EXPORT SPECIALIZATION OVER THE LAST FOUR DECADES: HOW DOES PORTUGAL COMPARE WITH OTHER COHESION COUNTRIES?*

*João Amador***

*Sónia Cabral***

*José Ramos Maria***

1. INTRODUCTION

Over the last four decades, trade openness has increased and international trade patterns have evolved significantly. Several papers have studied changes in specialization patterns.[1] From an individual country's perspective it is interesting to identify the modifications in the trade pattern because they may provide insights on the underlying structural changes in the economy, namely in its structure of production. In addition, the magnitude and the pace of such changes is an indirect indicator of the flexibility of the economy in allocating resources between sectors. Therefore, these elements are relevant to understand the growth performance of the economy. This type of analysis can be enhanced by taking a set of countries as a benchmark, thereby investigating their relative behaviours. In this article, we are particularly interested in understanding how does the relative sectoral specialization of Portuguese exports compare with that of the other initial EU Cohesion Fund beneficiaries (Spain, Greece and Ireland).[2] The article adopts a fact-finding approach, making extensive use of the standard Balassa (1965) index to assess the technological content of these countries' manufacturing exports. The evolution of the sectoral specialization of Portuguese exports naturally depends on aspects that are well identified in international trade theory, such as factor endowments, technologies, consumer preferences, market structures and geographical factors. Nevertheless, the article does not proceed in testing the relevance of these determinants or any specific trade model. Instead, it aims at identifying a set of stylized facts over a long period of time.

The results are derived from the CEPII-Chelem database covering the period from 1967 to 2004. The available 120 manufacturing products are grouped together in four main categories following the OECD classification of manufacturing industries according to technology intensity: high-technology, medium-high-technology, medium-low-technology and low-technology. Over the last four decades, the Portuguese export structure converged towards the world structure and, therefore, Portugal showed a reduction in its overall degree of export specialization. However, significant differences against the world average still remain. The same behaviour is found in Greece and, more strongly, in Spain, which is the least specialized country. Conversely, Ireland shows the strongest export specialization and there is evidence of an increase over this period. One striking feature of the evolution of

* This article presents some of the results included in Amador *et al.* (2007a). The authors thank Nuno Alves, Mário Centeno, Jorge Correia da Cunha and Ana Cristina Leal for their comments. The views expressed are of the authors and do not necessarily reflect those of the Bank of Portugal.

** Economics and Research Department.

(1) See De Benedictis *et al.* (2006) for a synopsis of the recent empiric literature on trade specialization dynamics.

(2) The Cohesion Fund, which started in 1994, is a structural instrument that helps European Union (EU) Member States to reduce economic and social disparities and to stabilize their economies. Eligible Member States of the Union are those whose gross national product (GNP) per capita is below 90 per cent of the EU-average. Four Member States, Spain, Greece, Portugal and Ireland, were eligible under the Cohesion Fund until the end of 2003. The European Commission's mid-term review of 2003 deemed Ireland (GNP average of 101 per cent) as ineligible under the Cohesion Fund as of 1 January 2004.

Portuguese international trade was the continuous decline in the export share of low-tech products over the last four decades. This decline was particularly sharp in food products, and textile and footwear products. Notwithstanding, Portugal remains more specialized than the world average in this technological category. In addition, there was a marked increase of the share of medium-high-tech exports over time, in particular motor vehicles and some machinery items since the nineties. Conversely, the Portuguese economy maintains a strong comparative disadvantage in high-tech products over the whole period.

The article is organized as follows. In the next section we briefly describe the methodology and the database used. Section 3 is devoted to the study of the evolution of the Portuguese export pattern. The section starts by examining the export structure of Portugal over the last forty years, using the shares of each sector in total manufacturing exports. The analysis is then developed using the Balassa (1965) index. This indicator, which aims to capture revealed comparative advantages, has been extensively employed in the empirical trade literature.[3] A special focus is placed on the behaviour of the indices grouped by technological content and on how country differences are explained by the contributions of the different sub-sectors. This section ends with an analysis of the shape of the distribution of the indicator to infer on the overall degree of specialization of the four countries considered. Section 4 presents some concluding remarks.

2. DATA AND METHODOLOGY

The empirical analysis included in this article is based on the CEPII – CHELEM database, which reports bilateral trade flows for goods in value terms (the unit being the US dollar). The sample period starts in 1967 and ends in 2004, with a product breakdown at the four digits level of the ISIC classification (rev.3), which includes 120 manufacturing products. These 120 manufactured goods are grouped in accordance with their technological intensity, following the OECD classification of R&D intensities.[4] This technological classification includes four main sectors: high-technology (HT), medium-high-technology (MHT), medium-low-technology (MLT) and low-technology (LT); and a second breakdown level containing twenty sub-sectors. This standard classification can bring important insights on the evolution of export patterns over the last forty years. Notwithstanding, this relatively broad sectoral breakdown can include activities at different levels of technological complexity under the same category.[5] In addition all intra-category relative changes, like the upgrading of quality and technology within existing activities, are not captured with this classification. Moreover, like all industry-based classifications, the existence of firm heterogeneity within each sector is not taken into account here.

The empirical trade literature suggests several methods to evaluate the trade specialization of a given country, most of them aiming at identifying the comparative advantages revealed *ex-post* by international trade. The methods solely based on trade flows can be divided in two broad groups. The first group only uses export data and the second uses both export and import data. The most widely used indicator in the first group is the Balassa index, as suggested in Balassa (1965), while the most popular

(3) In Amador *et al.* (2007b), we introduced an alternative index - the so-called B* - with suitable cardinal properties for a cross-country analysis within one single sector. For the sake of comparability with other studies, this alternative index was not adopted in this article.

(4) The OECD classification of manufacturing industries according to technology intensity was based on the analysis of R&D expenditures of 12 OECD countries in the period 1991-99 (see OECD (2005)).

(5) See Peneder (2003) for an analysis of the major classifications used in applied economic studies and Lall *et al.* (2005) for a discussion of the problems associated with the different product classifications, focusing on those dealing with technology intensities.

in the second group is the Lafay index, as suggested in Lafay (1992).[6] The analysis carried out in this article fits in the first group and is mainly based on the Balassa index.

The Balassa index can be defined as follows. Assume that the world economy comprises *N* countries and *m* products. Country *i* exports of product *j* are x_{ij} and total exports of country *i* are given by $X_i = \sum_{j=1}^{m} x_{ij}$. World exports of product *j* amount to $x_{Wj} = \sum_{i=1}^{N} x_{ij}$, while total world exports can be seen either as the sum of all products or as the sum of all countries, *i.e.* $X_W = \sum_{j=1}^{m} x_{Wj} = \sum_{i=1}^{N} X_i$. Using relative export structures, the Balassa (1965) index can be written as:

$$B_{ij} = \frac{\frac{x_{ij}}{X_i}}{\frac{x_{Wj}}{X_W}} \quad \text{country } i = 1,2,\ldots,N; \text{ product } j = 1,2\ldots,m \qquad (1)$$

According to (1), if the share of sector *j* in total exports of country *i* is higher than the equivalent share of sector *j* in world exports, *i.e.* $(\frac{x_{ij}}{X_i}) > (\frac{x_{Wj}}{X_W})$, then $B_{ij} > 1$ and country *i* is classified as having a *revealed* comparative advantage in sector *j*. Note also that, for each sector *j*, the denominator $\frac{x_{Wj}}{X_W}$ can be decomposed as a weighted average of all $\frac{x_{ij}}{X_i}$, where the weights are country-dependent and given by $\frac{X_i}{X_W}$. Henceforth, the denominator will be simply designated as "world average".

