Economic Integration, Knowledge Spillovers and Trade

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Abstract

In the paper we focus on the vertical dimension of product differentiation for emerging market economies, in order to explain the "within specialization", i.e., in high quality, high skill-intensive products or in low quality, low skill-intensive products. Exporting firms are distinguished by their pace of innovation: high-tech firms produce advanced goods, thanks to basic research activity, whereas low-tech firms manufacture traditional products. The international diffusion of knowledge speeds up the intensity of quality upgrading in high-tech industries that are able to compete in "quality dominated markets" and expand along the "intensive margin"; traditional firms step up the quality ladder with secondary innovations, and expand thanks to a traditional cost competition. We derive export demand for products of advanced and traditional industries, assuming that the intensity of quality preference depends on consumers' level of income.

We assess the empirical relevance of the model by performing estimations for trade between CEECs and EU. The focus is twofold: evaluate the supply-side factors in determining the "absorptive capacity" of the stock of foreign capital and the pace of quality upgrading, and assess the role of demand for quality in the evolution of market shares of up-market and down-market products.

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1. Introduction

A considerable body of theoretical and empirical contributions in international trade theory suggest that trade among countries largely occurs in differentiated products; brand proliferation as well as quality upgrading are distinctive features of the world-wide exchange in goods and services, and represent the outcome of innovations stemming from R&D activity. Hence, the structure of trade and its evolution over time reflect closely the stock of knowledge capital accumulated in a given country and its ability to innovate. For this reason, following the pioneering contributions of Krugman (1979), (1980) and Grossman and Helpman (1991), it is common to distinguish between trade between similar economies and trade between countries of the North and of the South of the globe. Rich economies conduct basic research activity that shifts outwards the technological frontier, allowing for the introduction of new products, differentiated as to variety or to quality characteristics. On the contrary, countries of the South engage in imitation activity that, when successful, allows them to climb the quality ladder and manufacture imitated product at lower costs than the North. The South then becomes the producer and exporter of the good, and puts pressure on the North for industry leadership, thus increasing the incentives for further innovation.

Yet, there are countries that do not fit either one of the two categories: such is the case of the emerging market economies (EMEs). These countries cannot be considered within the group of the South; yet they are still in a catching-up process, and differences in the structure of trade between EMEs and advanced economies persist, although it seems as the tendency is towards similar patterns. For these countries economic integration with advanced economies provides the mechanism for accelerating the catching-up process, thanks to the international dissemination of knowledge channelled by trade in goods and services, foreign direct investment, business contact, and so on. The more an economy is open to trade, the higher the benefits in terms of the diffusion of innovation capabilities from leading economies. Yet, economic integration *per se* is not sufficient for a successful catching up; the so-called "advantage of relative backwardness" takes place only in the presence of "absorptive capacity".[2]

In the paper we are interested in analysing EMEs' structure of trade and its evolution through time. The focus is on the vertical dimension of product differentiation. The idea is to measure the "within product" differentiation, in order to understand the extent of endowment-driven specialization. In fact, whereas for similarly skilled-endowed economies the intensity of product overlap is an appropriate measure of similarity, in the case of EMEs it is important to assess the "within specialization", i.e., in high quality, high skill-intensive products or in low quality, low skill-intensive products. [3] To this end we characterise exporting firms on the basis of their pace of innovation. We distinguish between firms that produce technologically advanced goods, thanks to basic

[2] The concept was first introduced into development economics by Gerschenkron (1962). See also Abramovitz (1986) and Baumol (1989).

[3] The point has been addressed extensively in Schott (2004).

research activity, and firms that manufacture traditional products. The latter are able to step up the quality ladder thanks to secondary innovations stemming from learning activity. The two types of firms show a different performance in trade: high-tech firms are able to compete in "quality dominated markets" and expand along the "intensive margin"; traditional firms rely on a traditional cost competition and therefore expand sliding down the demand curve of a given variety . The setting is that of a semi-small open economy, where all firms face a downward demand function and take foreign prices as given. We derive analytically export demand for products of the advanced and traditional industries, assuming both a horizontal and a quality dimension in households' preferences, so that export penetration of the advanced and traditional products differ. Moreover, since we consider the intensity of quality preference to depend on the level of income, market shares of the two types of products will depend on the income level of the partner country.

We study the benefits of economic integration with technologically advanced countries. Theoretical and empirical contributions emphasize that knowledge capital is at least partially a public good, and that trade in goods and services, foreign direct investment, migration and business contacts, among others, promote the international diffusion of knowledge. We assume the "absorptive capacity" of the basic and secondary research to differ: in the traditional industry there is less scope for exploiting the benefits of knowledge spillovers, owing to the relatively high complexity of the technological foreign goods.

We assess the empirical relevance of the model by performing some estimations for the CEECs, a group of countries economically integrated with advanced EU economies. We expect the CEECs' structure of trade to reflect the intensity of quality upgrading in production, in particular in medium- and high-skill industries. The latter, in fact, showed a large initial knowledge gap with respect to the EU partner countries, but a relatively high "absorptive capacity" when compared to low-skill industries of the CEECs. This makes medium- and high-skill industries better candidates to benefit by the international knowledge diffusion. The focus is twofold: evaluate the supply-side factors in determining the "absorptive capacity" of the stock of foreign capital and the pace of quality upgrading, and assess the role of demand for quality in the evolution of market shares of up-market and down-market products.

