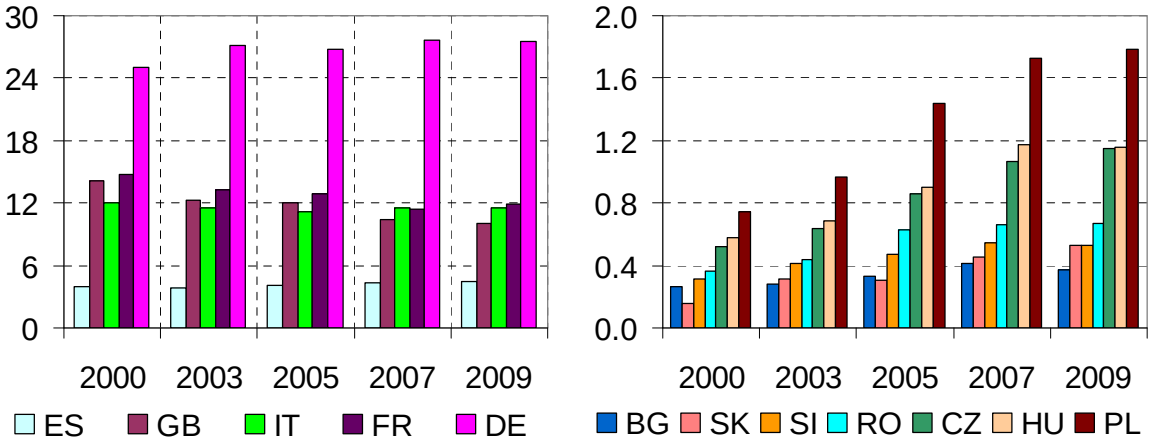
Germany and the Netherlands improved their performance between 2000Q1 and 2009Q4, in the same period Belgium, France, Italy and the UK reduced their market shares. All other Member States, Spain included, are below 5% even if their total share increased from about 25% in 2000Q1 to slightly more than 30% in 2009Q4.

Figure 4: Export performance index



Source: Authors' calculations based on Eurostat data.

Figure 5: Export performance: selected countries .



Source: Authors' calculations on Eurostat data.
Note: yearly averages of quarterly indices.

Figure 5 gives a more selective evidence of the global export performance of the EU countries. Comparing 2000 with both 2007 and 2009 Germany is the only Western

European country significantly increasing its export share (figure 7, left panel). At the same time, all central and Eastern European Member States significantly improved their global export performance (figure 5, right panel). The other "old-Europe" countries appear conversely to have lost market shares (figure 5, left panel).

Our data come from Eurostat and comprise quarterly figures for intra- and extra-EU trade (imports and exports), GDP and unit labor cost of the current 27 EU Member States from 1999Q1 to 2009Q4. Data are in current Euros and not seasonally adjusted. Trade data are released with a monthly frequency and have been aggregated to match the quarterly frequency of GDP.

Trade data are classified according to the Broad Economic Categories (BEC) Classification which allows us to easily identify intermediate goods. Intermediate goods are processed food and beverages mainly for industry, primary and processed industrial supplies not elsewhere specified, processed fuels and lubricants (other than motor spirit), parts and accessories of capital goods (except transport equipment) and parts and accessories of transport equipment. As in Buono and Vergara Caffarelli (2011), we exclude agricultural and energy commodities from the definition of intermediates.[12]

In the next section we present the econometric analysis to see whether our (theory-based) hypothesis that transnational outsourcing and openness are positively linked with the European countries' trade performances (as shares in global export markets) is verified.

4. Econometric analysis

We translate our theory-based relationship between export performance and European fragmentation and openness into a cointegrating relationship among the same variables. Hence in the long run the current export performance (export share) is determined by past fragmentation level and past international openness controlling for past relative unit labor cost[13] and we admit that the short-run relationship may be affected by disturbances while converging toward the long run equilibrium. Moreover we expect

[12] These correspond to the categories BEC111 "Primary food and beverages mainly for industry" and BEC31 "Primary fuels and lubricants".
[13] To control for country competitiveness we include unit labour cost relative to the EU average in the econometric model.

long-run coefficients to be equal across countries while short-run parameters may differ. In the short term idiosyncratic shocks may indeed prevail on the economic forces common among countries, but they will vanish in the longer term.