At any point in time, the cross-country differences of export specialization can be further examined by decomposing the differential of the Balassa indices in each broad technological category in the following way:

$$\left(B_{PT,J} - B_{i,J}\right) = \sum_j \alpha_j \left(B_{PT,j} - B_{i,j}\right) \text{ where } \alpha_j = \frac{X_{Wj}}{X_{WJ}} \text{ and } \sum_j \alpha_j = 1 \qquad (2)$$

where *PT* stands for Portugal and *i* for the other countries; *J* represents the main aggregate (LT, MLT, MHT and HT sectors) and *j* all second-level sub-sectors of each aggregate *J*; α_j is a set of weights that are not country-dependent.[7] If, for instance, the Balassa index in the main aggregate *J* is higher in Portugal than in country *i*, then $\left(B_{PT,J} - B_{i,J}\right) > 0$ and this difference can be split into the contributions of all sub-sectors. In this example, there must exist at least one sub-sector *j* that verifies the condition $\left(B_{PT,j} - B_{i,j}\right) > 0$, which is simply implying a higher export share of that product in total Portuguese exports than in the other country. Thus, each term $\alpha_j \left(B_{PT,j} - B_{i,j}\right)$ can be seen as the contribution of sub-sector *j* to the differential registered in the aggregate *J*.

The use of the Balassa index, which follows an asymmetric distribution with a fixed lower bound of 0, a variable upper bound and a variable mean, either across countries or across time, has been subject to several critiques, leading some authors to propose several modified versions. However, the popularity of the original suggestion remains in place and the traditional Balassa index has been used extensively

(6) The Lafay index, defined as the contribution of a product to the overall trade balance, is a country-based indicator of specialization that does not show the relative position vis-à-vis other countries. Therefore it is not the most appropriate indicator for the kind of analysis proposed here. Even if net exports are the theory-based measure of revealed comparative advantages, the Balassa index allows for comparisons between different countries with regard to a common benchmark, contrarily to the Lafay index. Nevertheless, we replicated most of the analysis using the Lafay index and, in the Portuguese case, the main results remain broadly unchanged. However, such outcome should not be seen as a general result for all countries. The most suited metrics and related theoretical motivations are a rather extensive subject in trade literature. For a discussion see Bowen (1983), Yeats (1985), Ballance *et al.* (1987), Vollrath (1991) and Iapadre (2001).

(7) The weights are, nevertheless, changing in time.

in the literature.[8] The transformation suggested by Laursen (1998) is very useful to analyse the entire distribution of the specialization indicator, given the typical high asymmetry of the traditional B_{ij} index. Laursen (1998) labelled this new index as ''Revealed Symmetric Comparative Advantage'', which is defined as:

$$BS_{ij} = \frac{B_{ij} - 1}{B_{ij} + 1}$$

Note that BS_{ij} ranges from -1 to 1 and has a threshold value in 0, leaving the rank-order and the specialization status of the sectors within each country unchanged.[9] The levels of the BS_{ij} have no longer an intuitive reading, with the exception of $BS_{ij} = 0$, which implies that $B_{ij} = 1$.

3. PORTUGUESE EXPORT PATTERN OVER FOUR DECADES

This section starts by examining the export structure of the Portuguese economy, *i.e*. the numerator of equation (1). The Portuguese export pattern underwent important changes over the last four decades. At the first product breakdown level, the most striking feature is the continuous decline over time of the LT sector share in total manufacturing exports (Chart 1(a)). On the contrary, the more marked increase took place in the MHT sector. Comparing the beginning and the end of the sample period at the second product breakdown level, there was a decline of the export share of all LT sub-sectors and, to a much lesser extent, of all chemical products (including pharmaceuticals), and an increase of the share in total exports of all other sub-sectors (Table 1).

LT exports, which represented 76 per cent of Portuguese manufacturing exports in 1967-69, declined to 42.4 per cent in the 2000-04 period. This decline was extensive to all sub-sectors, but was particularly sharp in ''Food products, beverages and tobacco'' and in ''Textiles, textile products, leather and footwear'' (Chart 1(b)). The reduction of export share of the former sub-sector was rather continuous until the beginning of the nineties, stabilizing at around 6.5 per cent of total Portuguese exports (from 23.5 per cent in 1967-69). In the latter sub-sector, the loss of importance was only visible after 1993, since its export share has even increased until that year. Thereafter the decline of the share of textiles and footwear exports was rather marked, which may reflect, at least partly, the increased competition from some developing countries.[10] In spite of the strong decrease of the LT sector share, it is still the most important technological category in Portuguese manufacturing exports.

On the contrary, a very strong increase of MHT exports has occurred: its share in total Portuguese manufacturing exports rose from 9.7 per cent in 1967-69 to 31.2 per cent in 2000-2004. In particular, there was a sharp increase of the export share of ''Motor vehicles, trailers and semi-trailers'', particularly in the second half of the nineties. This evolution was largely influenced by increases in the export capacity resulting from the entry into operation of industrial production units associated with foreign direct investment projects. There was also an increase of Portuguese exports of "Other electrical ma-

(8) Modified versions of the original Balassa index may be found, for instance, in Proudman and Redding (1997, 2000) and in Amador *et al.* (2007b). A list of references where the original version was used is included in Hinloopen and Marrewick (2001). See Widgrén (2005) for an application to Asian, American and European countries; and Shafaeddin (2004) and Hinloopen and Marrewick (2004) to China. US revealed comparative advantages by trading partner are mapped in Richardson and Zhang (1999). A recent application in another context can be found in Hidalgo *et al.* (2007). De Benedictis and Tamberi (2002), who discuss in detail the characteristics of the B_{ij} and the suggestion of Proudman and Redding (1997, 2000), end up using the original formulation of the index. Vollrath (1991), who surveys alternative measures of revealed comparative advantage states that, among the measures using only export data, the traditional Balassa index is one of "the most satisfying".

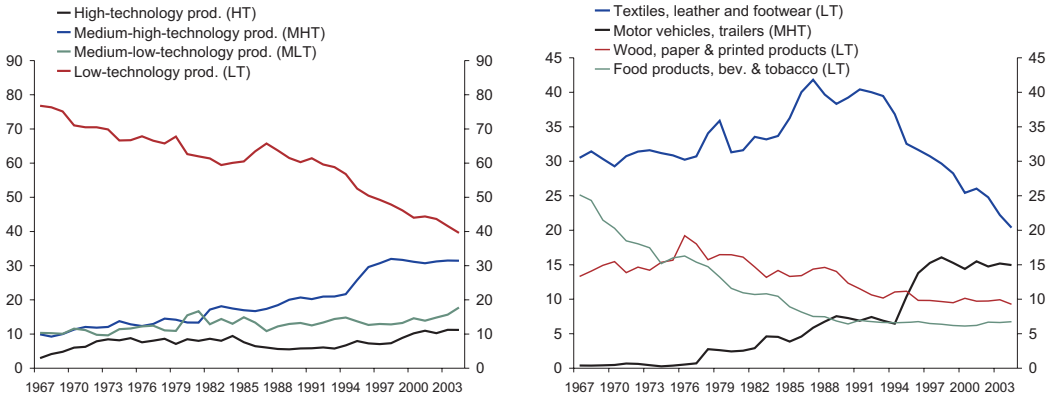
(9) See Laursen (1998) for detailed discussion of this transformation, Dalum *et al.* (1998) for an application of this indicator to twenty OECD countries and Vollrath (1991) for an alternative log-transformation.