The paper is organized as follows. Section 2 presents the basic relationships of the theoretical model, and derives export demands for the high-tech, high-skill industries, as well as for the low-tech, low-skill industries. Section 3 analyses the pace of quality upgrading in the two types of industries, and discusses the implications for market share growth rates of up-market and down-market products. Section 4 presents an estimation of the evolution of CEECs exports, distinguished by skill-intensive type of industries, to the EU partner countries, over the period 2000-2006. Section 5 draws some final conclusions.

2. The theoretical model

We consider an economy open to trade that manufactures a fixed number of differentiated final goods. Besides the horizontal dimension of differentiation, we distinguish between technologically advanced and traditional products on the basis of their different know-how content. Both kind of products are characterised by quality upgrading thanks to R&D activity. We assume heterogeneity in research and distinguish between basic research activity and secondary innovations. Fundamental research drives the innovation process in the quality upgrading of technological products, whereas secondary research leads to new realizations of traditional products, thanks to the application of the know-how generated in the advanced industry.

As in more recent trade theory, the framework considered is that of a semi-small open economy, where imported goods are purchased at given world prices, and producers of final goods compete monopolistically in international markets, given that traded products substitute imperfectly for each other in households' demand. We assume no tariffs, transportation costs or other trade barriers, and that all factors of production are immobile.

The supply side

We distinguish final products by the kind of labour resources employed, skilled and unskilled workers, and the kind of innovation activity taking place. On the one side, there are *N* differentiated high-tech goods that are manufactured with skilled labour and an aggregate of high-tech intermediate inputs that embody quality improvements stemming from basic research activity. On the other side, there are *M* differentiated traditional products manufactured with unskilled workers and a set of intermediate inputs characterised by a quality content that results from the application of the know-how created in the advanced industry. As in new-Schumpeterian quality ladder models, firms that manufacture high-tech innovative intermediates engage in research activity in order to create blueprints. When they succeed in up-front research they have the ability to gain industry leadership for the innovative product. Analogously, firms that manufacture the traditional intermediates employ labour resources in order to move up the quality ladder. When such firms succeed in secondary innovation, they capture industry leadership for the new generation product.

We characterise the typical firm that manufactures the advanced and the traditional products, Y_i and Y_j, respectively, by the following technologies:

$$Y_i = F_i H_i^{\alpha} A_i^{1-\alpha} \qquad i=1,..., N \qquad (1)$$

$$Y_j = F_j L_j^{\beta} B_j^{1-\beta} \qquad j= 1,..., M \qquad (2)$$

where H_i is employment of skilled labour and A_i is the amount of intermediates in the manufacturing of the final product by firm *i* of the advanced industry; L_j is unskilled labour and B_j is the amount of intermediates employed by firm *j* of the traditional industry, F_i and F_j are arbitrary constants reflecting the choice of units.[4]

In both kind of manufacture, firms employ a fixed assortment of vertically differentiated intermediate inputs, indicated by the following two indexes:

$$log\ A = \int_0^1 log\left(\sum_z q_{z\kappa} Z_{z\kappa}\right) dz \qquad (3)$$

$$log\ B = \int_0^1 log\left(\sum_s q_{s\kappa} S_{s\kappa}\right) ds \qquad (4)$$

where $Z_{z\kappa}$ and $S_{s\kappa}$ represent the components *z* and *s*, of the κ^{th} generation, in the indexes *A* and *B*, whose quality is $q_{z\kappa}$ and $q_{s\kappa}$. To simplify we let the innovation process be such that each new intermediate provides γ additional services with respect to the good of the previous generation, that is $q_{v\kappa} = \gamma q_{v(\kappa-1)}$, with v = *z*, *s*. The

[4] To save on notation we have omitted the time index.

intermediate indexes have the property that vertically differentiated inputs in a given industry substitute perfectly for one other when quality differences are appropriately accounted for. Moreover, each intermediate z and s enters its index symmetrically, and therefore enters symmetrically in the production of each final good, too.

The basic research sector is portrayed as in the patent-race literature. Firms target their research effort at the quality upgrading of any leading-edge production process; they issue equity to finance the R&D race and use a constant-return-to-scale technology where skilled labour is the only input. Any firm that engages H_R labour resources in industry z at time t is able to produce the new good with probability ι_H.[5] Firms will invest labour in research activity up to the amount for which the cost of R&D activity, $w_H \ell_H \iota_H$, equals the expected revenues $\upsilon_H \iota_H$. The following arbitrage condition determines entry:

$$w_H \ell_H \geq \upsilon_H \quad \text{with equality whenever } \iota_H > 0 \qquad (5)$$

where w_H is skilled workers wage, ℓ_H is a parameter reflecting the productivity of labour in basic research, υ_H is the stock market value of the innovating firm.

Analogously, firms that target their effort at obtaining secondary innovations invest L_R unskilled labour resources and have the ability to obtain a new realization of the good with probability ι_L. The amount of resources devoted to such a venture is given by the arbitrage condition:

$$w_L \ell_L \geq \upsilon_L \quad \text{with equality whenever } \iota_L > 0 \qquad (6)$$

where w_L is unskilled workers wage, ℓ_L is a parameter reflecting the productivity of labour in secondary research, υ_L is the stock market value of the innovating firm.

