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MOVING SKILLS FROM HANDS TO HEADS: IMPORT OF TECHNOLOGY AND EXPORT PERFORMANCE

by

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Abstract

This paper examines the link between imported technologies and a country's export performance, as measured by product quality. The analysis is set in the background of the process of regional integration between the EU and its neighbouring developing countries. The underlying question is whether trade integration fosters or dampens learning and technological upgrading. We find that unit values of exports from these countries to the EU rose steadily between 1988 and 1996, relative to the unit values of world exports to Europe. If increases in unit values satisfactorily proxy increases in product quality, then trade integration has fostered product upgrading and technological learning in the sample countries. We find that imported technologies and other sources of knowledge have a strong bearing on this pattern. Technological inflows are captured by the degree of involvement of European companies in export flows from our sample countries (Outward Processing Trade) and by the skill content of the machines imported.

Non Technical Abstract

Trade and greater economic integration affect the upgrading of technologies in less advanced areas. The open questions pertain to the direction of such change and to the channels through which technologies are transmitted. This paper explores the role of a few different channels for importing technologies and their impact on export performance. The study is set in the context of the process of economic integration between the European Union (EU) and its neighbouring developing countries, in particular Central and Eastern European Countries (CEECs) and the Southern Mediterranean Countries (SMCs).

New potential sources of technological inputs become available with declining trade barriers. Some of these technological inputs are deliberately purchased (new machines, foreign investments, skilled personnel) and others are acquired through spillovers, by trading with more technologically advanced partners, by gathering information in foreign markets, by learning from sophisticated imported goods.

In the present paper export performance is defined in terms of the quality of exported products, on the presumption that higher quality products imply the use of more complex technologies and have a strong learning potential. We find that unit values of exports from the sample countries to the EU rose steadily between 1988 and 1996, relative to the unit values of world exports to Europe.

We then investigate whether imported technologies and other sources of knowledge have some bearing on this pattern. Particular attention is devoted to the technologies embodied in the machines. We develop a measure of technological complexity of the machines imported related to the level of skills required to use them. We also jointly estimate the role of Outward Processing Trade which indirectly captures foreign investments and other forms of involvement of European firms in our sample countries.

These channels of technological imports appear to have a statistically discernible and positive role on product quality for all the countries analysed. Imported machines are the

most important determinant of product upgrading in the SMCs, while foreign firms play a dominant role in the CEECs.

This result is consistent with stylised facts. The pattern of trade liberalisation and specialisation was quite different for the two groups of countries. In the CEECs liberalisation was sudden and drastic. Trade patterns changed considerably, both in terms of products and market destination. Foreign companies are playing a crucial role in this pattern of transition. In the SMCs things have been smoother. Trade is being liberalised more gradually and many of these countries have a strong specialisation in textile. Although based on imported technologies, upgrading and learning appears to be rooted in the local production structure rather than being channelled by foreign companies.

1. Introduction

There is broad consensus among economists and policymakers that trade and greater economic integration affect the upgrading of technologies in less advanced areas. The open questions pertain to the direction of such change and to the channels of through which technologies are transmitted.

This paper explores the role of a few different channels for importing technologies and their impact on export performance. The study is set in the context of the process of economic integration between the European Union (EU) and its neighbouring developing countries. This has greatly increased in the last two decades. Under the umbrella of the Europe Agreement, Central and Eastern European Countries (CEECs) have moved from quasi-autarky to quasi-free trade and some of them will enter the EU in the near future. Turkey has implemented very liberal policies in the Eighties and will soon be part of a Custom Union with the EU. Finally, many of the Southern Mediterranean Countries (SMCs) have negotiated or are negotiating reciprocal free trade agreements with Europe, under the Euro Mediterranean Agreement. Whereas the restructuring of trade for the EU regional agreements has been widely studied (Landesmann and Székely, 1995; CEPR, 1992; Faini and Portes, 1995; Djankov and Hoekman, 1996), changes in technological flows have rarely been investigated.

There are two strings of transmission between trade and diffusion of technologies. The first one depends on the pattern of specialisation of the country in question. Learning is faster if the country specialises in goods with higher learning potential, both in terms of learning by doing and of deliberate learning investments. Goods with higher learning potential are generally more technologically sophisticated from the viewpoint of production technology, product quality or product varieties. Thus, trade will induce technological upgrading if opening up countries face a higher incentive to specialise in high tech products than in autarky. This mechanism has been explored in the endogenous growth literature (Krugman, 1987; Stockey, 1988, 1991; Young 1991) and at the micro level using firm level panel data (Roberts and Tybout, 1996; Hunt and Tybout, 1998).

However, technological upgrading is not just based on domestic resources. The second string of transmission is linked to the new potential sources of technological inputs becoming available under free trade. Some of these technological inputs are deliberately purchased (new machines, foreign investments, skilled personnel) and others are acquired through spillovers, by trading with more technologically advanced partners, by gathering information in foreign markets, by learning from sophisticated imported goods. Of course, these two strings are intertwined, in that the easier and the cheaper the imported technological inputs the more likely are countries to specialise in high tech products.

Rivera-Batiz and Romer (1991) and Grossman and Helpman (1991) analyse the relationship between international flows of technology and endogenous growth with symmetric and asymmetric countries respectively. Both contributions provide strong theoretical backing to the hypothesis that inflows of technology positively affect growth. This result is supported by empirical findings in the seminal work by Coe and Helpman (1995) and for developing countries by Coe, Helpman, and Hoffmaister (1997). These papers examine whether aggregate trade flows serve as channels for the transmission of R&D spillovers. Keller (2000) extends this approach by looking at sector level effects. Recently, Eaton and Kortum (2000) relates productivity differences to the quality of the capital equipment imported.

An important dimension of this issue is the link between imported technologies and export performance. There is good evidence of a positive correlation between exports and productivity at the firm level, although the causal direction of such link is still disputed (Clerides, Lach, and Tybout, 1998 and Aw, Chung, and Roberts, 2000). Thus, an indirect way of looking at the impact of imported technologies on growth is to look at their impact on export performance. Earlier work (Djankov and Hoekman, 1996, 1997) examined the role of imported technologies on the export performance of CEECs as measured by revealed comparative advantage. It was found that in most CEECs changes in export structure have been driven by imports of intermediate inputs and machinery. In addition, the direct involvement of foreign enterprises in domestic production, either through FDIs or Outward Processing Trade (OPT), has not been very influential. [1]

The present paper addresses the same issue but differs from these earlier contributions in a few respects. Firstly, export performance is defined in terms of the quality of exported products, on the presumption that higher quality products imply the use of more complex technologies and have a strong learning potential. Secondly, the impact of the specific technology embodied in the machines, is the central focus of analysis.[2] Previous work looked at the impact of R&D spillovers conveyed by generic groups of inputs. Thirdly, this study analyses jointly two channels for importing technologies: machines and foreign direct investments. Finally, this study compares the CEECs with Turkey, an earlier liberaliser, and with the SMCs which, although having signed or being about to sign the Euro-Med agreement, are rather resilient in reforming their trade regimes.

The empirical analysis we carry out focuses on the textile industry. Textiles are a major export industry for all the countries considered and it has been heavily affected by trade liberalisation. Textile machines can be easily linked to the products they produce and classified according to the skills necessary to operate them. Finally, foreign investors had a relatively prominent role in this industry.