(10) For instance, Cabral and Esteves (2006), using a sample of 96 individual (product and geographical) markets representing 70 per cent of Portuguese manufacturing exports, found that in the markets where Portugal's export share losses were the most significant, namely in textiles, clothing and footwear products, the biggest share gains were mostly achieved by developing Asian economies and by Central and Eastern Europe countries.

Chart 1

PORTUGUESE MANUFACTURING EXPORTS BY TECHNOLOGICAL INTENSITY

Shares as a percentage of total exports



(a) Four main technological categories

(b) Four main sectors in Portuguese exports

Sources: Chelem database and own calculations.

chinery and apparatus" and of "Other machinery and equipment", which sum up to 11.5 per cent of total manufacturing exports in the 2000-2004 period (3.7 per cent in the 1967-69 period).[11] Although marginally, the only MHT sub-sector that has lost some ground over the last four decades was the ''Chemicals excluding pharmaceuticals'' sub-sector, specially due to its evolution since the second half of the eighties. In 2000-04, the aggregated MHT sector stands out as the second most important export sector in Portugal.

The share of MLT and HT sectors in total Portuguese exports also increased over the last four decades, but to a much lesser extent than the MHT sector. In HT products, all sub-sectors increased their export share, with the exception of ''Pharmaceuticals''. The highest increase took place in ''Radio, TV and communications equipment'' (from 1.9 per cent in 1967-69 to 6.1 per cent in 2000-04). In MLT exports, the evolution was more similar across sub-sectors, with the main increase being in ''Rubber and plastics products'' (from 1.2 per cent in 1967-69 to 3.3 per cent in 2000-04).

Although the Portuguese export structure underwent major changes over the last decades, such developments must be placed in perspective against the world, which has also changed dramatically over the same period. In particular, the technological content of world manufacturing trade rose markedly over the last forty years. The share of high-tech goods increased by around 15 percentage points, accounting for more than 25 per cent of total exports in the 2000-2004 period, while the share of low and medium-low-tech decreased by around 9 and 7 percentage points, respectively.

In general, the Portuguese manufacturing export structure converged towards the world weighted average, *i.e.* the denominator of (1). This can be illustrated by the evolution of the sectoral Balassa indices included in Table 2. Portuguese export shares above the world average showed a general downward movement; export shares below the world average tended to increase. The most striking exception is the HT sector: the Balassa index for this broad sector was 0.4 both in 1967-69 and 2000-04, pointing to the maintenance of a strong comparative disadvantage of the Portuguese economy in these products. In particular, the Portuguese ''Pharmaceuticals'' sub-sector moved in the oppo-

(11) Portuguese exports of machinery and equipments showed high growth rates in 2006 and in the first half of 2007, strongly contributing to the favourable behaviour of total exports.

Table 1

STRUCTURE OF PORTUGUESE MANUFACTURING EXPORTS BY TECHNOLOGICAL INTENSITY
As a percentage of total exports

	1967-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
High-technology products	**4.0**	**7.7**	**7.9**	**8.5**	**6.1**	**6.0**	**7.7**	**10.8**
Aircraft and spacecraft	0.2	0.1	0.2	0.5	0.2	0.3	0.4	0.7
Pharmaceuticals	1.5	1.3	1.0	0.9	0.7	0.5	0.8	1.2
Office, accounting and computing machinery	0.3	1.2	1.2	1.6	0.8	0.5	0.4	1.8
Radio, TV and communications equipment	1.9	4.3	4.5	4.6	3.6	3.9	5.2	6.1
Medical, precision and optical instruments	0.2	0.7	1.1	0.9	0.6	0.8	1.1	1.0
Medium-high-technology products	**9.7**	**12.5**	**13.5**	**16.0**	**18.2**	**20.9**	**30.0**	**31.2**
Other electrical machinery and apparatus	1.5	2.3	2.3	1.7	2.9	5.2	7.0	5.7
Motor vehicles, trailers and semi-trailers	0.4	0.5	1.6	3.5	6.1	7.0	14.2	15.0
Chemicals excluding pharmaceuticals	5.3	6.3	5.1	6.6	5.3	4.2	3.8	4.5
Railroad equipment and other transport equip.	0.3	0.6	0.3	0.3	0.2	0.3	0.4	0.4
Other machinery and equipment	2.2	2.9	4.2	3.9	3.8	4.3	4.5	5.8
Medium-low-technology products	**10.2**	**10.7**	**11.5**	**14.4**	**12.7**	**13.7**	**13.1**	**15.6**
Coke, refined petroleum prod. and nuclear fuel	1.3	2.2	1.5	5.3	2.9	3.2	2.1	2.1
Rubber and plastics products	1.2	1.0	0.6	0.7	1.2	1.6	2.2	3.3
Other non-metallic mineral products	3.0	2.7	2.7	3.0	3.7	4.7	4.1	3.8
Building and repairing of ships and boats	0.1	0.8	1.4	0.7	0.9	0.5	0.3	0.2
Basic metals	2.1	1.4	2.8	2.2	1.8	1.3	1.5	2.9
Fabricated metal products, excluding machinery	2.5	2.5	2.6	2.5	2.2	2.4	2.8	3.3
Low-technology products	**76.0**	**69.2**	**67.0**	**61.1**	**63.1**	**59.3**	**49.2**	**42.4**
Other manufacturing and recycling	7.6	6.1	2.4	2.6	2.1	2.4	2.2	2.7
Wood, pulp, paper and printed products	14.2	14.7	16.9	14.9	14.1	11.1	10.0	9.7
Food products, beverages and tobacco	23.5	17.3	14.9	10.9	7.6	6.7	6.5	6.5
Textiles, textile products, leather and footwear	30.7	31.0	32.9	32.7	39.4	39.2	30.5	23.4

Sources: Chelem database and own calculations.

site direction of that recorded in the world, particularly after the period 1970-74. The same has happened in the MHT sub-sector of ''Chemicals excluding pharmaceuticals'', but to a much lesser extent.

Portugal reveals a sustained and clear comparative advantage in the broad LT sector since 1967 (Table 2). The sub-sectors of ''Textiles, textile products, leather and footwear'' and ''Wood, pulp, paper and printed products'' have rather high Balassa indices during the entire period. In the latter there is even a slight increase of the index from the first to the last period of the sample. The MLT sub-sector of ''Other non-metallic mineral products'' shows also high specialization coefficients over the whole period, with an upward trend since the eighties. This leads to an increase of the difference against the world average from the beginning to the end of the sample. Other sub-sectors have $B_{ij} > 1$ but only over the last decade: ''Fabricated metal products, excluding machinery'', ''Rubber and plastics products'', ''Other electrical machinery and apparatus'' and ''Motor vehicles, trailers and semi-trailers''. Finally, there was a temporary revealed comparative advantage in ''Radio, TV and communications equipment'' in the seventies. All other sub-sectors have indices lower than 1.