As to the manufacture of intermediates, firms use a constant-return-to-scale technology that employs only labour, and compete monopolistically with a limit pricing outcome. Hence, the price is set as a mark-up γ over the unit labour cost, where γ is the increase in quality embodied in the superior, state-of-the-art intermediate, that is: $P_z = \gamma w_H$, and $P_s = \gamma w_L$. In equilibrium, all intermediates bear the same price, that is: $P_z = P_Z$ and $P_s = P_S$. Since better quality inputs are more productive, in that they allow to produce a higher-quality final good, producers of the final goods buy only state-of-the-art varieties; and since all demanded components Z_z are employed in equal quantities, and the same applies for S_s, the aggregate intermediate A and B can be expressed as $A = q_A Z$ and $B = q_B S$ where Z and S denote the aggregate volumes of the two types of intermediates, whereas q_A and q_B are the two indexes of productivity of intermediates.[6]

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[5] The arrival of research successes is guided by a Poisson process, with ι denoting the parameter of the density function. Although the arrival of research successes among firms is guided by independent Poisson processes, by the law of large numbers, the process of technological advance at the aggregate level is smooth and non-random. For a similar reasoning, see Grossman and Helpman, 1991.

[6] As to the productivity indexes q_A and q_B, they reflect the state of knowledge embodied in high-tech and traditional final products, respectively, and are proportional to the total "number" of R&D successes in basic and secondary research. From equation (3) and (4) we have $log\, A = \int_0^1 log\, \overline{q}_z dz + log\, Z$ and $log\, B = \int_0^1 log\, \overline{q}_s ds + log\, S$ where $\overline{q}_z$ and $\overline{q}_s$ represent the quality of the state-of-the-art brands of intermediates z and s, respectively. Hence, the index q_A is $q_A = \gamma^{I_{Ht}}$, where $I_{Ht} \equiv \int_0^T \iota_H(t)dt$

In both kind of manufactures, every firm producing a final product is a monopolistic competitor in the world market, so that its behaviour is described by a standard profit maximization problem, given the technology and demand constraint. It follows that each producer sets the price of the manufactured good as a fixed margin over the marginal costs of production. All firms producing high-tech goods have identical technology and face the same demand; the same applies to all firms producing the traditional goods. Prices of all inputs are taken as given. We thus have symmetry within firms producing a distinct type of product, that is, $P_i = P_{Y^A}$ and $P_j = P_{Y^B}$.

The demand side

Preferences of the representative household *h* are described by the following intertemporal utility function

$$U_\tau = \int_\tau^\infty e^{-\rho(t-\tau)} \log u_t dt \qquad (7)$$

where ρ represents the subjective discount rate and u_t the instantaneous utility function:

$$u_t = \left(\sum_h q_h^\omega C_h^\sigma\right)^{\frac{1}{\sigma}}, \qquad \text{for all } t \qquad (8)$$

where q_h is the quality level attached to consumption good C_h; $\sigma = \frac{\theta - 1}{\theta}$ and θ is the constant elasticity of substitution between each pair of goods, whereas ω is the intensity of preference for quality. In line with theoretical and empirical contributions[7] we assume parameter ω to be proportional to each household's level of income.

Among the set of available varieties, we further distinguish between domestic high-tech goods, C_i, domestic traditional products, C_j, and products manufactured abroad C_f, so that each household's instantaneous utility may be reformulated as:.

$$u_t = \left(\sum_{i=1}^N q_i^\omega C_i^\sigma + \sum_{j=1}^M q_j^\omega C_j^\sigma + \sum_{f=1}^V q_f^\omega C_f^\sigma\right)^{\frac{1}{\sigma}}, \qquad \text{for all } t \qquad (9)$$

Equation (9) thus reflects the twofold dimension of preferences: in addition to the horizontal dimension of differentiation we allow for the quality content of goods to shape the structure of demand. This feature may be better understood by reformulating equation (9) as:

$$u_t = G\left(Q_A^\omega \sum_{i=1}^N C_i^\sigma + Q_B^\omega \sum_{j=1}^M C_j^\sigma + Q_F^\omega \sum_{f=1}^V C_f^\sigma\right)^{\frac{1}{\sigma}} \qquad (10)$$

where $G \equiv \left(\sum_r q_r^\omega\right)^{\frac{1}{\sigma}}$, with $r = A, B, F$, and $Q_r \equiv \frac{q_r}{\sum_r q_r}$ is the relative quality content of any distinct type of good, i.e., the high-tech, traditional and foreign good. The above formulation makes clear the dimension of quality in preferences, since Q_r is a "distribution" parameter that represents the weight of the three different types of goods in households' expenditure.

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represents the total "number" of basic research successes from time $t = 0$ up to $t = T$, whereas $q_B = \gamma^{I_{Lt}}$, where $I_{Lt} \equiv \int_0^T \iota_L(t)dt$ represents the total "number" of secondary innovations from time $t = 0$ up to $t = T$.

[7] Hallak (2006), Crinò-Epifani (2008).