The paper is organised as follows. The next section provides the basic facts about the process of regional integration between the EU and its neighbouring developing countries. Section 3 sets the ground for the empirical analysis and reports the main findings. Section 4 concludes.

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1 OPT includes temporary exports and imports between European and extra-European firms and it is reported in EU trade statistics. OPT is an indirect measure of the involvement of European firms in production in neighbouring developing countries and it accounts for trade flows generated under foreign investments or looser non-equity agreements between Northern and Southern firms.

2. Regional Integration and Trade Reforms between EU, CEEs and SMCs

All the economies included in our analysis have undergone a process of trade liberalisation which has affected the structure of their trade flows to Europe. Yet, the extent and timing of trade reforms and export restructuring have not been uniform across regions. Indeed, it is possible to tell at least three different tales. The first one concerns the CEECs. Starting from 1989, these countries have practically moved from a situation of autarky under the CMEA to a situation of virtually free trade with a dramatic geographic reorientation and restructuring of their exports. The second one refers to Turkey, an early liberaliser, which has implemented a very considerable programme of trade reforms starting from the early Eighties. The third one concerns the other SMCs, which have been slow and resilient reformers.[3]

As for the CEECs, there is overwhelming consensus that the extent of trade reforms has been considerable; equally, trade concessions from the EU were generous. Shortly after the fall of the Berlin Wall, the extension of the Generalised System of Preferences (GSP) immediately enhanced the access of CEECs exports into Europe. The Europe Agreement, signed in 1991, by Czechoslovakia, Hungary, and Poland and in 1993 by Rumania and Bulgaria, strengthened this pattern by abolishing all quantitative restrictions on industrial imports from the CEECs, as well as tariffs on over 50% of EU imports (Faini and Portes, 1995).[4] Although there is some debate on the effectiveness of

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[2] Embodied technology is measured by an index of technological complexity of the machines imported based on the minimum skills required to operate such machines. This methodology was developed in (Barba Navaretti, Soloaga, and Takacs 2000).

[3] These countries are grouped together, in that their pace of reforms has indeed been much slower than the CEECs. Still, there are considerable differences. Particularly non oil-exporting countries like Marocco, Tunisia, Israel, and Jordan are moving much faster in the direction of free trade than the other countries in this group.

[4] Sensitive products like textile and clothing are an exception: trade concessions were made dependent upon the phasing out of the Multi Fibre Agreement (MFA) as negotiated within the Uruguay Round. In any case MFA quota granted to the CEECs were sufficiently loose not to be binding. Utilisation rates of MFA quotas never exceeded 65% in 1992 (Corado, 1995).

the Europe Agreement in liberalising trade,[5] the CEECs exports to Europe rose dramatically between 1989 and 1995: 26.3% for the Czech and Slovak republics, 19.8% for Bulgaria 18.7% for Poland and 13.7% for Hungary. This increase implied a very considerable geographic reorientation of exports: the share of exports to Europe rose from below 40% to above 70% for most of the CEECs, whereas the share of the former COMECON countries shrank dramatically. CEECs also underwent a change in specialisation of the products exported. It is now well established that the increase in exports to Europe consisted for a large part of new products, i.e. products not previously exported, even to the CMEA countries (Dijankov and Hoekman, 1996, 1997).

The second story concerns Turkey. This country has implemented extremely liberal policies already in the Eighties and it has recently decided to implement a Custom Union with Europe, applying the EU common external tariff to third countries' imports. Liberalisation policies have drastically changed the export structure: the share of manufacturing in total exports went from 36% in 1981 to 79% in 1987. Turkey also established itself as an important exporter of textile products to Europe and its share of European imports of clothing products was 5.79% in 1994.

Finally, the picture is quite different for the other SMCs. Although some of these countries (Tunisia, Morocco, Israel, Jordan, and Egypt) have negotiated or are negotiating reciprocal free trade agreements with Europe, trade regimes have been up to now, and often still are, quite protectionist. In particular, there are high rates of effective protection, substantial dispersion of protection across industries and non-transparent implementation of trade policies. Average tariffs have declined since the mid-eighties, but they are still between 25% and 35 %, whereas countries that have undergone radical liberalisation processes have now average tariffs ranging between 10% and 20%. The Euro-Mediterranean agreement is certainly likely to affect trade patterns between the undersigning SMCs and the EU, even though there are doubts that such agreement will really improve accessibility to the European market, but its impact is just starting to be

5 Liberalisation on agricultural products is still modest and anti-dumping and contingent protection clauses may cause uncertainty on the effective nature of the new trade regime (see CEPR, 1992).

visible. Up to now, the relative restrictiveness of trade regimes is reflected in the poor performance of the SMCs in terms of exports to Europe. Whereas the average yearly growth rate of exports to Europe between 1989 and 1993 has been of 18.7% for the CEECs, it was only 2.5% for the SMCs.

The availability of three different patterns of liberalisation renders the EU-LDCs regional integration process particularly suitable and rich for the purpose of our analysis. As we will show below, these patterns have important effects on the impact of imported technologies on trade performance.

3. The Empirical Analysis

3.1. Background

A fundamental external channel for learning which opens up with trade is the export market. Many case studies and empirical evidence support this view, showing that exporting firms are more efficient than non-exporting ones (Pack, 1992; Bernard and Jensen, 1997; Clerides, Lach, and Tybout, 1998; Aw, Chung, and Roberts, 2000)

A relevant question in this context is the role played by imported inputs in the link between export, learning and productivity growth. In other words, does learning also take place because firms, by exporting, have access to a wider range of imported intermediate inputs? Djankov and Hoekman (1996, 1997) use trade data to relate imports of inputs and FDI to the export performance of the CEECs. There, export performance is measured by an index of revealed comparative advantage for 23 sectors. Different inflows of technology are taken into account: imported inputs, estimated on the basis of input-output tables, foreign direct investment, and outward processing trade (OPT), which measures the import of intermediate goods under subcontracting and through FDIs. The authors find that imported inputs are particularly significant in explaining trade performance and much less so foreign direct investments.

3.2. What is New in This Paper

Our exercise is similar to Djankov and Hoekman (1996, 1997)'s, but it is more focussed on the learning process enticed in the imported technologies-export performance link. First, we use a measure of export performance which is related to the process of technological learning: the unit value of the exported products, as a proxy for quality (Aw and Roberts, 1986). Djankov and Hoekman use Revealed Comparative Advantage (RCA) as their measure of export performance. But RCA is an index of the ability of the exporters to stay in the market and increase their market share and not of technological upgrading. A high RCA can be achieved with low skills and poor quality products. Product quality is basically an ex-post index of the technological skills of exporting producers in our sample country. It indicates the ability to achieve a given technical level, even though the performance in terms of RCA could be negative. Second, as for imported inputs we focus on capital goods, namely imported machines, and we distinguish them on the basis of their technological characteristics. This indicator of imported technology differs from those developed by earlier contributions which fail to consider the technological features of imports. Coe and Helpman (1995), the pioneering empirical analysis relating imported technologies to growth, and subsequently Coe, Helpman, and Hoffmeister (1997) and Keller (1998 and 2000), look at R&D spillovers conveyed through general imports of machinery. The larger the share of imports from countries with large R&D investments the larger the expected productivity gains in the importing countries. Eaton and Kortum (2000) relates differences in aggregate real GDP per capita to the quality of imported inputs for a sample of 34 countries. Djankov and Hoekman (1996, 1997) analyse more carefully the role of imported intermediates at the micro level with the use of input output tables. Specifically, they compute the share of imported intermediates and its impact on productivity, but they do not distinguish between capital goods and other inputs and among different types of capital goods.