In the 2000-2004 period, and despite the broad convergence of the Portuguese export structure towards the world average over the past decades, significant differences are still in place. The proportion of the LT sector is still twice the world average, specially concentrated in ''Textiles, textile products, leather and footwear'' and in ''Wood, pulp, paper and printed products'', which include cork products, where Portugal has a particularly high export market share.[12] In MHT and MLT sectors, the Balassa index remains below 1 in the broad sector but the difference with the world average is not very significant

(12) The Balassa index can also be written with export market shares. Regarding products of wood, articles of cork, straw and plaiting materials (ISIC 2029), almost 12 per cent of total world exports have their origin in Portugal, compared with a share in total world manufacturing exports of around 0.5 per cent in 2000-04.

Table 2

RELATIVE EXPORT SPECIALIZATION OF THE PORTUGUESE ECONOMY, BALASSA INDEX

	1967-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
High-technology products	**0.4**	**0.7**	**0.7**	**0.6**	**0.4**	**0.3**	**0.3**	**0.4**
Aircraft and spacecraft	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.3
Pharmaceuticals	0.9	0.9	0.7	0.7	0.5	0.3	0.3	0.4
Office, accounting and computing machinery	0.2	0.7	0.6	0.6	0.2	0.1	0.1	0.3
Radio, TV and communications equipment	0.6	1.2	1.1	1.0	0.6	0.6	0.6	0.6
Medical, precision and optical instruments	0.1	0.3	0.4	0.3	0.2	0.2	0.3	0.3
Medium-high-technology products	**0.3**	**0.4**	**0.4**	**0.4**	**0.5**	**0.6**	**0.8**	**0.9**
Other electrical machinery and apparatus	0.5	0.8	0.7	0.5	0.8	1.3	1.5	1.2
Motor vehicles, trailers and semi-trailers	0.0	0.0	0.1	0.3	0.5	0.6	1.2	1.3
Chemicals excluding pharmaceuticals	0.6	0.7	0.6	0.7	0.6	0.5	0.4	0.5
Railroad equipment and other transport equip.	0.5	0.7	0.4	0.4	0.3	0.4	0.8	0.7
Other machinery and equipment	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.6
Medium-low-technology products	**0.4**	**0.4**	**0.5**	**0.6**	**0.6**	**0.7**	**0.8**	**0.9**
Coke, refined petroleum prod. and nuclear fuel	0.3	0.5	0.3	0.7	0.6	0.9	0.7	0.6
Rubber and plastics products	0.7	0.6	0.3	0.3	0.5	0.6	0.8	1.1
Other non-metallic mineral products	1.8	1.6	1.5	1.7	2.2	2.7	2.6	2.6
Building and repairing of ships and boats	0.1	0.4	0.7	0.5	0.8	0.5	0.4	0.3
Basic metals	0.2	0.1	0.3	0.2	0.2	0.2	0.2	0.5
Fabricated metal products, excluding machinery	0.9	0.9	0.8	0.9	0.8	0.9	1.0	1.3
Low-technology products	**2.5**	**2.4**	**2.6**	**2.5**	**2.5**	**2.4**	**2.1**	**2.0**
Other manufacturing and recycling	2.2	1.8	0.8	0.9	0.6	0.7	0.7	0.9
Wood, pulp, paper and printed products	2.2	2.5	3.3	3.1	2.8	2.2	2.1	2.3
Food products, beverages and tobacco	2.1	1.6	1.6	1.2	1.0	0.9	0.9	1.1
Textiles, textile products, leather and footwear	3.3	3.5	3.9	4.0	4.4	4.3	3.7	3.1

Sources: Chelem database and own calculations.
Note: All Balassa indices higher than 1 are highlighted.

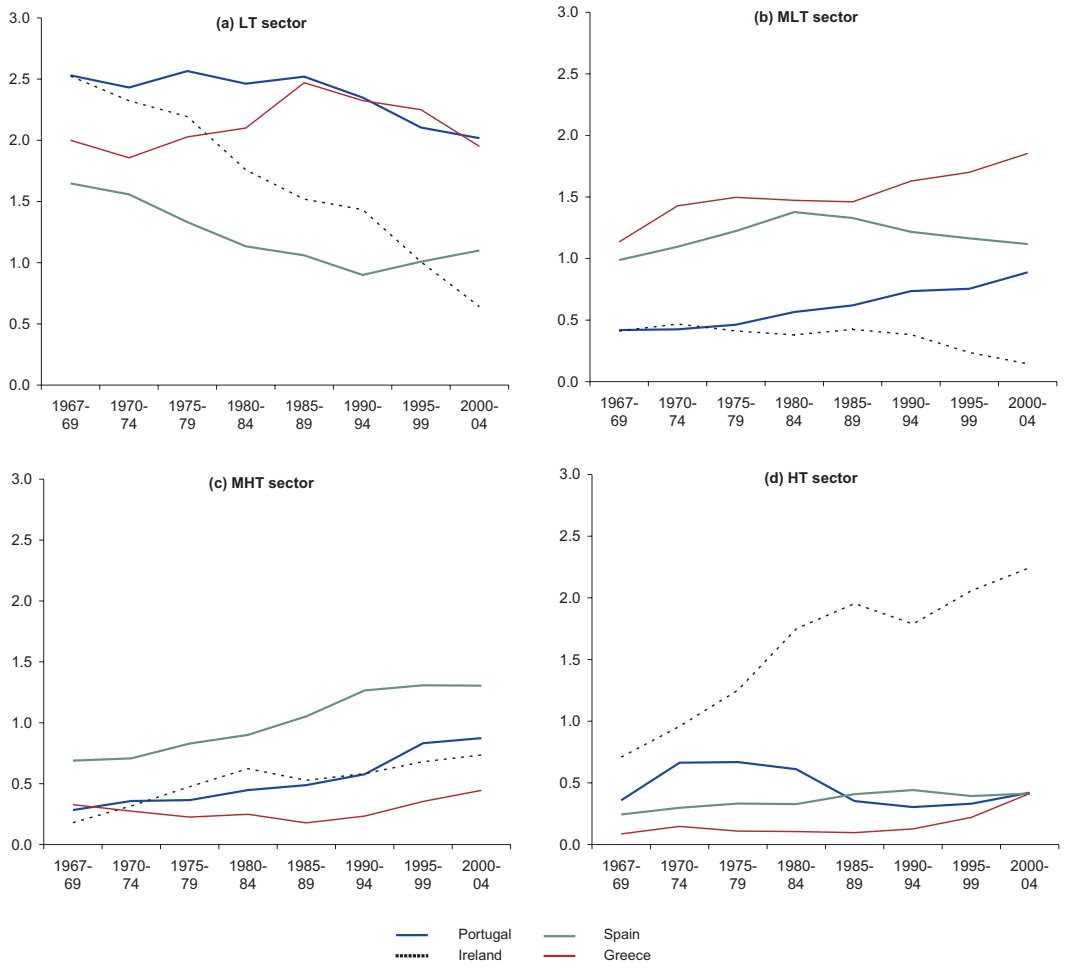
and has been decreasing over the last two decades. In the 2000-2004 period, Portuguese exports are relatively more specialized than the world average in some MLT sub-sectors, like ''Other non-metallic mineral products'', and, less importantly, ''Fabricated metal products, excluding machinery'' and ''Rubber and plastics products''. Portuguese exports also reveal a comparative advantage in some MHT sub-sectors in the most recent period, namely ''Motor vehicles, trailers and semi-trailers'' and ''Other electrical machinery and apparatus''. As regards HT products, the difference with the world export structure is considerable: the high-tech export share in Portugal is less than 1/2 the world average, with all sub-sectors revealing very low indices. Overall, the stronger trends identified in Portuguese exports over the last two decades were the decreasing specialization in LT products and the increased export share of MLT and MHT sectors.