Maximization of equation (7) subject to the dynamical budget constraint and to the transversality condition[8] gives the representative household static demand function for any good *i*:

$$C_i = \frac{\left(\frac{P_i}{q_i^{\omega}}\right)^{-\theta} E}{q_A^{\omega\theta}\sum_{i=1}^{N} P_i^{1-\theta} + q_B^{\omega\theta}\sum_{j=1}^{M} P_j^{1-\theta} + q_F^{\omega\theta}\sum_{f=1}^{V} P_f^{1-\theta}} \tag{11}$$

where E denotes expenditure of the representative consumer.[9] Analogously, demand for any good *j* and *f* is given by substitution of the own prices and quality in the numerator of equation (10). In particular, we may reformulate the demand for any high-tech product as:

$$C_i = \left(\frac{P_i}{P}\right)^{-\theta} Q_A^{\omega\theta} \frac{E}{P}, \tag{12}$$

where $P \equiv Q_A^{\omega\theta}\sum_{i=1}^{N} P_i^{1-\theta} + Q_B^{\omega\theta}\sum_{j=1}^{M} P_j^{1-\theta} + Q_F^{\omega\theta}\sum_{f=1}^{V} P_f^{1-\theta}$ is the price index consistent with preference specification given in equation (8), and the price of any foreign good P_f is expressed in the domestic currency. Analogously, demand for any traditional product *j* and foreign good *f* is given by substitution of the own price and quality index in equation (12).

The inclusion of the quality dimension has implications for the structure of demand. In fact the representative household's relative demand between any two types of products is:

$$\frac{C_i}{C_j} = \left(\frac{P_i}{P_j}\right)^{-\theta}\left(\frac{Q_A}{Q_B}\right)^{\omega\theta}; \quad \frac{C_i}{C_f} = \left(\frac{P_i}{P_f}\right)^{-\theta}\left(\frac{Q_A}{Q_F}\right)^{\omega\theta}; \quad \frac{C_j}{C_f} = \left(\frac{P_j}{P_f}\right)^{-\theta}\left(\frac{Q_B}{Q_F}\right)^{\omega\theta} \tag{13}$$

Equation (13) shows that for given relative prices and elasticity of substitution, the composition of demand depends on the products' quality ratio, and that the higher is the intensity of quality preference ω the more relative quality matters. Since ω is assumed proportional to each household's level of income, demand of high-income consumers is more quality oriented than demand of low-income households. A similar result is obtained in Crinò-Epifani (2008) although from a different specification of households' preferences.

Consider now only foreign demand. We assume preferences to be symmetric across countries, so that, at each time *t*, non-resident aggregate demand for domestic goods is obtained by aggregating equation (12) over all (foreign) consumers

$$X_{Y^A} = \sum_{i=1}^{N}\left(\frac{P_i}{P}\right)^{-\theta} Q_A^{\omega\theta}\frac{E_F}{P} \tag{14}$$

$$X_{Y^B} = \sum_{j=1}^{M}\left(\frac{P_j}{P}\right)^{-\theta} Q_B^{\omega\theta}\frac{E_F}{P} \tag{15}$$

where E_F denotes aggregate foreign expenditure in terms of the domestic currency. Equations (14) and (15) state that exports of both types of goods depend on real foreign

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[8] The dynamical budget constraint is: $\sum_i P_{it} C_{it} + \dot{W}_t = w_{ht} N_{ht} + rW_t$ for all *t*, where *W* is nonhuman wealth and *N* is the amount of (skilled or unskilled) labour supplied. To rule out explosive paths the standard transversality condition of non-explosive indebtedness is assumed to hold. The optimal spending profile implies the Euler equation to be satisfied.

[9] Expenditure is given by the wage earned, either unskilled or skilled, and the return on the share of asset holdings.

income, relative prices, and the relative quality content. In particular, we may reformulate, in the aggregate, the same argument made above, that is, the ratio between total exports of advanced and traditional products $\frac{X_{Y^A}}{X_{Y^B}}$ depends, other things equal, on relative quality , i.e., $\frac{Q_A}{Q_B} \equiv \frac{q_A}{q_B}$, and the higher the intensity of foreigners' preference for quality, the more such quality gap matters. The implications for competitiveness and export orientation is that firms producing advanced goods well-perform in "quality dominated markets", and therefore are more export-oriented towards high income countries, with respect to firms producing traditional goods. Moreover, market penetration of the two types of goods will be based on two different strategies: advanced firms are able to expand along the "intensive margin", that is, to gain market shares at a given terms of trade; on the other hand traditional firms struggle to expand in high income countries, and are able to maintain their market shares only thanks to a traditional cost competition. The two features of competition appears clearly when looking at the evolution through time of exports' shares of advanced and traditional goods.

By taking the logarithmic differentiation with respect to time of equations (13) and (14) we get:

$$\tilde{X}_{Y^A} - \tilde{X}_{Y^B} = -\theta\left(\tilde{P}_{Y^A} - \tilde{P}_{Y^B}\right) + \theta\omega\left(\tilde{q}_A - \tilde{q}_B\right) \tag{16}$$

which says that for given relative prices, exports of advanced, up-market products can grow faster than exports of traditional, down-market products, thanks to the advantage in the process of quality upgrading. On the other hand, market shares of traditional products can be ensured only by a persistent terms-of- trade deterioration.

3. Quality dynamics and exports

According to the above equations the pace of quality upgrading is crucial in shaping the evolution of trade. Firms step up the quality ladder thanks to innovations resulting from the employment of labour resources to research activity. As usual, knowledge has the nature of a public good within a given industry. Yet, we assume knowledge to be heterogeneous: skilled workers conduct upfront research that leads to fundamental innovations, whereas unskilled workers engage in applied research that leads to secondary innovations, that is, to new realizations of manufactured products.