In contrast, we focus on the technology embodied in machines. This distinction is important. We expect that the types of machines imported from any given country will differ. In this respect, imports of the same total value of machines from different countries have a different effect on economic performance and growth because the bundles of imported machines differ across countries. High tech machines may generate more growth simply because they are more efficient or they induce more efficient learning processes, not necessarily because they convey positive externalities from the country producing such machines. Countries with relatively large R&D investments may generate more learning and growth because they export a larger share of high tech machines not necessarily because they convey larger R&D spillovers. Following Djankov and Hoekman (1996, 1997), we test jointly for the impact of different sources of technological inflows: foreign direct investment and other looser forms of connection between domestic and EU enterprises.

3.3. The Sample

As said, the sample countries are from Central and Eastern Europe (CEECs) and from the Southern Mediterranean (SMCs). Specifically the former group include Bulgaria, Hungary, Czechoslovakia (for consistency we have pooled together the Czech and Slovak republics after 1992), Poland, Slovenia and Croatia, while the latter group is comprised of Cyprus, Israel, Morocco, Turkey, Egypt, Malta, Tunisia, and Syria. As argued in Section 2, we can broadly classify countries into three groups according to the evolution of their trade policy regime: Turkey, which is an early liberaliser and about to form a custom union with the EU, the CEECs which have virtually moved to a free trade regime after 1989 and the remaining SMCs which are liberalising at a very slow pace. We focus on the period between 1988 and 1996.

The empirical analysis on the three groups of countries focuses on the textile industry. This choice rests upon a number of arguments. Firstly, textile is a major export industry for all the countries considered and it has been drastically affected by trade liberalisation and particularly by the loosening of the Multifibre Arrangement (MFA). Secondly, imported inflows of technology had a major role in the industry: a large share of European foreign investments in neighbouring developing countries is in textile and clothing. Moreover, European firms in the sector are heavily redeploying their labour intensive production facilities. This process has taken place either through the setting up of subsidiaries and joint ventures (direct investments) or through arm-length production agreements with local firms. Imports of textile machines are also important. Thirdly, it is possible to link technological inflows to export performance. Textile machines are specific purpose machines which can be distinguished according to the segment of the industry which uses them. It is therefore possible to establish a link between types of machines imported and textile products exported. This would not be the case with general-purpose machines, like metalworking.

The analysis proceeds in two steps. We first provide some stylised facts on import of technologies and export performance. We devote particular attention to the construction of an index that classifies machines according to the minimum skills necessary to use them (the skill index). We then present some econometric evidence on the link between inflows of technologies and export performance.

3.4. The Construction of the Skill Index and Stylised Facts on Imports of Technology

The skill index measures the *minimum skills* necessary to use a machine efficiently. Note that we are not looking at the technology embodied in the machine (complexity in construction) but at how difficult it is to use it. We let the index take on values from 1 to 4. The higher the index, the more sophisticated the required minimum skills to use the machine. When the index is one or two, machines are basically operated by skilled or unskilled workers (skills in the hands). When it takes values 3 or 4 they require technicians and engineers (skills in the heads). For textile machines the index takes mostly values of 2 or 3. For other types of machines, not examined in this work, like metal working machines, the index takes also value 4.[6]

[6] This index can arise some controversy as it is sometimes argued that automated machines require very unskilled personnel at the shop floor. This is true, but the index considers the minimum skills necessary to run the machine and automated machines cannot be run without technicians and engineers.

The subsequent step is to classify imported textile machines according to the skill index. This can be done because EU trade statistics are highly disaggregated: at the 8 digits level of the harmonised code. By sitting with engineers familiar with the industry, it was possible to assign the right index to each of the machines listed in trade statistics. As we are able to do this exercise for machines imported from the EU only, before moving any further we need to check how significant are imports of European machines on total imports of textile machines. To this end Table 1 shows the share of European machines on total machines imported by the countries listed (which are the major importers among our sample countries) in 1996. As we can see the share is never below 65%.

		Table 1		
Import of Textile and Clothing Machinery				
	(share of imports from EU12)			
	Tunisia		77,79%	
	Hungary		78,36%	
	Poland		77,15%	
	Czech Republic		82,53%	
	Morocco		79,64%	
	Turkey		66,30%	
	Egypt		69,12%	

We can now compute an aggregate weighted average skill index for each of our sample countries and for each year examined (1988 to 1996), using values of machines imported as weights:

$$S_{c,t} = \sum_{i} (V_{i,c,t} S_i) / V_{c,t} \tag{1}$$

where $S_{c,t}$ is the average skill index in country *c* in year *t*, S_i is the skill index of machine *i* classified at the 8 digit level, $V_{i,c,t}$ is the value of machines *i* imported by county *c* in year *t*, and $V_{c,t}$ is the total value of textile machines imported by country *c* in year *t*.

It is therefore possible to look at the time trend of total imports of textile machines and of the skill index between 1988 and 1996 (Figures 1A and 1B). To make trends more stable we have computed three years averages for the skill index. To understand these trends it is convenient to maintain the three country groupings used in section 2: the CEECs, Turkey and the SMCs. As for the CEECs (Figure 1A), the average skill index has invariably declined and rather drastically so. As our data include observations for 1988, the year preceding the fall of the Berlin wall and the opening up of trade towards Europe, it is quite clear that this decline heavily reflects the impact of trade liberalisation. Interestingly enough, the skill index has declined whereas values of machines imported have increased for most of the CEECs. In other words, the decline in the average index corresponds to a period when investments in textile machines boosted.

In contrast Turkey, the old liberaliser, shows a constant increase in the index and an extraordinary, almost seven-fold boom in the total values of the machines imported. Thus, Turkey, which is not hit by a trade shock in this period, at least as large as the CEECs, seems to have been constantly upgrading its textile technology. Finally, the index is quite stable or declining for most SMCs.

We now move beyond aggregate evidence. Textile machines can be classified into five broad categories, following the production cycle: spinning, weaving, knitting, finishing and clothing machines. Each of these group of machines have a different average skill index. Furthermore, within each of these categories there are machines which embody different technologies. Thus, when we observe a variation in the index, we cannot say whether this change has occurred because the country has changed the overall structure of the machines imported (e.g. from spinning to weaving machines) (*structural effect)* or the technology of machines performing the same functions (e.g. from hand looms to automated looms) (*substitution effect)*. To disentangle these two effects, we decompose the variation of the index between the first (1988-1992) and the last period averages (1992-1996) as follows:[7]

7 Note that in this case we use four years averages, whereas in (1) we used two years averages.

Figure 1A: CEECs Imports from EU of Textile and Clothing Machinery (HScode:8444-8452) and Average Skill Index. Average 1988-1996.