The analysis of the Portuguese relative export structure can be further enhanced with a direct comparison with the ones of Spain, Greece and Ireland. Charts 2(a) to 2(d) depict the evolution of the Balassa indices of the main sectors over the last forty years in these four countries and Table 3 reports the situation at a more disaggregated level for the period 2000-04. In order to explore the differences in these countries´ export structures at each point in time, the differential of the Balassa indices of the four broad sectors was subject to decomposition (2) as described in Section 2. Charts 3(a) to 3(l) plot the result of these decompositions.

In the LT broad sector, the main features can be summarized as: (i) Portugal has the highest specialization coefficient during most of the sample, although in a downward path since mid-eighties; (ii) the path of Greece is very similar to the Portuguese one since mid-eighties; (iii) Spain has the lowest index until the nineties, being the only country evidencing an upward trend in the last decade; (iv) having

Chart 2

BALASSA INDICES BY TECHNOLOGICAL INTENSITY



Sources: Chelem database and own calculations.

started with a Balassa index almost identical to the Portuguese, Ireland has the sharpest downward trend during the whole period and ends up with the lowest index in this sector. Using decomposition (2), the contributions of the sub-sectors ''Wood, pulp, paper and printed products'' and ''Textiles, textile products, leather and footwear'' are always positive, although in the latter sub-sector it has virtually disappeared against Greece in the last two decades. In comparison with Ireland, the diverging path depicted in Chart 2(a) is also explained by the less negative contribution of the sub-sector ''Food products, beverages and tobacco'', as the high share of these products in Irish exports declined steadily. On the contrary, Greece has a larger export share of ''Food products, beverages and tobacco'' than Portugal over the whole period.

In the MLT sector, Chart 2(b) reveals that (i) Greece is the country more specialized in this category during the whole period, evidencing an upward trend since mid-eighties; (ii) the specialization coefficient of Spain has been decreasing in the last 20 years; (iii) the Portuguese index increases over the whole sample, leading to a smaller gap with Spain in the most recent period; (iv) on the contrary, Ireland shows again a decreasing trend and has the lowest coefficient over the last three decades. Using decomposition (2), the stable negative contributions of the sub-sectors ''Basic metals'' and ''Coke, refined petroleum products and nuclear fuel'' mostly explain the lower levels of the Balassa index for Por-

Table 3

MANUFACTURING EXPORTS BY TECHNOLOGICAL INTENSITY (SHARES AS A PERCENTAGE OF TOTAL EXPORTS AND BALASSA INDICES)
Average 2000-2004

	Shares in total exports					Balassa indices			
	World	Portugal	Spain	Ireland	Greece	Portugal	Spain	Ireland	Greece
Memo item:									
Share in total world manufacturing exports	100.0	0.5	2.2	1.5	0.2				
High-technology products	**26.0**	**10.8**	**10.6**	**57.7**	**10.6**	**0.4**	**0.4**	**2.2**	**0.4**
Aircraft and spacecraft	2.6	0.7	1.3	0.5	1.3	0.3	0.5	0.2	0.5
Pharmaceuticals	3.4	1.2	3.4	21.1	4.7	0.4	1.0	6.2	1.4
Office, accounting and computing machinery	6.1	1.8	1.3	22.0	0.8	0.3	0.2	3.6	0.1
Radio, TV and communications equipment	10.1	6.1	3.3	8.0	2.9	0.6	0.3	0.8	0.3
Medical, precision and optical instruments	3.8	1.0	1.4	6.1	1.0	0.3	0.4	1.6	0.3
Medium-high-technology products	**35.6**	**31.2**	**46.6**	**26.3**	**15.9**	**0.9**	**1.3**	**0.7**	**0.4**
Other electrical machinery and apparatus	4.6	5.7	3.7	2.3	2.8	1.2	0.8	0.5	0.6
Motor vehicles, trailers and semi-trailers	11.9	15.0	26.8	0.6	1.7	1.3	2.2	0.0	0.1
Chemicals excl. pharmaceuticals	8.6	4.5	7.9	21.2	6.6	0.5	0.9	2.5	0.8
Railroad equipment and other transport equip.	0.6	0.4	0.9	0.0	0.1	0.7	1.5	0.1	0.3
Other machinery and equipment	9.8	5.8	7.3	2.1	4.6	0.6	0.7	0.2	0.5
Medium-low-technology products	**17.5**	**15.6**	**19.6**	**2.5**	**32.5**	**0.9**	**1.1**	**0.1**	**1.9**
Coke, refined petroleum prod. and nuclear fuel	3.7	2.1	3.1	0.3	10.3	0.6	0.8	0.1	2.8
Rubber and plastics products	2.9	3.3	3.5	0.7	3.2	1.1	1.2	0.2	1.1
Other non-metallic mineral products	1.5	3.8	3.6	0.5	3.1	2.6	2.4	0.3	2.1
Building and repairing of ships and boats	0.8	0.2	1.1	0.0	0.9	0.3	1.3	0.0	1.1
Basic metals	6.1	2.9	5.2	0.5	12.3	0.5	0.9	0.1	2.0
Fabricated metal products, excl. machinery	2.6	3.3	3.1	0.6	2.7	1.3	1.2	0.2	1.0
Low-technology products	**20.9**	**42.4**	**23.1**	**13.5**	**41.0**	**2.0**	**1.1**	**0.6**	**2.0**
Other manufacturing and recycling	3.2	2.7	2.4	0.7	1.3	0.9	0.8	0.2	0.4
Wood, pulp, paper and printed products	4.2	9.7	4.1	4.0	2.5	2.3	1.0	1.0	0.6
Food products, beverages and tobacco	6.1	6.5	9.5	7.9	16.1	1.1	1.6	1.3	2.7
Textiles, textile products, leather and footwear	7.5	23.4	7.1	0.8	21.1	3.1	0.9	0.1	2.8

Sources: Chelem database and own calculations.