As usual in this context, we estimate a dynamic linear equation in which the difference of the export performance is decomposed into the direct effects from past changes in fragmentation level, openness degree and relative unit labor cost (allowing for quarterly seasonality as well) and the indirect effects from changes in the export performance during previous periods, while it was out of equilibrium. To take into account possible simultaneity problems, all independent variables are lagged by one quarter.

The empirical model is:

$$\begin{aligned}\Delta Perf_{i,t} &= \phi\left(Perf_{i,t-1} + \theta_1 RCA(\text{trade})_{i,t-1} + \theta_2 Open_{i,t-1} + \right. \\ &\quad \left. + \theta_3 RULC_{i,t-1}\right) - \delta_{0,i} - \delta_{1,i}\Delta RCA(\text{trade})_{i,t-1} + \\ &\quad - \delta_{2,i}\Delta Open_{i,t-1} - \delta_{3,i}\Delta RULC_{i,t-1} - \delta_{4,i}\Delta Perf_{i,t-1} + \\ &\quad + \chi_{1,i}Q_1 + \chi_{2,i}Q_2 + \chi_{3,i}Q_3 + \chi_{4,i}Q_4 + \varepsilon_{i,t}\end{aligned} \tag{4}$$

where $Perf_{i,t}$ is export performance, $RCA(\text{trade})_{i,t}$ fragmentation of production and $Open_{i,t}$ intra-EU openness, defined by equations (1) to (3), $RULC_{i,t}$ is the country's unit labor cost relative to the EU-27 average and Q_1, Q_2, Q_3 and Q_4 are quarter dummies.

The interpretation of the coefficients requires a short premise. The coefficient of the error correction, ϕ, indicates the speed of adjustment towards the long-run equilibrium relationship: it is expected to be significantly negative. It should be significantly different from zero to guarantee the existence of a long-run relationship and negative so that the dependent variable shows a return to a long-run equilibrium. The vector $\boldsymbol{\theta_\ell}$ contains the long-run coefficients: we expect that its first two elements to be significantly positive (and equal across countries) according to our theoretical assumption, while the relative unit labor cost should be negatively significant (and again equal across countries) as it accounts for the lack of competitiveness of the economy, as standard export equations show. We are not interested in the individual short-run coefficients included in the vectors $\boldsymbol{\delta_{\ell,i}}$ neither in the vectors of quarterly dummies' coefficients $\boldsymbol{\chi_{\ell,i}}$.

Table 1 in Appendix C collects the summary statistics of the variables used in the regressions. The average performance is 3.7 indicating that the average EU member accounts for almost 4% of the total EU exports. The sample mean of the fragmentation index is positive, yet small, indicating that Member States are indeed involved production sharing within the EU. For each country the intra-EU openness corresponds on average to more than half of its GDP. Finally, the relative unit labor cost has by construction a mean equal to one.

Export share, fragmentation, trade openness and relative unit labor cost are $I(1)$ and cointegrated.[14] We consequently estimate an error correction model on the panel[15] of the EU Member States from 2000Q1 to 2009Q4.

In our empirical strategy we estimate equation (4) using the Pooled Mean Group (PMG) estimator (Pesaran et al., 1999) which restricts the long-run coefficients to be equal across individuals. The PMG estimator not only embeds the equality restriction of the long-run parameters, but also (i) involves weighting of the individuals increasingly by speed of adjustment and decreasingly by their variability and (ii) explicitly accounts for the heterogeneity among the individuals.[16]

The equality restrictions on the long run coefficients, as well as the weighting and the correction for the heterogeneity, are tested by means of a Hausman test.[17] It is accepted with high significance ($\chi^2_2 = 3.53$, p-value = 0.32).

The estimation results are presented in Table 2 in Appendix C. All the coefficients of interest are significant and have the expected sign. We find a small but highly significant speed of adjustment of .15. Moreover in the long run the intra-EU

[14] The test results are significant at 1%.