As to the basic research sector, we model quality upgrading assuming international spillovers from more advanced countries, so that high-tech firms are able to take advantage in their research activity of the foreign know-how. It follows that the productivity of human capital resources in research increases with both the stocks of domestic and foreign knowledge capital. The technology of innovation for advanced goods is:

$$\frac{dq_A}{dt} = \varphi_H \left(q_A^{\delta}\, q_F^{1-\delta}\right) \frac{H_R}{\ell_H} \log \gamma \tag{17}$$

where the parameter φ_H reflects the efficiency with which the overall stock of knowledge is converted into R&D activity; the term in brackets is a measure of the stock of knowledge capital useful in research; the parameter $(1-\delta)$ is the weight of the foreign component in the overall stock of knowledge capital available to researchers. It reflects the importance of foreign knowledge flows for the high-tech research activity undertaken in the economy.

Differently, we assume that the innovation activity for traditional firms has a limited benefit by the international diffusion of knowledge, given the technological distance between high-tech research in advanced countries and domestic secondary innovation. We thus express quality changes over time in the production of traditional goods as:

$$\frac{dq_B}{dt} = \varphi_L \left(q_B^{\varepsilon}\, q_F^{1-\varepsilon} \right) \frac{L_R}{\ell_L} \log \gamma \tag{18}$$

We consider the following to hold: $\varphi_H > \varphi_L$ and $\frac{H_R}{\ell_H} > \frac{L_R}{\ell_L}$, which implies that the high-tech research activity enjoys both a higher efficiency in building upon the overall stock of knowledge and a higher productivity of labour resources devoted to innovation activity. Since at any time *t*, $q_B < q_A < q_F$, it follows that pace of quality upgrading in the production of traditional goods falls short of the pace in high-tech products. As a consequence, for given foreign income and dynamics of relative prices, traditional products will record a lower export growth than high-tech goods. In addition, given the income-related intensity of demand for quality, high-tech innovative goods will find easier markets in high income countries whereas traditional products are constrained to be more export oriented towards low income countries.

4. Quality upgrading and exports: An empirical investigation

On the basis of the theoretical setting outlined above, we analyse the evolution of the pattern of trade between Central and Eastern European countries (CEECs) and European Union economies (EU-14). Our aim is to understand the within product specialization, i.e., the up-market or down-market position in the quality ladder both in EU and world markets. In this perspective, we focus on the evolution of exports of high skill-intensive industries and low skill-intensive industries, with the view of testing the theoretical hypothesis of the model that export penetration in high-income EU markets depends on product quality. To this end we disentangle the contribution of supply-side and demand-side factors in explaining "successful quality competition". The supply-side determinants include technological variables that account for the quality upgrading of products, whereas demand-side variables are designed to capture the intensity of consumers' preference for quality. Given that the CEECs have undergone a process of intense economic integration in particular within the European Union, in specifying the technology components we include terms for the interaction between domestic and foreign knowledge, that account for the industry's "absorptive capacity".

Data and variables description

We consider exports from six countries (Czech Republic, Estonia, Hungary, Latvia, Poland and Slovenia) – reporter countries – towards EU-14 partner countries.[10] Trade data from 2000 to 2006 are taken from Eurostat COMEXT database at 8-digit level of industrial products (CN8).

Exports' breakdown is based on the NACE (DA-DN) classification that divides manufactured products into 14 industries. In a first estimation of the evolution of CEECs' market shares we consider exports of all industries. The market share is defined as the ratio of exports of the reporter country to the total imports of the partner country.

[10] Among the EU new member States we do not consider Slovakia and Lithuania, for lack of data, whereas among the EU-15 countries we do not consider Luxembourg, owing to its small dimension.

For each combination of reporter and partner country, and for each industry, we consider two different aggregates of traded goods: the first one refers only to those products that were bilaterally traded, both in 2000 and 2006, whereas the second comprises also new traded goods, that is, products that were not traded in the initial year. When only products traded in both years are considered, the market share measures the increase in the "intensive margin",[11] whereas by considering the second aggregate we take into account also changes in export penetration due to the introduction of new products, or to changes in imports' product structure of the partner country. We obtain trade at constant values by evaluating 2000 quantities at 2006 unit values, that are then aggregated into the 14 industries. The variables that enter the regression are: products relative price, the "Linder term" for the intensity of quality demand, and technological variables.

The relative price of the reporter's exports to the partner's total imports for each type of industry is built - consistently with our definition of market share - as a weighted average of the relative unit values at product level, where the weights are the share of each product export in industry's total exports. We dropped observations belonging to the upper and lower 5% of their distribution, since huge differences between export and import prices point to a composition effect within product categories, that is, to the presence of heterogeneous goods; in this case, price differences are not associated to differences in the goods quality content.

As to the variables referring to the demand side, we include the GDP per capita of the partner country in order to capture a general scale effect. In any case, this variable does not vary among reporters, hence its impact can be captured by a partner-specific fixed effect. A second term captures the intensity of preference for quality, and is given by the product of the growth rate of per capita GDP and the growth rate of the UVRs of each type of industry. The choice of the above interaction term is suggested in Hallak (2006), where however the interaction is between export unit values and GDP per capita of the partner country,[12] whereas we interact the *relative* price with GDP per capita of the partner country, since we are interested in evaluating market share dynamics.