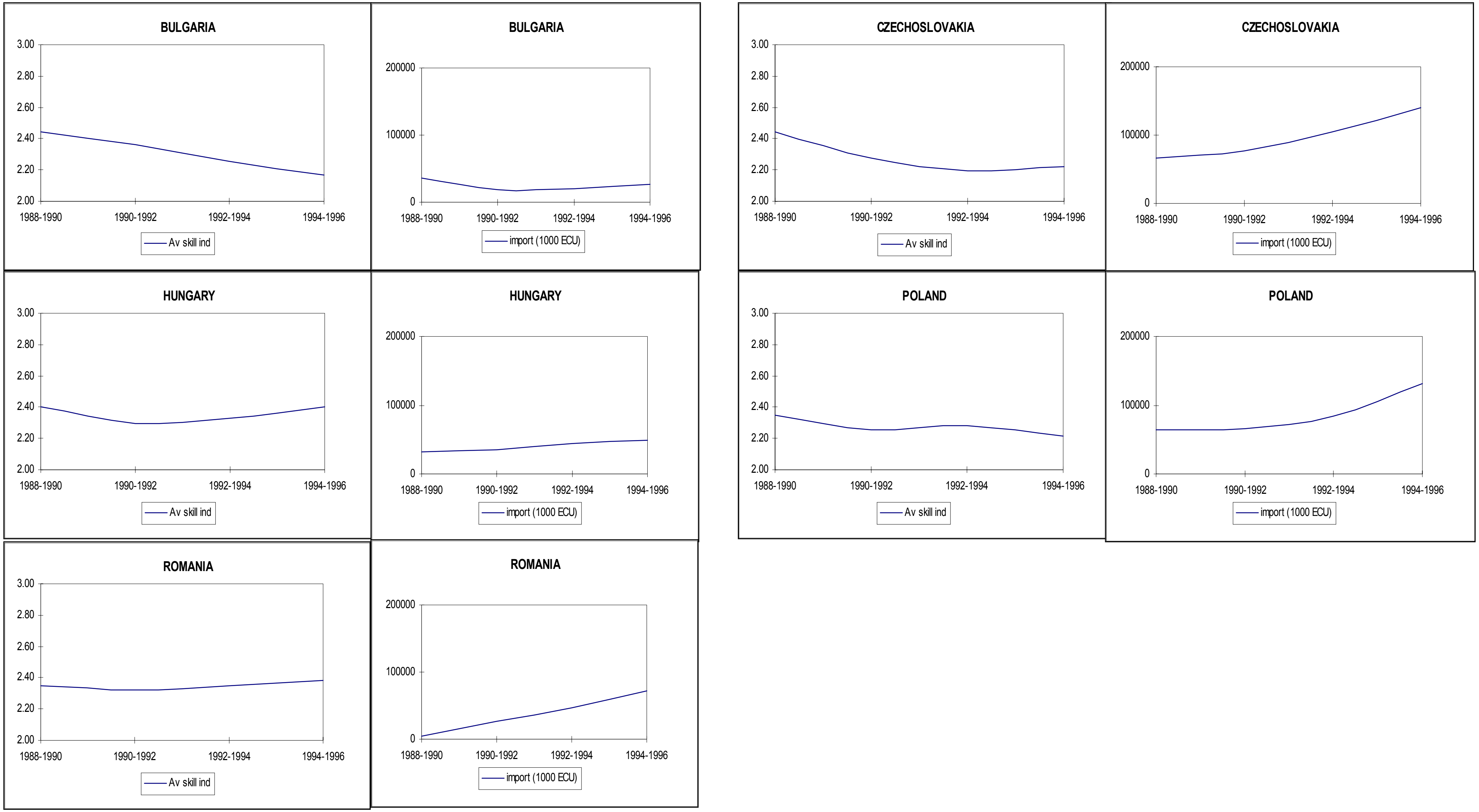
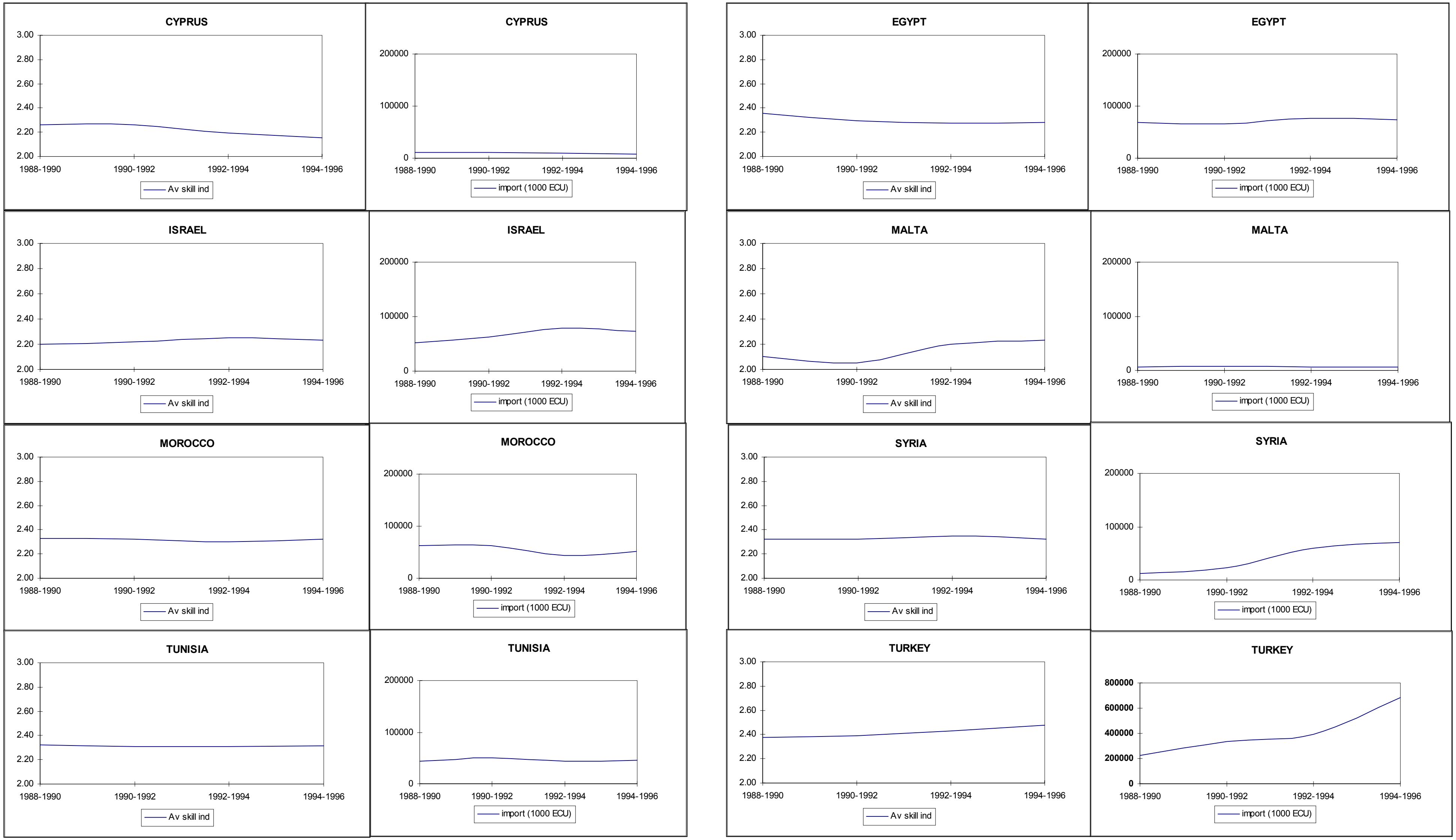


Figure 1B: SMCs Imports from EU of Textile and Clothing Machinery (HScode:8444-8452) and Average Skill Index. Average 1988-1996.