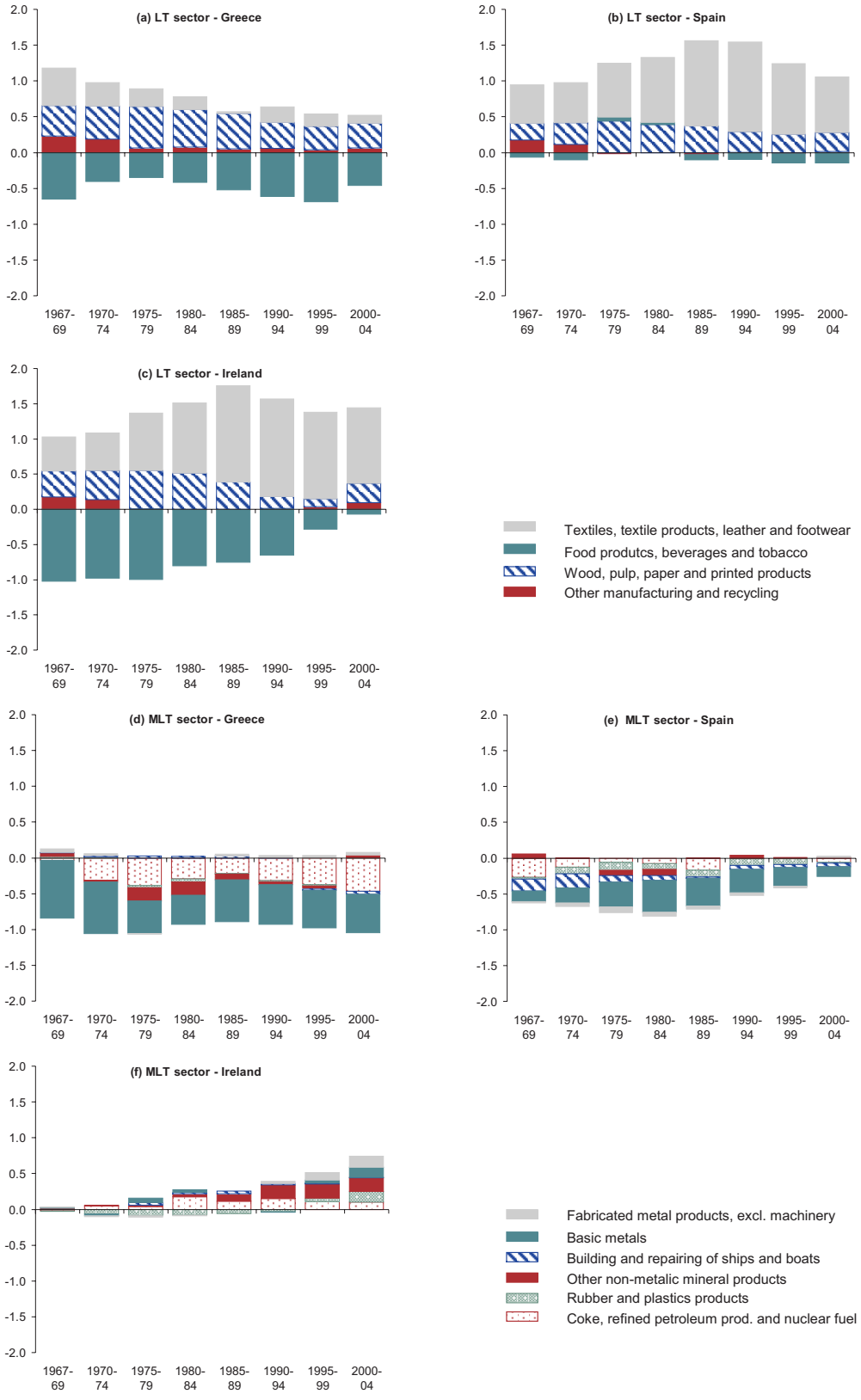
tugal against Greece. Against Spain, a broad convergence has taken place over all sub-sectors of this aggregate, although ''Basic metals'' still account for a lower share in Portuguese exports. The increasing gap between Portugal and Ireland is broadly based across sub-sectors.

In general, the four countries tended to increase their specialization in the MHT sector, with the exception of Greece until the eighties (Chart 2(c)).The Balassa indices were rather close among Portugal, Ireland and Greece in the beginning of the sample. Spain has the largest share of MHT exports over the whole period. The negative gap of Portugal against Spain, which has remained relatively stable over the last forty years, is basically explained by the sub-sector ''Motor vehicles, trailers and semi-trailers''. Against Greece and Ireland, Portugal shows a higher degree of specialization in this sub-sector, specially after mid-eighties. In the case of Ireland, this increasing gap has not created a larger difference in terms of specialization in the MHT sector as a whole, being compensated by the higher importance of the Irish sub-sector ''Chemicals excluding pharmaceuticals'', particularly since the eighties.

In the HT sector, Portugal, Spain and Greece show a high resemblance over the entire sample period, always with coefficients below 1. Portugal had a slightly higher specialization index than Spain and Greece until mid-eighties, but that difference disappeared in the most recent period. On the contrary, Ireland stands out by its substantial and increasing share of HT exports, which represent almost 60 per cent of total Irish manufacturing exports in the period 2000-04 (10.8 per cent in Portugal). Using de-

Chart 3 (to be continued)

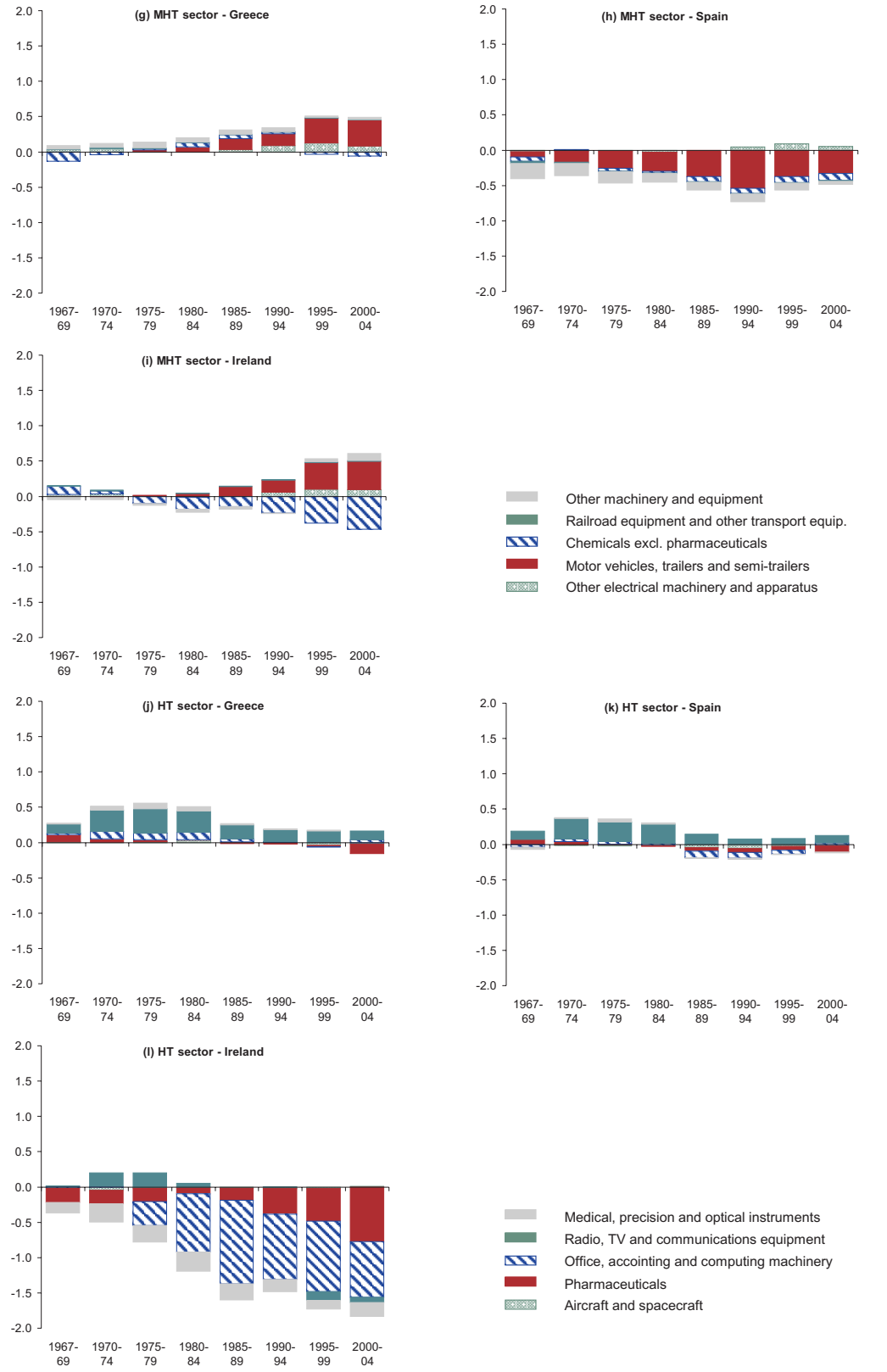
DIFERENTIAL OF THE BALASSA INDICES RELATIVELY TO PORTUGAL $\alpha_j(B_{PT,j} - B_{i,j})$