[15] The data refer to 27 "individuals", the EU Member States, observed in 40 quarters. There may be reasons for potentially objecting the panel nature of the data set (and rather considering it a multivariate time-series) mainly due to the fact that the number of periods exceeds that of the individuals. However we consider the data set a panel for institutional reasons. Indeed, all the 27 countries belong to EU (and those which did not for the entire observation period were Candidate Countries for EU accession). Hence all individuals are subject to a set of common shocks in the field of trade policy. Moreover (only) the countries belonging to the Euro Area, or to the Exchange Rate Mechanism II, are also hit by common monetary policy shocks. However, fiscal policies and – more importantly – industrial policies were only loosely coordinated during the observation period. Consequently we expect the unobserved heterogeneity in the data to be determined by idiosyncratic rather than common shocks.

[16] See Pesaran et al. (1999), equations 9, 10 and 11, p. 625.

[17] As a benchmark for the test we estimate equation (4) with the Mean Group (MG) estimator (Pesaran and Smith, 1995) which leaves both long- and short-run coefficients unrestricted. The MG results are available upon request.

fragmentation measure has a positive and significant (at 1%) coefficient (1.26). Also the European openness appears to have a significant (at 1%) impact on the export performance (2.76). Finally the relative unit labor cost significantly (at 1%) reduces the export share (-1.48).

The interpretation of these results is line with our priors. Traditional drivers of export performance (commercial openness and cost competitiveness) indeed prove to significantly affect the market share of the EU Member States over the observation period. Moreover our coefficient of interest shows that a high involvement trans-European fragmentation further increases the export performance when we control for the effects of commercial integration and of the relative unit labor costs. The estimated coefficient of $RCA(\text{trade})_{i,t}$ implies that a country moving from the first to the last quartile of the fragmentation distribution would increase its export performance by .17 percentage points which correspond to almost 5% of the sample average export share.[18]

Hence and to sum up, the estimates of equation (4) fully validates our theoretical assumption on the role of fragmentation and openness in determining the EU Member States export performance in the period 2000-2009. As a robustness exercise in the appendix we perform the econometric analysis using a different export performance measure. Estimation results for the main variables of interest are confirmed.

5. Concluding remarks

In this paper we explore the link between international fragmentation of production (IFP), trade openness and global export performance as to the EU 27 Member countries. Our starting point is a common result of many theoretical models featuring international production fragmentation: higher levels of IFP and of related international openness improve the export performance of a country.

A review of the experience of the most representative EU Member States shows that Germany and the central and Eastern European countries combine a high involvement in trans-EU fragmentation and openness with an increase in their global export shares.

[18] As discussed in the previous section the degree of EU openness partially captures also trans-European fragmentation. Consequently the "true" effect of fragmentation could be higher than the estimate.

The econometric analysis confirms our hypothesized relationship. We estimate an error correction model on the panel of the European countries with quarterly data from 2000Q1 to 2009Q4. Results show that intra-European IFP and openness are significant long-run determinants of the export performance of the EU Member States.

The implications for policy could be that policymakers should not restrict access to foreign sources of intermediate goods and services since it could negatively affect the productivity and competitiveness of domestic firms. Policies that try to prevent the firms' internationalization of production and global networking could severely penalize the very same firms' export performance in the medium and in the long term. At the same time such restrictive policies would weaken a country's position in global production networks, with long-run negative effects on domestic jobs and growth. Alternatively an open trade policy would allow firms and countries to fully benefit from international production networks.

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Appendix A. Robustness

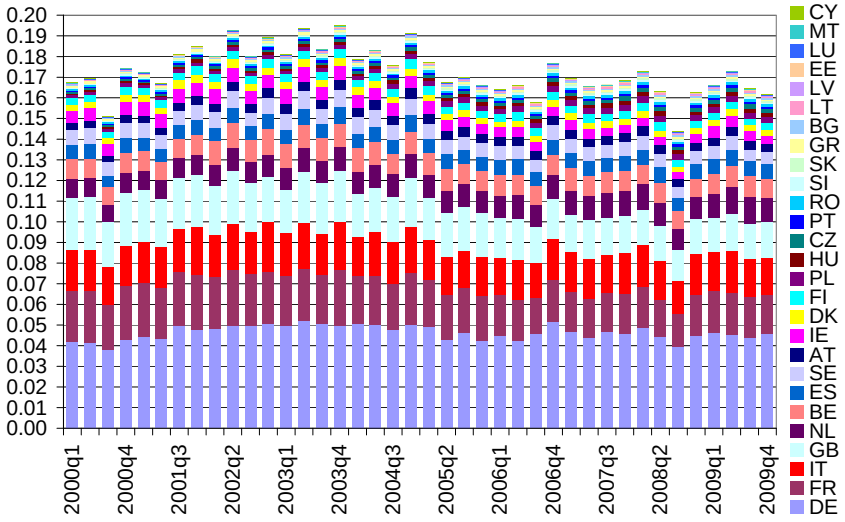
As a robustness exercise we introduce a different measure of export performance and carry out the same empirical analysis. We now measure export performance with the share on the extra-EU export market. Hence our index is the ratio between each European country's extra-EU exports and total world exports excluding EU internal trade:

$$WPerf_{i,t} = \sum_{j \in W \setminus EU} X^{\text{Tot}}_{i,j,t} \Bigg/ \left(\sum_{j,k \in W} X^{\text{Tot}}_{j,k,t} - \sum_{h,\ell \in EU} X^{\text{Tot}}_{h,\ell,t} \right) \quad \text{(A1)}$$

where, as usual, i, h and ℓ are EU Member State, j and k are non European countries, t the quarter, $W \setminus EU$ the whole world excluding the EU, X exports and the superscript Tot refers to total trade.

We combine exports from our usual Eurostat database with total world exports from the IMF Direction of Trade Statistics and Euro/Dollar exchange rate from the ECB. Because of data unavailability we cannot exclude agricultural and energy commodities from total world exports, as we did in the rest of paper. Consequently commodities are included in the trade flows used to compute $WPerf_{i,t}$. Figure A1 depicts the performance index relative to the world in the period 2000Q1-2009Q4.

Figure A1: Performance index relative to the world



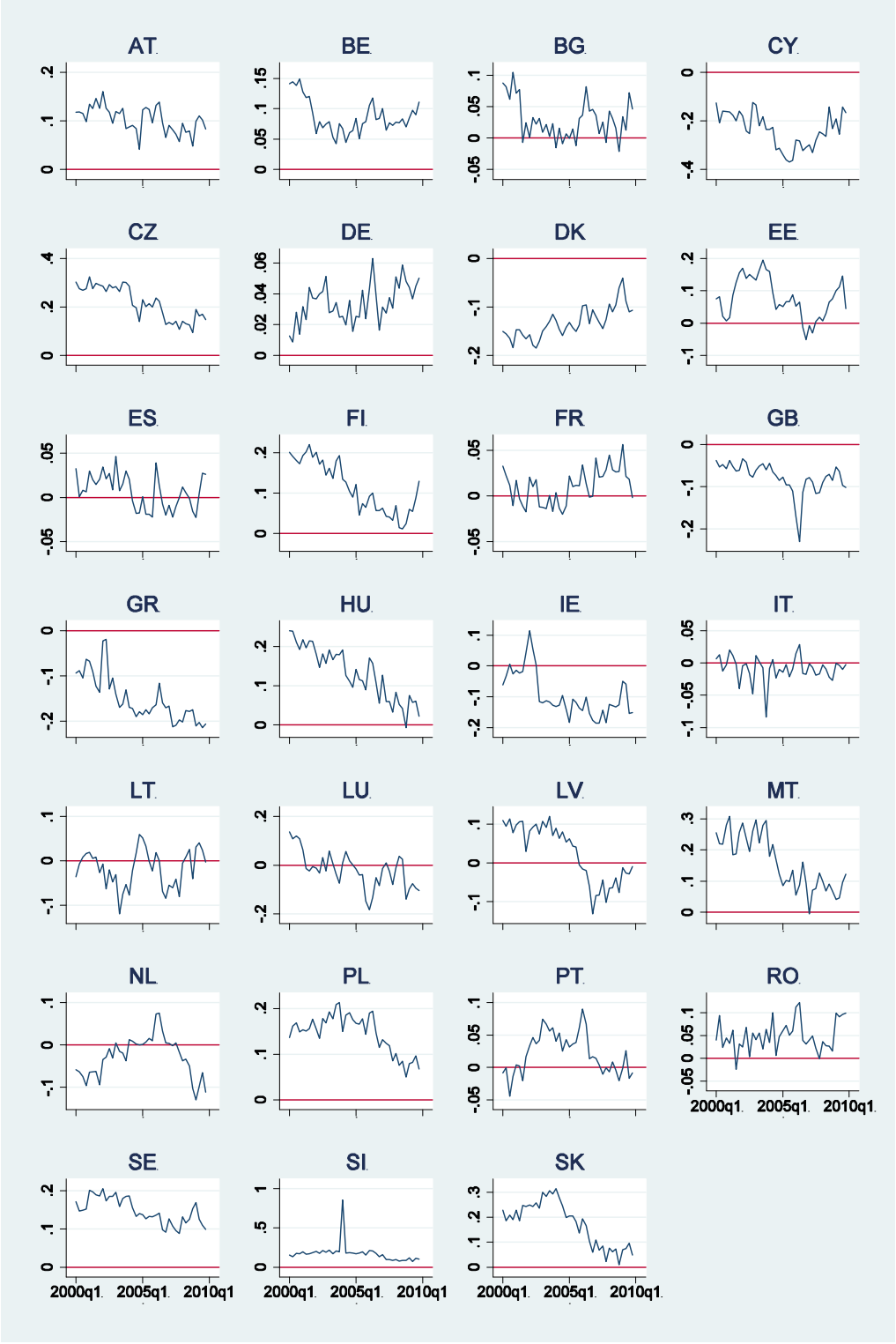
Source: Authors' calculations based on Eurostat, IMF and ECB data.