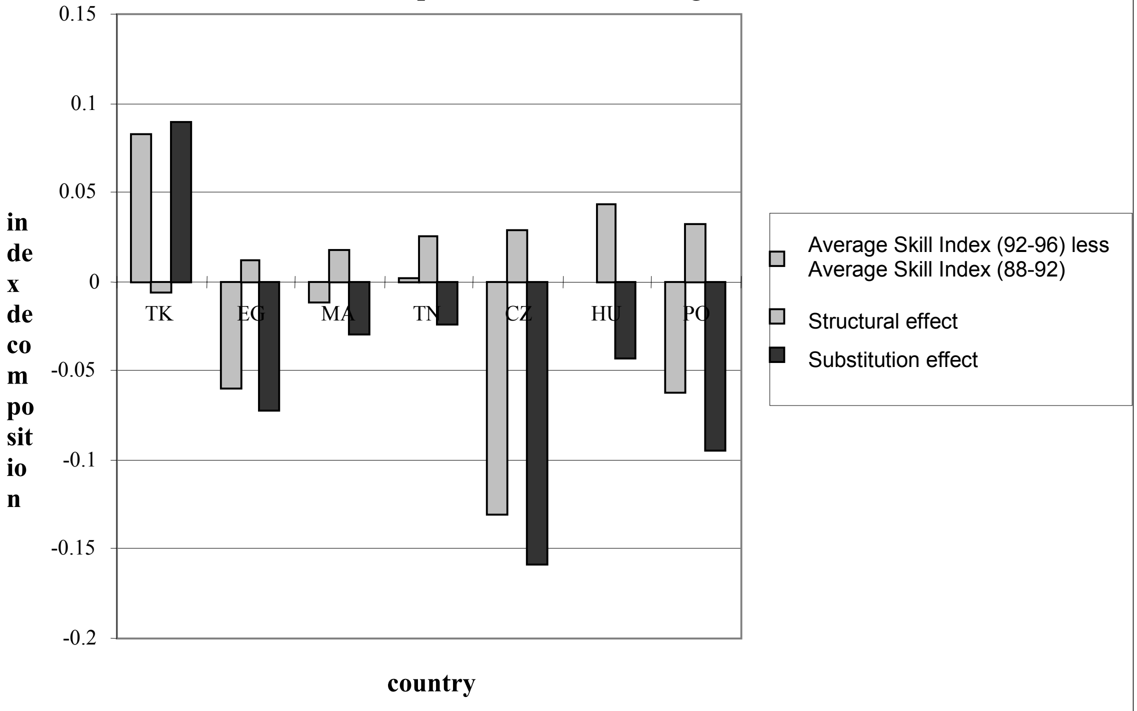
$$
\begin{aligned}
S_{c,t} - S_{c,t-1} = & \sum_j [(V_{c,j,t} / V_{c,t} - V_{c,j,t-1} / V_{c,t-1}) S_{j,t+(t-1)} \\
& + (V_{c,j,t+(t-1)} / V_{c,t+(t-1)})(S_{j,t} - S_{j,t-1})] \\
= & \sum_j [\Delta(V_{c,j} / V_c) S_{j,t+(t-1)}] + \sum_j [(V_{c,j,t+(t-1)} / V_{c,t+(t-1)}) \Delta S_{j]}
\end{aligned} \tag{2}
$$

In (2) the index *t* refers to the 1992-1996 period average, *t-1* to the 1988-1992 period average, and *t+(t-1)* to the 1988-1996 period average

The two components represent the *structural* and the *substitution* effect respectively: (i) the first one (first term of the right hand side of (2)) captures the reallocation of imports between different machines j (where j represents the five types of textile machines, which correspond to 4 digits in the trade statistics), i.e. the change in the share of machines of category j in total textile machines imported, weighted by the average skill index for each category over the entire time period; (ii) the second one captures the reallocation of imports within groups of similar machines (remember that the skill index is constructed for machines classified at the 8 digit level), i.e. the change in the average skill index of category j, weighted by the share of machines of category j in total textile machines imported over the entire time period.

Figure 2 shows how the actual index is decomposed for some of the countries in our sample. The difference between Turkey and the CEECs is rather striking. In the former there is not much structural change but a steadily upgrading of the existing machines. In the latter, in contrast, the substitution effect is negative and dramatically so for Czechoslovakia and Poland. The structural effect is larger than for Turkey but rather moderate. Whereas Turkey has been able to move up the technology ladder, the CEECs have downgraded the technology of the textile machines imported since the fall of the Berlin wall.

Figure 2: Import of Textile and Clothing:
Decomposition of the Average Skill Index



This result provides some support to the idea that the opening up of trade may induce countries to downgrade their technologies in the shorter term. In the case of the CEECs this may be the result of different factors. First, before the fall of the Berlin wall, these countries were importing most of their machines from other planned economies. Machines imported from the EU were few and probably just high tech ones, for which no substitute was available in the CEECs or in the Soviet Union. Second, investment decision were not based on the objective of maximizing profits, and thus the compatibility between skills, machines and product demand was not regarded as an important issue. Consequently, a decline in the index in the years following liberalisation does not necessarily mean a downgrading of the average technologies used in the importing countries, nor a negative loss of technological knowledge. Rather, it may reflect the substitution of low-medium tech European machines for equivalent Soviet machines and the shift to technologies more appropriate to the available mix of factors of production.

The case of Turkey supports the case for longer term learning trends. Countries which have liberalised long ago gradually accumulate the skills necessary to move to more advanced technologies in the longer term. Note that also for Hungary, Rumania and the Czech republic the index stabilises after the first years of decline and then starts growing slowly again. Interestingly, the change in the skill index is dominated by the substitution effect in both groups of countries. Most of the upgrading and the downgrading takes place in those segments of the industry where our sample countries are already specialised. There is no drastic change towards new types of products.

The three Mediterranean countries reported in Figure 2 are those which are most specialised in textile, that is Tunisia, Morocco and Egypt. Theirs is an intermediate case. The skill index declined, although less dramatically than for the CEECs. In this case too the substitution effect is dominant. Indeed they have opened up to trade quite recently and later than Turkey.

Foreign investments are also an important source of technological inflow. As reported in Table 2, FDI to the CEECs in constant US dollars in textile and clothing grew substantially in the first half of the Nineties. FDI flows to Turkey were not as large. Unfortunately, we have no sector specific data for the other SMCs.

Table 2: Textile and Apparel FDI Inflows

	FDI Growth (1990-1995)	1995 Value (millions 1995 dollars)
Czechoslo	45%	63
Hungary	31%	118.7
Bulgaria	39%	70.1
Poland	62%	11
Romania	.	2

But data on FDI capture only a small part of the involvement of European enterprises in neighbouring developing countries. A large share of the redeployment of production takes place through sub-contracting or other production agreements that do not figure as FDI. An indirect way to capture these links is to look at Outward Processing Trade

(OPT) data. OPT is a custom regime under the Multifibre Arrangement, according to which enterprises can import processed commodities free of duty and within quota which are granted on top of the standard MFA bilateral quota. OPT are expected to capture flows of temporary trade between subcontractors and between parent companies and subsidiaries. Thus they are an all-encompassing measure, capturing both FDI and subcontracting. There is some debate on the difference between FDI and sub-contracting arrangements as vehicles for technology transfer. The main difference is that locals are directly involved in managing local production, so their opportunity and their incentive to learn is larger. But this is right for wholly owned subsidiaries. If we consider joint ventures, which are also captured by FDI data, it can be shown that they are as efficient in transferring technology as any other looser inter-firm agreement like subcontracting.