Turning to the supply side, we follow the theoretical and empirical literature in considering domestic R&D expenditure as the primary source of total factor productivity growth, and hence, within the context of our analysis, as the engine of quality upgrading in manufacturing.[13] Data are from Eurostat. As in our sample there are several missing values, we used the average R&D expenditure. We also consider two variables that should capture the international knowledge spillover, i.e., the stock of inward FDI and bilateral flows of imports of intermediate goods. FDI data are from the WIIW database on Foreign Direct Investments, that includes FDI stocks and flows in each industry for several Central and Eastern European countries. Intermediates imports are obtained from the COMEXT database at product level, aggregated by matching the CN8 and the Broad Economic Categories (BEC) classifications. Intermediate goods consist of primary and processed commodities as well as parts and components.

In the literature there is mixed evidence of the effect of FDI on total factor productivity growth. In fact, both FDI inflows and intermediates imports may be linked to the delocalisation process of EU activities and give rise to outsourcing related exports. FDI inflows may also take place for delocalisation purposes (the so-called vertical FDI), as well as for penetration on local markets (horizontal FDI). The effect of horizontal FDI is likely to be null or even negative if the production of foreign

[11] Hummels - Klenow (2005).

[12] This is because in Hallak (2006) the focus is exclusively on the demand determinants of quality in explaining trade trends, and thus cross country differences in export unit values are taken as proxies of the difference in quality of exported goods.

[13] Khan - Luintel, 2006.

subsidiaries for the host market crowds out the domestic production, and therefore exports.[14] In order to control for the different features of the delocalisation process,[15] we interact the spillover variables with domestic R&D expenditure growth.

Table 1 - All industries				
	Goods in both years		All Goods	
	Market shares			
	EU competitors	World competitors	EU competitors	World competitors
DlnPrel	-0.654***	-0.718***	-0.567***	-0.676***
	[0.118]	[0.119]	[0.125]	[0.133]
Qdem	-0,57	-0,676	-0,112	0,742
	[2.118]	[2.069]	[2.344]	[2.180]
DlnFDI	-0,068	-0,05	-0.159**	-0,125
	[0.054]	[0.049]	[0.079]	[0.083]
DlnMI	0,061	0,079	0,029	0,041
	[0.055]	[0.055]	[0.083]	[0.082]
DlnRD	0.109**	0.124**	0.201***	0.210***
	[0.055]	[0.052]	[0.068]	[0.063]
DlnFDI*DlnRD	-0,095	-0.114*	-0.170*	-0.199**
	[0.069]	[0.069]	[0.098]	[0.094]
DlnMI*DlnRD	-0.080*	-0.078*	-0,05	-0,048
	[0.044]	[0.041]	[0.071]	[0.067]
Constant	-0,143	-0,179	-0,251	-0.274*
	[0.134]	[0.145]	[0.154]	[0.156]
Partner Dummies	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes
Observations	667	667	667	667
R-squared	0,19	0,21	0,11	0,13

The estimated equation is thus the following:

$$\begin{aligned}\Delta ln\, MKTsh_{i,j} &= \alpha + \beta_1 \Delta ln UVR_{i,j} + \beta_2 QDEM_{i,j} + \beta_3 \Delta ln\, FDI_i + \beta_4 \Delta ln\, MI_{i,j} \\ &+ \beta_5 \Delta ln\, RD_i + \beta_6 \Delta ln\, FDI_i * \Delta ln\, RD_i + \beta_7 \Delta ln\, MI_{i,j} * \Delta ln\, RD_i + \Delta\gamma_i + \Delta\eta_j + \varepsilon_{i,j}\end{aligned} \tag{19}$$

where *MKTsh* is the market share of the reporter country *i* in the partner country *j*. *UVR* is products' relative price. *QDEM* is the "Linder term", expressed as the interaction between the relative price growth and the partner country's per-capita GDP growth. *FDI*, *MI* and *R&D* are the stock of foreign direct investments, imports of intermediates

[14] The first wave of FDI in Central and Eastern European countries (CEECs) was mainly of the horizontal type, with the delocalisation of low-tech productions, whereas in more recent years the role of vertical FDI increased; thus, the current FDI stock is a mix of vertical and horizontal FDI (Hunya - Geishecker, 2005).

[15] The evidence for CEECs is that initially delocalisation concerned mainly low-skill intensive activities, such as the assembling of simple processed goods (Egger and Stehrer, 2003), whereas in more recent years there has been an increase in the complexity and skill intensity of outsourcing related exports (Kaminski - Ng, 2005; Esposito - Stehrer, 2009b)

and domestic R&D expenditure, respectively. The remaining two terms (*FDI*RD* and *MI*RD*) capture the interaction between *FDI* and *MI* spillovers with the domestic R&D variable. Finally, γ, and η are reporter and partner specific fixed effects. These dummies control for the variables influencing production costs in the exporting country and for the general demand effect of the importing country. All variables are expressed in log differences between 2000 and 2006 data, and therefore we estimate growth rates. Moreover, technological variables are expressed in percentage of the exporting country GDP and thus represent intensities (GDP data come from Eurostat). We carry out OLS regression with standard errors clustered for partner country. The results are shown in Table 1.

With reference to relative prices, estimates show that an increase in relative price growth is associated with a decrease in the market share; as to quality demand, that we proxy with QDEM, the variable is not significant. With regard to the technological variables, domestic R&D is the only significant variable. We explain the above result as an outcome of the increase in EU outsourcing activities, regardless of any technological upgrading. We interpret the poor explanatory power of this first regression with the aggregation of all industries' exports. Evidently, a role for quality in trade should be looked for only in high-tech industries.