The main difference with respect to the measure used in the rest of the paper is the fact that the index does not sum to 100% across countries (indeed it sums to the overall market share of the EU). For the rest the new measure yields to very similar results.

We then re-estimate equation (4) in our panel of 27 countries in 40 quarters (2000Q1-2009Q4). The PMG regression outcomes are presented in table 3 in Appendix C and confirm the previous estimation results for the main variables of interest (table 2). Fragmentation, openness and (counter-intuitively) relative unit labor cost have all positive and significant long-run coefficients. Indeed we can confirm that inter-European fragmentation and openness significantly increase the (rest of the) world export market share of the EU Member States.

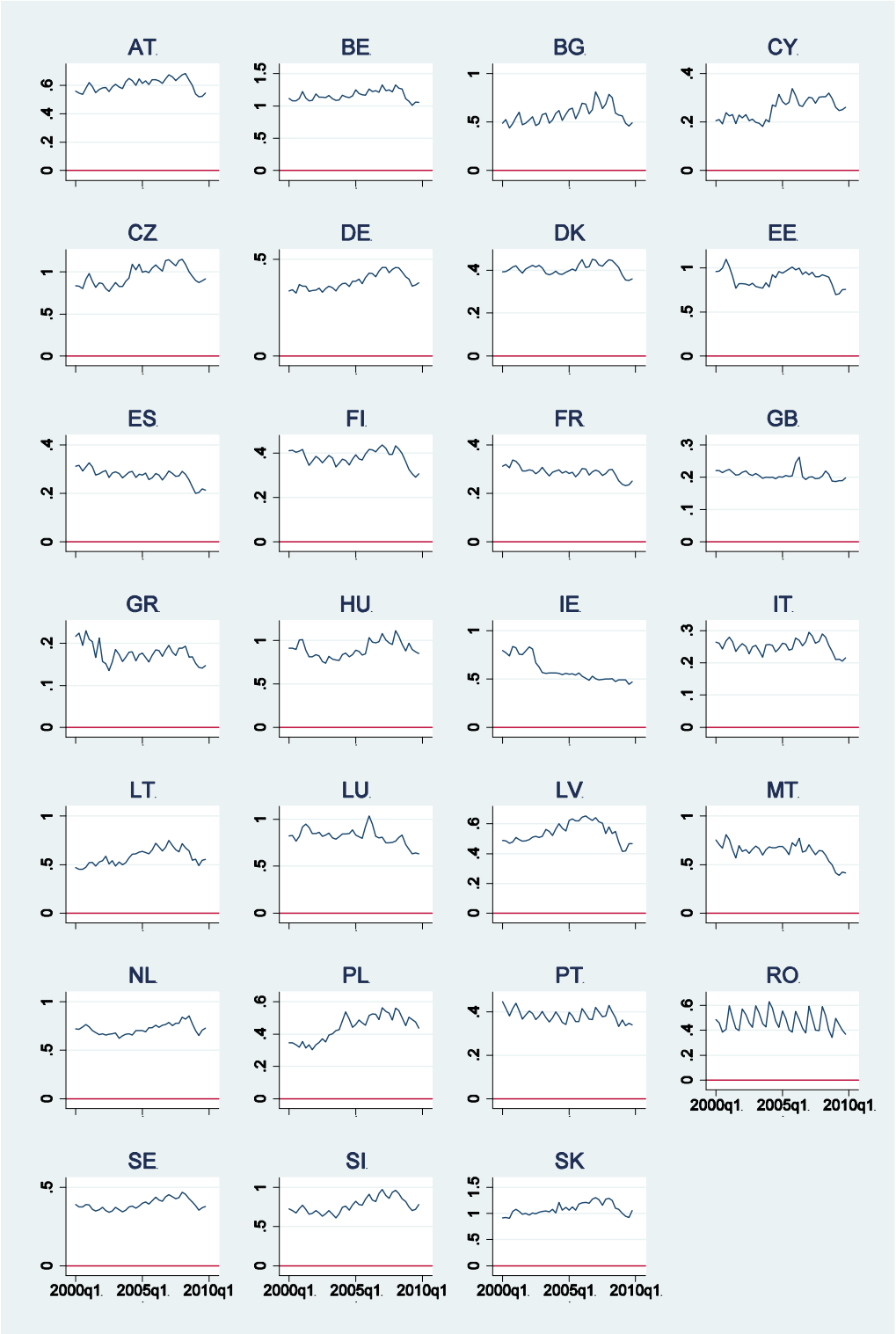
Appendix B. Figures

Figure B1: A measure of intra-EU fragmentation



Source: Authors' calculations based on Eurostat data.

Figure B2: Intra-EU openness.



Source: Authors' calculations based on Eurostat data.

Appendix C. Tables

Table 1. Summary statistics

Variable	num. obs.	mean	std. dev.	min.	max.
Performance	1080	3.703	5.332	0.011	25.789
RCA(trade)	1080	0.035	0.122	-0.369	0.854
Open	1080	0.561	0.278	0.136	1.324
RULC	1080	1.000	1.736	0.301	8.996

Table 2. Estimation results

Long Run		