Table 3: Share of Outward Processing Trade

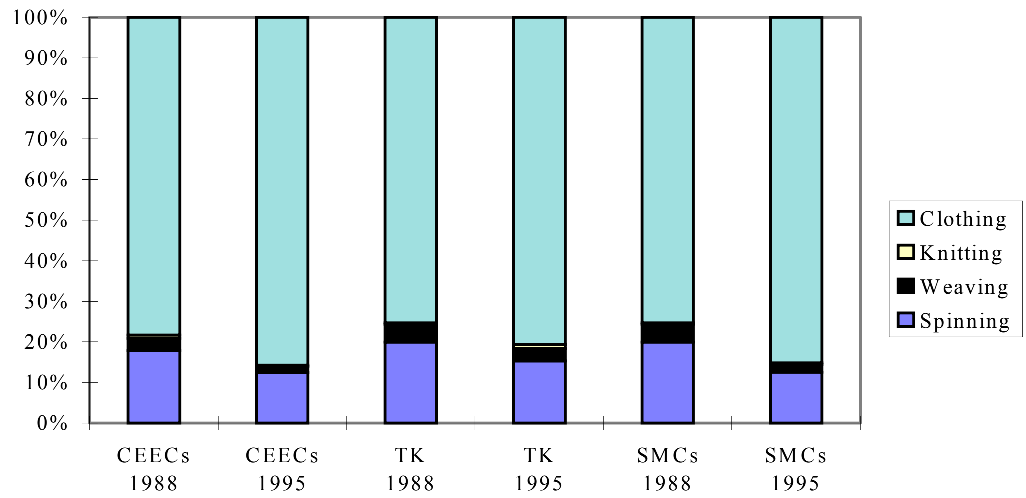
Sector	CEECs 88-92	CEECs 92-96	SMCs 88-92	SMCs 92-96	Turkey 88-92	Turkey 92-96
Spinning	8.8%	12.9%	0.1%	0.2%	0.0%	0.0%
Weaving	15.3%	10.7%	1.5%	2.3%	0.0%	2.8%
Knitting	20.1%	38.9%	2.1%	3.1%	0.3%	0.2%
Clothing	60.6%	52.4%	7.6%	7.8%	5.1%	4.0%

Table 3 shows the share of OPT on total trade for our three groups of countries. It compares the 1988-92 and the 1992-96 average shares. For all three groups of countries OPT is rather stable in the two periods and mostly concentrated in clothing, the most labour intensive stage of production. OPT is overwhelmingly important for the CEECs (more than 50% in clothing) and much less so for the other two regions.

3.5. Stylised Facts on Exports

As textile is a major export industry for all the countries analysed, we would expect to observe a close link between the evolution of the structure of imported inputs and the evolution of the structure of exports of textile products. Figure 3 shows that the export composition of textile products in 1988 and 1995 for the CEECs, Turkey and the SMCs, is virtually unchanged. This is consistent with the little structural change observed for imported machines. Thus, although exports to Europe of textile products have increased for all our sample countries (the average yearly compound growth rate of exports of textile products between 1988 and 1995 is 26% for the CEECs and 12% for Turkey and the SMCs), the composition of exports is and remains (even increasingly so) biased in favour of clothing products.

Figure 3: Export Composition of Textile and Clothing Products



But if we take into account other, less aggregated indicators we can see that within the four product categories considered there has been a lot of change. A simple indicator is the correlation between the Balassa index of revealed comparative advantage (RCA) in 1988 and 1995: the closer the correlation ratio to 1, the smaller the change in export specialisation.[8] Table 4 computes this indicator at the 4-digit level for three of our four subsectors composing the textile industry. As we can see, for many of the countries in the sample the change has been quite considerable, particular in the upstream

8 Table 6 below shows how this variable is computed. See Dijankov and Hoekman (1996) for an application of this measure to overall exports of the CEECs.

subsectors, spinning and weaving. Change is lower in the clothing sector which has traditionally been the major export subsector.

		Table 4: Changes in Specialization						
	Simple correlation coefficients between RCAs in 1988 and 1995							
	Spinning			Weaving			Clothing	
Malta		0,12542	Syria		-0,07683	Syria		0,27813
Tunisia		0,14165	Cyprus		-0,00581	Egypt		0,36024
Hungary		0,18742	Bulgaria		-0,00478	Morocco		0,47354
Bulgaria		0,23552	Hungary		0,21144	Bulgaria		0,53363
Poland		0,26376	Turkey		0,32589	Hungary		0,53373
Czechoslovakia		0,32692	Morocco		0,34967	Poland		0,53918
Israel		0,3576	Poland		0,40658	Malta		0,62247
Morocco		0,44964	Czechoslovakia		0,42058	Israel		0,74243
Cyprus		0,48364	Egypt		0,51963	Croatia		0,75482
Turkey		0,52062	Israel		0,5804	Turkey		0,75527
Egypt		0,52414	Slovenia		0,79572	Tunisia		0,77145
Slovenia(1992-1995)		0,77352	Tunisia		0,82813	Czechoslovakia		0,77573
Syria		0,90848	Croatia		0,94146	Cyprus		0,79666
Croatia(1992-1995)		0,95986	Malta		0,99997	Slovenia		0,9258

Thus, although we observe a relatively static composition of exports in the industry at the two-digit level, if we move to the four digit levels (looking at what happens within the subsector), we note a much less stable picture. This result is consistent with the finding, reported in the previous section, that, for many of the sample countries, the substitution effect seems to dominate the structural effect in explaining the change in the aggregate average skill index.

A final important indicator is the change in unit value of exports. Unit values can be interpreted as a proxy for product quality. An increase in unit value shows whether exporters are able to move towards products which are technologically sophisticated and have a high value added. It is therefore a measure of performance related to the process of technological learning. There are some methodological problems in using unit values as measures of product quality. First, as discussed by Aw and Roberts (1986), changes in unit values for a given product category may reflect both changes in quality and changes in the product bundle. The problem is more serious the more aggregate the product categories. To overcome composition effects we compute Tornqvist price indices. We compute unit values at a very disaggregated level (8 digits) and aggregate them at the 2 digits level using fixed weights (the average period share of the 8 digit categories over the 2 digits categories) for every year in our sample. Second, unit values may capture price changes which have little to do with product quality. This problem is of particular concern during trade liberalisation. Import prices are expected to drop because of the rise in the supply of imports. Indeed, unit values of European imports of textile and clothing products dropped since 1992. To control for the trade liberalisation effect, we therefore compute the ratio between the unit values of EU imports of product j from country c and of total EU imports of product j. This works as far as we assume that the trade policy shock on prices is symmetric for all exporting countries. In this case the ratio purely reflects country specific factors. Moreover, these indices are useful if we want to make cross product comparisons. The unit value index of product j (2 digit categories) exported by country c at time t is therefore given by:

$$UVA_{c,j,t} = \frac{\sum_i (X_{c,i,t} / T_{c,i,t})(X_{c,i,AV} / X_{c,j,AV})}{\sum_i (X_{w,i,t} / T_{w,i,t})(X_{w,i,AV} / X_{w,j,AV})} \tag{3}$$

where X refers to values and T to quantities (tonnes), suffix i stands for 8 digit product categories, w for total EU imports and AV for period average values. Table 5 reports $UVA_{c,j,t}$ for exports from our three groups of countries to the EU. Note that the ratios are on average higher for simpler products like clothing, that there is a generalised increase for all countries and all products between the 1988-92 average and the 1992-96 average; and that the CEECs have been able to catch up from initial levels which were quite lower than for the other two groups. These trends, therefore, show an upgrading of the quality of the products exported from our sample countries to Europe.