Sources: Chelem database and own calculations.

Chart 3

DIFERENTIAL OF THE BALASSA INDICES RELATIVELY TO PORTUGAL $\alpha_j(B_{PT,j} - B_{i,j})$



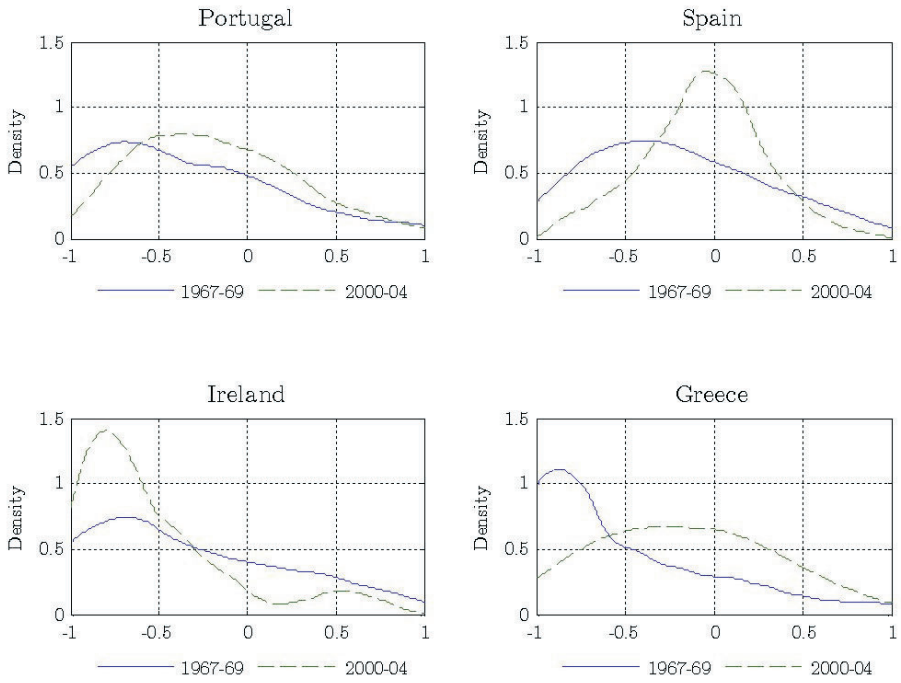
Sources: Chelem database and own calculations.

composition (2), the diverging path of Ireland is mostly due to higher exports of ''Office, accounting and computing machinery'' and ''Pharmaceuticals''. The approximation between the indices of Portugal against both Greece and Spain reflects mainly the reduction of the positive gap in ''Radio, TV and communication equipment''.

The export specialization pattern of a given country can be characterized by the cross-industry distribution of its Balassa indices and changes in the overall extent of export specialization relate to the evolution of the external shape of the distribution over time. Empirical research on the dynamics of trade patterns using the entire distribution was pioneered by Proudman and Redding (1997, 2000). Since then, several empirical studies analysed the product specialization of a given country (or group of countries) by estimating the entire (cross-sector) distributions over time.[13] Changes in the overall extent of export specialization depend on whether there is an increasing concentration in a limited number of sectors or whether the specialization becomes more uniformly distributed across industries. Chart 4 shows the results of estimated kernel densities with 120 manufacturing products, for each country, using an Epanechnikov kernel function in the first and last periods of the sample.[14] Given that the high asymmetry of the traditional index complicates the interpretation of the estimated distribution,

Chart 4

EXPORTS - ESTIMATED KERNEL DENSITIES



Sources: Chelem database and own calculations.
Note: The higher the probability mass around zero, the closer are the country 's export shares to the equivalent world averages and the lower is the overall degree of specialization.

(13) See Brasili *et al.* (2000), De Benedictis (2005) and Di Maio and Tamagni (2006).

(14) Kernel density estimation is a method for adjusting probability density functions from the available observations. Density estimates depend crucially on the choice of the bandwidth or smoothing parameter. Several bandwidths variations were tested and the results were qualitatively similar. We used the optimal bandwidth for estimating densities for the normal distribution as the optimal smoothing parameter for the Epanechnikov kernel function, as suggested by Silverman (1986), seemed to oversmooth the results.

the original Balassa indices were subject to the transformation suggested by Laursen (1998) (see Section 2).

The visual inspection of the density estimates confirms the existence of important differences in terms of specialization among the four countries. In the Irish case, the density function is markedly more right skewed than that of the other countries, indicating a higher overall degree of specialization. On the contrary, the density function of Spain is much more symmetric and roughly centered around the demarcation value in the most recent period. Over time, the density estimates of Portugal, Spain and Greece tend to become more symmetric, pointing to a general decrease of the overall degree of specialization in these countries.[15] The opposite happens with Ireland, whose distribution becomes more polarized in the most recent period, with the density concentrating more around extreme values.

4. CONCLUSIONS

Over the last decades, Portugal and the other EU15 Cohesion countries (Spain, Greece and Ireland) significantly increased their trade openness. In Ireland, however, the gap relatively to the other countries has increased over time and, at present, its degree of openness is substantially higher than that of Portugal, Spain and Greece, which are clustered around similar figures. This article focuses on the evolution of the export pattern of Portugal over the last forty years and confronts it with developments in the other three EU15 Cohesion countries. In general, the changes seen in Portugal bear similarities with those observed in Spain and Greece. Conversely, Ireland shows remarkable differences in many aspects of the evolution of its pattern of international specialization.

The aggregation of the available 120 manufacturing products into four broad categories with distinct technological intensities (high, medium-high, medium-low and low-technology) reveals that one striking feature of the evolution of Portuguese international trade was the continuous decline in the export share of low-tech products over the last four decades. This decline was particularly sharp in "Food products, beverages and tobacco" and "Textiles, textile products, leather and footwear". On the contrary, there was a marked increase of the share of medium-high-tech exports, in particular "Motor vehicles, trailers and semi-trailers" since the second half of the nineties.