$RCA(\text{trade})_{t-1}$	1.26	***
	(.28)	
$Open_{t-1}$	2.76	***
	(.36)	
Relative unit labour cost	-1.48	***
	(.16)	
Short Run		
Speed of adjustment (ϕ)	-.15	***
	(.05)	
$\Delta RCA(\text{trade})_{t-1}$	.65	
	(.52)	
$\Delta Open_{t-1}$	.56	
	(.61)	
$\Delta RULC_{t-1}$	.40	
	(.73)	
$\Delta Performance_{t-1}$	-.16	***
	(.04)	
Number of observations	27×40	
Maximum log likelihood	1463.32	
Country fixed effects	Yes	
Quarterly dummies	Yes	
Linear Trend	No	

Note: standard-errors in parenthesis; ***: significant at 1%. Dependent variable is the export performance of country *i*. Quarterly data from 2000Q1 to 2009Q4.

Table 3. Estimation results

Long Run		
$RCA(\text{trade})_{t-1}$	3.97	***
	(.82)	
$Open_{t-1}$	2.84	***
	(.69)	
Relative unit labour cost	3.45	***
	(.49)	
Short Run		
Speed of adjustment (ϕ)	-.06	**
	(.02)	
$\Delta RCA(\text{trade})_{t-1}$	-.40	
	(.30)	
$\Delta Open_{t-1}$	-.65	**
	(.22)	
$\Delta RULC_{t-1}$	.53	
	(.26)	**
$\Delta Performance_{t-1}$	-.24	***
	(.04)	
Number of observations	27×40	
Maximum log likelihood	3113.10	
Country fixed effects	Yes	
Quarterly dummies	Yes	
Linear Trend	No	

Note: standard-errors in parenthesis; ***: significant at 1%; **: significant at 5%. Dependent variable is the export performance of country *i* relative to the world. Quarterly data from 2000Q1 to 2009Q4.

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