Table 5: Average Unit Value Index of Exports to the EU						
	CEECs 88-92	CEECs 92-96	SMCs 88-92	SMCs 92-96	Turkey 88-92	Turkey 92-96
Spinning	0.71	0.96	1.23	1.19	0.92	1.05
Weaving	0.68	0.69	0.58	0.69	1.50	1.27
Knitting	0.66	0.99	0.70	1.07	0.63	0.77
Clothing	1.02	1.19	1.22	1.22	1.07	1.14

3.6. The Link between Imports of Technologies and Export Performance: Econometric Evidence

We now relate the unit value of exports to technological inflows in order to uncover the relevance and impact of the latter upon the former. To this end we carry out a panel analysis involving fourteen countries, seven years of data (1989 to 1996) and four product categories (clothes, knitted products, woven fabric and yarn). We postulate the following simple linear model with fixed effects:

$$\begin{aligned} UVA_{c,j,t} &= \alpha_0 + \alpha_C D_c + \alpha_J D_j + \alpha_T D_t + \alpha_1 SKILL_{c,j,t} + \alpha_2 SPE_{c,j,t} \\ &\quad + \alpha_3 SKILL_{c,j,t} SPE_{c,j,t} + \alpha_4 OPT_{c,j,t} + \varepsilon_{c,j,t} \end{aligned} \tag{4}$$

Variables subscripts refer to the characteristics of sector *j* whose products are produced by using machines of category *j* (yarns with spinning machines, knitted products with knitting machines, woven products with textile and finishing machines and clothing products with clothing machines), to country *c* and to year *t*.[9] The model relates the unit value of exports of a product *UVA* to the average skill index of machines used for that product (*SKILL*), to exports under outward processing trade (*OPT*) and to a measure of relative comparative advantage of the country in product *j* (*SPE*). The *SKILL* and the *SPE* variables enter the model both individually and interacted with each other. Table 6 illustrates the definition of these variables in details.

In (4) we specify two measures of technological inflows: the complexity of the machines imported and the share of outward processing trade exports on total exports. Sector specific data for FDI were only available for Turkey and the CEECs and were consequently neglected. As a matter of fact we ran a regression for this smaller sample, but results were not satisfactory and we do not report them. In any case, as discussed above, OPT is a good proxy of both subcontracting and FDIs.

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9 Note that we have 5 categories of textile machines and 4 categories of textile products. This is so because finishing is a further stage of the textile process (after weaving), but we cannot distinguish the finishing stage at the product level, i.e. the same product (woven textile) is produced by both textile and finishing stages.

Table 6: Definitions and Sources of Variables

$UVA_{c,j,t}=\Sigma_i[(X_{c,i,t}/T_{c,i,t})(X_{c,i,AV}/X_{c,j,AV})]/\ \Sigma_i[(X_{w,i,t}/T_{w,i,t})(X_{w,i,AV}/X_{w,j,AV})]$ is the unit value of exports of product *j* from country *c* to the EU at time *t* over unit value of world exports of product *j* to the EU. Unit values of product categories *j* are constructed as weighted averages of unit values of the 8 digits product categories *i* contained in *j* at time *t*, with period average (*AV*) fixed product weights (source COMEXT).

$SKILL_{c,j,t}= \Sigma_i S_i\ (V_{c,i,t}/V_{c,j,t})$ is the average skill index of machines used for the production of *j* imported by country *c* at time *t* (source COMEXT and our index)

$SPE_{c,j} = (X_{c,j,}/X_c)/(X_{w,j}/X_w)$ is the Balassa index of revealed comparative advantage for country *c* in product *j*, average 1988-96 (source COMEXT)

$OPT_{c,j,t} =XOPT_{c,j,t}/X_{c,j,t}$ is the share of exports under outward processing trade over total exports of product *j* from country *c* at time *t* (source COMEXT)

D_C is a country dummy equal to 1 for country *c* and 0 otherwise

D_j is a sector dummy equal to 1 for sector *j* and 0 otherwise

D_t is a time dummy equal to 1 for time *t* and 0 otherwise

$\varepsilon_{c,j,t}$ is a disturbance error term

Legenda

X is the value of exports to the EU; *T* is exports to the EU in metric tons; *V* value of imports from the EU; S_i is the skill index for machine *i*; *j* denotes product categories at the 4 digits; *i* product categories at the 8 digits contained in each *j*th category; *w* denotes “world”; *t is* years, from 1989 to 1996.

Our a priori expectation suggests that large and skill intensive imports of technologies favour a process of learning in the importing country and positively affect unit values of exports. However, this learning process is influenced by the learning capacity of the importing country which could be proxied by the relative specialisation of a country in the production and export of a given product. To capture this last effect we use an index of the average revealed comparative advantage of country *c* in product *j*. By interacting *SPE* with the *SKILL* variable, we intend to isolate the effect of technological complexity on product quality for specialised countries.

We allow for three sources of heterogeneity in our model, related to different sectors, countries and time periods. We control for their effect on the dependent variable by including in the specification appropriate dummy variables, respectively denoted by D_j, D_c, and D_t.

We also recognize the likely endogeneity of our measures of technological inflows. The choice of a given technology depends on the expected performance such technology will generate. In the context of our paper firms choose high tech machines if they know that they can use such machines to produce high quality products. This problem is common to all studies which look at the link between imports of technology and economic performance. In order to correct for the correlation between those explanatory variables and the disturbance term, which may also be induced by measurement errors, we instrument out our regressors using a constant, the dummy variables, and the first lag of the model regressors. Using an additional lag in the instrument set does not produce noticeable differences in the estimated results presented hereafter. Given the specific sectoral context of our empirical investigation and the countries involved, finding exogenous, rather than predetermined, instruments is extremely difficult if not impossible. After instrumenting we use a standard least squares dummy variable estimation method.

In table 7 we report results for three different regressions. In the first column results are presented for all the countries in the sample. The effects of unmeasured country specific factors ought to be captured by country dummies. However, the same factors in principle may also affect the slope of the coefficients. Therefore we also divide the sample in groups, on the basis of their pattern of trade liberalisation, and distinguish between SMCs – excluding Turkey - (column 2), and CEECs (column 4). As discussed in section 2, the case of Turkey stands in isolation if compared to the other two country groupings. However, if we run a pseudo-F test (not reported) to check for the possibility of pooling Turkey with the other SMCs we find that the two samples can be pooled together without loss of information. We therefore also run a pooled regression whose results are reported in column 3. We include country dummies also in the regressions for the country sub-samples. This would have not been necessary had the division in groups been sufficient to eliminate the effect of country specific factors on the intercept. A pseudo-F test (not reported) on the joint significance of country dummies enables us to reject the hypothesis for SMCs, but not for the CEECs. A similar F test designed to ascertain the impact of sector specific effects on unit values not captured by the explanatory variables rejects the hypothesis of no impact in all cases.

The overall performance of the model is satisfactory if judged by the R-square and by the significance of individual regressors. Note that the implied standard errors are robust to heteroskedasticity. In addtion, instruments appear to be relevant if judged on the basis of first stage R-squares.[10] Finally, we checked for but failed to detect any sign of (first order) serial correlation. On these premises we proceed to consider more closely the empirical role of the explanatory variables.