We thus proceed with the breakdown of exports according to skill intensities. The high-tech/high quality industries are: Paper, Printing and Publishing (DE), Coke and Refined Petroleum Products (DF), Chemical Products (DG), Machinery and Equipments (DK), Electrical and Optical Equipments (DL) and Transport Equipments (DM). All other branches are classified as low-technology/low quality.[16] In this second estimation the market share is defined as the ratio of high-tech (low-tech) industries exports of the reporter country to the total high-tech (low-tech) imports of the partner country.

The estimated equation is thus the following:

$$\begin{aligned} \Delta \ln MKTsh_{i,j,k} &= \alpha + \lambda_1 \Delta \ln UVR_{i,j,k} + \lambda_2 QDEM_{i,j,k} + \lambda_3 \Delta \ln FDI_{i,k} \\ &+ \lambda_4 \Delta \ln MI_{i,j,k} + \lambda_5 \Delta \ln RD_{i,k} + \lambda_6 \Delta \ln FDI_{i,k} * \Delta \ln RD_{i,k} \\ &+ \lambda_7 \Delta \ln MI_{i,j,k} * \Delta \ln RD_{i,k} + \Delta\gamma_i + \Delta\eta_j + \Delta\sigma_k + \varepsilon_{i,j,k} \end{aligned} \tag{20}$$

where now *MKTsh* is the market share of the reporter country *i* in the partner country *j* for industry *k*, and where σ is the industry-specific fixed effect.

Tables 2 and 3 show the estimates of equation (20) separately for the high-tech/quality industries and low-tech/quality industries. Again, with regards to relative prices, an increase in relative price growth is associated with a decrease in the market share. As for quality demand, we consider the variable QDEM only in the estimations for the high-tech industries where – as expected – it is positive and significant especially when considering the market share with respect to EU competitors. As to the technological variables, none of them is significant in low-tech industries, whereas in high-tech/quality industries domestic R&D is significant, and with the expect sign, in particular when also new traded goods are considered. As for FDI, this variable is significant and negative with reference to the larger aggregate of traded goods; this result may be interpreted as the consequence of a "crowding out" effect on domestic production and exports of the horizontal part of FDI.

[16] This classification reflects the increased specialisation of these countries in medium to high-tech goods and the concentration of skill biased technical change in these branches (see Esposito - Stehrer, 2009a).

Table 2 – High-tech/quality industries				
	Goods in both years		All Goods	
	Market shares			
	EU competitors	World competitors	EU competitors	World competitors
DlnPrel	-0.745***	-0.739***	-0.722***	-0.779***
	[0.176]	[0.168]	[0.154]	[0.160]
Qdem	5.126*	4.538*	4.348*	3,816
	[2.652]	[2.633]	[2.358]	[2.559]
DlnFDI	-0,066	-0,063	-0.220**	-0.184*
	[0.075]	[0.070]	[0.092]	[0.094]
DlnMI	-0,017	-0,004	0,045	0,04
	[0.080]	[0.081]	[0.098]	[0.098]
DlnRD	0.157*	0.170**	0.268***	0.285***
	[0.089]	[0.085]	[0.085]	[0.084]
DlnFDI*DlnRD	-0,212	-0,22	-0,315	-0.397**
	[0.169]	[0.159]	[0.195]	[0.180]
DlnMI*DlnRD	-0,044	-0,054	0,026	0,03
	[0.056]	[0.052]	[0.079]	[0.076]
Constant	0,285	0,247	0,217	0,131
	[0.227]	[0.219]	[0.277]	[0.263]
Partner Dummies	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes
Observations	299	299	299	299
R-squared	0,26	0,27	0,22	0,24

Table 3 – Low-Tech Industries				
	Goods in both years		All Goods	
	Market shares			
	EU competitors	World competitors	EU competitors	World competitors
DlnPrel	-0.685***	-0.754***	-0.491***	-0.614***
	[0.165]	[0.172]	[0.185]	[0.204]
DlnFDI	-0,124	0,023	0,108	0,231
	[0.188]	[0.170]	[0.189]	[0.179]
DlnMI	0,024	0,054	-0,117	-0,079
	[0.079]	[0.079]	[0.123]	[0.126]
DlnRD	0,056	0,031	-0,045	-0,06
	[0.102]	[0.096]	[0.114]	[0.110]
DlnFDI*lnRD	-0,269	-0,145	-0,061	0,065
	[0.211]	[0.143]	[0.155]	[0.118]
DlnMI*lnRD	-0,079	-0,073	-0,174	-0,167
	[0.090]	[0.079]	[0.115]	[0.115]
Constant	0,014	-0,157	-0,133	-0,216
	[0.203]	[0.198]	[0.221]	[0.230]
Partner Dummies	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes
Observations	399	399	399	399
R-squared	0,19	0,21	0,12	0,13

We now refine the price term on the basis of the following considerations. There may be two reasons behind the changes in the unit value ratios (UVR) of each type of industry when considering only those products that were traded, both in 2000 and 2006: changes in relative prices at product level and changes in the weights of the basket. “Within” product price increases are commonly used in literature as a proxy for quality upgrading, whereas “between” product price increases point to changes in the export specialisation towards a different composition of products. In order to separate these two effects, we split the UVR changes into “within” and “between” components to detect whether they have a differentiated impact on the market share.