The four countries considered have become less specialized in low-tech products over the last four decades, as measured by the evolution of the Balassa (1965) index of revealed comparative advantage. This trend was especially strong in Ireland, which is the only country where a specialization in low-tech products is not present in the most recent period. On the contrary, Portugal still has a clear specialization in this type of products in the 2000-04 period, similar to that of Greece. In what concerns medium-low-tech products, there was an increase of its export share in Portugal, although still showing a Balassa index below 1. The same upward trend was observed in Greece, whose specialization index has always been the highest. On the contrary, Ireland and Spain showed a decreasing trend over the last 20 years, although the later country maintains a higher specialization in these products. As for medium-high-tech products, all countries increased their export share of these products, though Spain shows values substantially higher than those of the other countries and above the world average since mid-eighties. In the case of high-tech products, Portugal, Spain and Greece show a high resemblance over the entire sample period, always with coefficients below 1. Portugal had a slightly higher special-

(15) This result is in line with other empirical studies of specialization patterns using export data. Proudman and Redding (2000) that analyse the international trade dynamics of the G5 economies only find evidence of an increase of specialization in Japan. Brasili *et al*. (2000) examine the dynamics of trade patterns of some developed and emerging countries studying the shape of the sectoral distribution and conclude that, although emerging countries are still more specialized than the industrialized countries, both groups show a tendency towards a reduced polarization and a more symmetric distribution of the specialization index. Similarly, De Benedictis *et al*. (2005) and De Benedictis *et al*. (2006) conclude that sectoral export diversification tends to increase over time, as countries continuously diversify along their path of economic development.

ization index than Spain and Greece until mid-eighties, but that difference disappeared in the most recent period. The specialization index in Portugal is broadly similar in the beginning and the end of the sample period, pointing to the maintenance of a strong comparative disadvantage of the Portuguese economy in these products. The striking point in this technological category is the sharp increase of export specialization observed in Ireland, partly associated with its participation in vertical specialization activities.

Our results point to a decline of the overall degree of specialization of Portuguese exports between 1967-69 and 2000-04. There is evidence of some diversification of the range of products in which Portugal specializes, with smaller differences among them. However, in spite of the convergence of the Portuguese export structure to the world average, significant differences still remain. The same convergence movement is evident in Greece and, in a much larger extent, in Spain, which is the least specialized of the four countries. On the contrary, the Irish export structure is the most concentrated and substantially different from the world benchmark, with its specialization relying in fewer products. Additionally, Ireland is the only of the four countries considered where there is an increase of the overall extent of specialization from the beginning to the end of the sample period.

REFERENCES

Amador, J., Cabral, S. and Maria, J. R. (2007a), International trade patterns in the last four decades: How does Portugal compare with other Cohesion countries?, *Working Paper* 14-2007, Banco de Portugal.

Amador, J., Cabral, S. and Maria, J. R. (2007b), Relative export structures and vertical specialization: A simple cross-country index, *Working Paper* 1-2007, Banco de Portugal.

Balassa, B. (1965), 'Trade liberalization and "revealed" comparative advantage', *The Manchester School of Economic and Social Studies* 33(2), 99-123.

Ballance, R., Forstner, H. and Murray, T. (1987), 'Consistency tests of alternative measures of comparative advantage', *The Review of Economics and Statistic* 69(1), 157-161.

Bowen, H. P. (1983), 'On the theoretical interpretation of indices of trade intensity and revealed comparative advantage', *Weltwirtschaftliches Archiv* 119(3), 464-472.

Brasili, A., Epifani, P. and Helg, R. (2000), 'On the dynamics of trade patterns', *De Economist* 148(2), 233-258.

Cabral, S. and Esteves, P. S. (2006), 'Portuguese export market shares: an analysis by selected geographical and product markets', Banco de Portugal *Economic Bulletin* Summer, 57-74.

Dalum, B., Laursen, K. and Villumsen, G. (1998), 'Structural change in OECD export specialisation patterns: de-specialisation and "stickiness", *International Review of Applied Economics* 12(3), 423 - 443.

De Benedictis, L. (2005), 'Three decades of Italian comparative advantages', *The World Economy* 28(11), 1679-1707.

De Benedictis, L., Gallegati, M. and Tamberi, M. (2005), Semiparametric analysis of the specialization-income relationship, Available at SSRN: http://ssrn.com/abstract=732263.

De Benedictis, L., Gallegati, M. and Tamberi, M. (2006), Overall specialization and development: Countries diversify!, Paper presented at the European Trade Study Group 8th Annual Conference, Wien 7-9 September 2006.

De Benedictis, L. and Tamberi, M. (2002), A note on the Balassa index of revealed comparative advantage, *Working Paper* 158, Universita' Politecnica delle Marche, Dipartimento di Economia.

Di Maio, M. and Tamagni, F. (2006), The evolution of world trade and the Italian "anomaly": a new look, *Temi di discussione* 39, Universitµa degli Studi di Macerata - Dipartimento di Istituzioni Economiche e Finanziarie.

Hidalgo, C., Klinger, R., Barabasi, L. and Hausmann, R. (2007), 'The product space conditions the development of nations', *Science* 317, 482-487.

Hinloopen, J. and Marrewick, C. v. (2001), 'On the empirical distribution of the Balassa index', *Weltwirtschaftliches Archiv* 137(1), 1-35.

Hinloopen, J. and Marrewick, C. v. (2004), Dynamics of Chinese comparative advantage, *Discussion Paper* 034/2, Tinbergen Institute.

Iapadre, P. L. (2001), 'Measuring international specialization', *International Advances in Economic Research* 7(2), 173-183.

Lafay, G. (1992), "The measurement of revealed comparative advantages", in M. Dagenais and P.-A. Muet, eds, *International Trade Modelling*, Chapman & Hall, chapter 10, pp. 209-234.

Lall, S., Weiss, J. and Zhang, J. (2005), The sophistication of exports: A new measure of product characteristics, *Working Paper* 123, Queen Elisabeth House, University of Oxford.

Laursen, K. (1998), Revealed comparative advantage and the alternatives as measures of international specialisation, *Working Paper* 30, Danish Research Unit for Industrial Dynamics.

OECD (2005), *OECD Science, Technology and Industry Scoreboard* 2005, OECD.

Peneder, M. (2003), 'Industry classifications: Aim, Scope, and Techniques', *Journal of Industry, Competition and Trade* 3(1/2), 109-129.

Proudman, J. and Redding, S. (1997), Persistence and mobility in international trade, *Working Paper* 64, Bank of England.

Proudman, J. and Redding, S. (2000), 'Evolving patterns of international trade', *Review of International Economics* 8(3), 373-396.

Richardson, J. D. and Zhang, C. (1999), Revealing comparative advantage: Chaotic or coherent patterns across time and sector and U.S. trading partner?, *Working Paper* 7212, NBER.

Shafaeddin, S. (2004), 'Is China's accession to WTO threatening exports of developing countries?', *China Economic Review* 15(2), 109- 144.

Silverman, B. W. (1986), "Density estimation for statistics and data analysis", *Monographs on statistics and applied probability* No. 26, Chapman & Hall, London.

Vollrath, T. L. (1991), 'A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage', *Weltwirtschaftliches Archiv* 127(2), 265-280.

Widgrén, M. (2005), Revealed comparative advantage in the Internal Market, *Working Paper* 989, The Research Institute of the Finnish Economy.

Yeats, A. J. (1985), 'On the appropriate interpretation of the revealed comparative advantage index: Implications of a methodology based on industry sector analysis', *Weltwirtschaftliches Archiv* 121(1), 61-73.