Consider, first, the case with all the countries in column 1. Here both the indicators of technological inflows (*SKILL* and *OPT*) positively and significantly affect unit values of export. *SPE* has a positive sign but it is not significant. Yet, the interacted variable has a negative and statistically significant impact. Remember that the interacted variable captures the impact of imported machinery on unit values for the specialised countries (i.e. countries with a comparative advantage in product *j*).

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10 These are: (i) .532 (total sample), .556 (CEECs), .532 (SMCs) for *SKILL*; (ii) .951 (total sample), .947 (CEECs), .952 (SMCs) for *SPE;* (iii) .946 (total sample), .941 (CEECs), .947 (SMCs) for *SKILL*SPE;* (iv) .858 (total sample), .848 (CEECs), .827 (SMCs) for *OPT.*

Table 7: Regression Estimate Results				
Dependent variable: $UVA_{c,j,t}$				
	All sample	SMCc	SMCs+Turkey	CEECs
Explanatory variables				
$SKILL_{c,j,t}$	0.313 (2.02)**	0.927 (3.597)***	0.6(2.66)***	0.29 (1.09)
$SPE_{c,j,t}$	0.314 (1.544)	0.947 (3.307)***	0.472(1.8)*	0.695(0.759)
$SKILL_{c,j,t}SPE_{c,j,t}$	-0.159 (-1.721)*	-0.45 (-3.54)***	-0.232(-1.97)**	-0.293 (-0.716)
$OPT_{c,j,t}$	0.352 (2.53)***	-1.256 (-0.926)	-1-12(-0.986)	0.719 (2.047)**
Spinning	0.258 (4.9)***	0.475 (3.867)***	0.394(4.798)***	0.1 (1.3)
Weaving	-0.066 (-1.336)	-0.069 (-0.877)	0.012(0.17)	-0.093 (-0.969)
Clothing	0.329 (5.373)***	0.583 (6.741)***	0.5(6.87)***	-0.133 (-0.792)
BUL	-0.68 (-10.21)***			-0.156 (-1.573)
CYP	-0.412 (-5.58)***	-0.537 (-3.478)***	-0.53 (-4.06)***	
CZECH	-0.634 (-9.273)***			-0.167(-1.957)**
EGY	-0.655 (-7.378)***	-0.89 (-4.194)***	-0.819(-4.517)***	
HUN	-0.511 (-5.85)			-0.08 (-0.91)
ISR	-0.168 (-2.019)**	-0.328 (1.75)*	-0.308(-1.99)**	
MOR	-0.102 (-1.533)	-0.117 (-1.067)	-0.123(-1.255)	
POL	-0.546 (-7.033)***	-)		-1.2(0.229)
ROM	-0.425 (-4.954)***			
SYR	-0.862 (-11.411)***	-1.13(-6.159)***	-1.051(-6.742)***	
TUN	0.661 (0.814)	-0.039 (-0.346)	-0.536(-0.557)	
TUR	-0.112(-1.214)		-0.222(-1.269)	
1990	0.0557 (0.866)	-0.04 (-0.441)	0.06(0.658)	0.065 (0.817)
1991	0.136 (0.021)	-0.07 (-0.782)	-0.471(-0.547)	0.042 (0.55)
1992	0.055 (0.904)	-0.021 (-0.259)	0.219(0.027)	0.082 (0.86)
1993	0.131 (2.012)**	0.068 (0.735)	0.084(0.929)	0.141 (1.473)
1994	0.066 (1.153)**	0.149 (0.17)	0.465(0.06)	0.105 (1.281)
1995	0.17 (3.04)***	0.141 (1.51)	0.128(1.59)	0.209 (2.567)***
1996	0.176 (2.88)***	0.127 (1.433)	0.115(1.374)	0.215 (2.2)**
Intercept	0.498 (1.64)	-0.734 (-1.4)	-0.06(-0.13)	0.018 (0.031)
No. Obs.	374	190	222	152
Adjusted R^2	0.5	0.623	0.5	0.442

Notes: (i) T-statistics in brackets computed from heteroskedastic robust standard errors.
(ii) One, two, and three asterisks denote respectively 90%, 95%, and 99% significance.
(iii) The instrument list includes a constant, industry, country and time dummies, and the first lag of the regressors.

If we postulate that specialised countries buy on average more sophisticated machines, the negative sign could reflect decreasing returns in the relationship between the sophistication of the imported machines and product quality. Outward processing trade positively influences unit values. Thus, when export flows are driven by foreign firms, product quality is higher.

The whole sample, however, combines completely different patterns emerging in specific country groups. This is quite clear if we look at the results reported in columns 2 to 4. In the case of CEECs the only variable which has a statistically discernible role in our model is OPT. Thus inflows of machines do not seem to have an impact on product quality per se, independently from the role of foreign investors. In contrast, in SMCs, product upgrading appears to be driven essentially by inflows of machinery. This result is not too surprising, given the role of foreign firms in formerly planned economies. Indeed, there is now solid evidence that the CEECs have been playing the most important role among Europe's neighbouring cheap labour countries as the off-shore basis of many European producers. Moreover, the sudden and dramatic shift in markets and products in Eastern Europe could probably have not taken place without a heavy involvement of foreign producers. The case for the SMCs is different. Indigenous learning through imported machines appears to have played a more important role in this case. OPT is never significant. This sample includes traditional producers of textile products, like Egypt, Tunisia and Morocco. Changes in unit values reflect a longer term pattern of product upgrading, where foreign producers play a minor role. Note that when we pool Turkey together with the other SMCs the variance explained by our model, the significance and the size of the coefficients of the explanatory variables all decline. Turkey is indeed the champion of our Southern Mediterranean sample, and probably relies less on imported technologies for product upgrading than the other countries sampled in our analysis.

4. Conclusions

In this paper we have examined the link between imported technologies and export performance. The analysis has been set in the background of the process of regional integration between the EU and its neighbouring developing countries and has focused on the textile industry. The underlying question to which we attempted to answer is whether trade integration fosters or dampens learning and technological upgrading.

Since the turn of the decade trade between the EU, the Central and Eastern European Countries (CEECs), Turkey and most of the Southern Mediterranean Countries (SMCs) was substantially liberalised. We find that unit values of exports from these countries to the EU rose steadily between 1988 and 1996, relative to the unit values of world exports to Europe. If increased unit values satisfactorily proxy increases in product quality, trade integration fostered product upgrading and technological learning in the sample countries. In this paper we have investigated whether imported technologies and other sources of knowledge have some bearing on this pattern.

Technological inflows are captured by the degree of involvement of European companies in trade (Outward Processing Trade) and by the skill content of the machines imported. These variables appear to have a statistically discernible and positive role on product quality for all the countries analysed. Imported machines are the most important determinant of product upgrading in the SMCs, while foreign firms play a dominant role in the CEECs.

The pattern of trade liberalisation and specialisation of the two groups of countries has been quite different. In the CEECs liberalisation has been sudden and drastic. Trade patterns changed considerably, both in terms of products and market destination. Foreign companies have therefore played a crucial role in this path of transition. In the SMCs things have been much smoother. Trade is being liberalised more gradually and many of them have a strong specialisation in textile. Although based on imported technologies, upgrading and learning appears to be rooted in the local production structure.

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