We also use two indicators of the “Linder term”, by interacting foreign per-capita GDP with “between” and “within” relative prices growth, respectively. As stated before, the “within” interaction better captures the demand for quality because “within” product price changes are a proxy for quality upgrading. The “between” component instead represents those changes in UVR growth due to changes in the quantity of each traded product, and thus accounts for compositional changes between the two years of analysis.

The estimated equation is now the following:

$$\begin{aligned} \Delta ln\, MKTsh_{i,j,h} &= \alpha + \delta_1 \Delta ln\, UVRw_{i,j,h} + \delta_2 \Delta ln\, UVRb_{i,j,h} + \delta_3 QDEMw_{i,j,h} \\ &+ \delta_4 QDEMb_{i,j,h} + \delta_5 \Delta ln\, FDI_{i,h} + \delta_6 \Delta ln\, MI_{i,j,h} + \delta_7 \Delta ln\, RD_{i,h} \\ &+ \delta_8 \Delta ln\, FDI_{i,h} * \Delta ln\, RD_{i,h} + \delta_9 \Delta ln\, MI_{i,j,h} * \Delta ln\, RD_{i,h} + \Delta\gamma_i + \Delta\eta_j + \varepsilon_{i,j,h} \end{aligned} \quad (21)$$

where the index *h* represents the high-tech industries. The results are shown in Table 4.[17]

Table 4 – "Within" and "Between" Demand and Price Components in High-tech industries		
	Market shares	
	EU competitors	World competitors
DlnPrel "within"	-0.785***	-0.752***
	[0.122]	[0.113]
DlnPrel "between"	-0.703***	-0.742***
	[0.168]	[0.164]
Qdem "within"	7.894***	7.392***
	[2.113]	[2.061]
Qdem "between"	0,745	-0,215
	[2.629]	[2.570]
DlnFDI	-0,063	-0,058
	[0.078]	[0.076]
DlnMI	-0,01	0
	[0.080]	[0.078]
DlnRD	0.170**	0.180**
	[0.076]	[0.074]
DlnFDI*lnRD	-0,218	-0.232*
	[0.133]	[0.129]
DlnMI*lnRD	-0,038	-0,045
	[0.049]	[0.048]
Constant	0,127	0,015
	[0.284]	[0.276]
Partner Dummies	yes	yes
Country Dummies	yes	yes
Observations	299	299
R-squared	0,28	0,29

With reference to relative prices, both components have the usual negative sign for all industries as well as for high-tech industries alone. When we take into account the "within" and "between" components of quality demand, the variables are still not significant with reference to all industries, whereas for high-tech industries only the "within" component results to be significant. This means that, since "within" UVR is the price component that better captures quality upgrading, quality demand variation

[17] We want also to point out the impact of the coefficients in terms of standardized elasticities. Such standardized (or beta) coefficients are obtained by multiplying the coefficients estimates by the standard deviation of the explanatory variable and dividing them by the standard deviation of the dependent variable. In this way the regression coefficients are converted into units of sample standard deviation and give us a measure of how much variability can be explained by the explanatory variable (see Wooldridge, 2003, section 6.1). For instance, considering the coefficient of Qdem*w* in column 1, we get a standardized elasticity of ((7.893629*.0387042)/1.405277=.218. This means that a one standard deviation increase in the growth rate of the Demand "within" implies an increase of 0.218 standard deviation in the growth rate of the Market share.

actually plays an important role in explaining the increase in market penetration of the CEECs toward EU.

Summing up, in high-tech/quality industries there is evidence of a relevant role for demand determinants of successful quality competition and of a role for domestic R&D in explaining the growth of the CEECs market share in EU countries and on world markets. Finally, the influence of European economic integration is emphasised by the greater dimension of the effects of the dependent variables on the evolution of the pattern of trade toward EU countries with respect to the world market.

5. Concluding remarks

In the paper we consider the role of vertical innovation on the structure of trade and its evolution over time for emerging market economies undergoing a process of economic integration with technologically advanced countries. We first address the issue from a theoretical point of view, and then provide some empirical evidence by considering the case of the CEECs integration in the EU. The aim is to assess the "within specialization" in up-market or down market products, deriving from skill-intensive endowments.

In the theoretical part of the work we distinguish between firms that produce technologically advanced goods, thanks to basic research activity, and firms that manufacture traditional products; the latter are able to step up the quality ladder thanks to secondary innovations. High-tech firms show a higher pace of quality upgrading than traditional firms, also thanks to their superior efficiency in benefiting by the international dissemination of knowledge fostered by economic integration. As a result, exporting firms of the two kind of industries perform differently: high-tech firms are able to compete in "quality dominated markets" and expand along the "intensive margin"; traditional firms rely on a traditional cost competition and therefore expand sliding down the demand curve for a given variety.

Our empirical investigation supports the conclusion obtained in the theoretical analysis. As far as the CEECs are concerned, our estimations show that in high-tech industries both supply factors (technology) and quality demand factors are significant in explaining the growth of the CEECs market share in EU countries. In addition, we find evidence of a positive impact of the international diffusion of knowledge, channelled by FDI flows, for high-tech exporting firms. As to low-tech industries, the evidence shows only a traditional relative price effect in explaining market shares dynamics.

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