Industry similarities, comparative advantage and upscale opportunities for Portugal in the process of structural transformation: an empirical assessment based on 2005 trade data.

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Abstract: In this paper we provide an empirical assessment of the "sophistication" of the Portuguese export basket in 2005 and we evaluate the implication of the current specialization pattern for the process of structural transformation. Adapting from Hausmann and Klinger (2007), we use the structure of international trade in 2005 to estimate a measure of "relatedness" for each pair of products, which intends to capture similarities in terms of the capabilities they use. In particular, we run a PROBIT model to estimate the increment in the probability of a country having revealed comparative advantage (RCA) in one product given that the same country has RCA in another product. Contrary to Hausmann and Klinger, our measure of "relatedness" is subject to a statistical scrutiny and can be either positive or negative. We find that a large number of pairs of products (83.9%) are not statistically related and that most significant relations (97.6%) have a positive sign. For some products in which Portugal has RCA, we build measures assessing how related they are to products with higher "income content". We then investigate the extent to which upscale products in which Portugal didn't develop RCA are related to the set of products in which the country already has developed RCA. These measures are used to assess the opportunities of Portugal in the process of structural transformation.

Key-Words: International trade, Structural Transformation, Industry Heterogeneity, The Portuguese Economy.

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1. Introduction

In the current debate on the Portuguese economy, there is a view that the country' specialization pattern – arguably dominated by low-skilled labour intensive products – is a major obstacle to convergence. According to this view, with the emergence of new trading partners in the international arena, the future performance of the Portuguese economy will depend critically on its ability to shift its specialization pattern towards goods with higher productivity content. In the case of Portugal, an extensive literature already exists focusing on the role of institutions, especially those in the labour market, and also on human capital, as a major obstacle to structural transformation. Less attention has been given to *industry heterogeneity* as a main barrier to industry reallocation. This paper provides an empirical assessment of the productivity content ("sophistication level") of the Portuguese export basket and evaluates the extent to which the current specialization pattern is helping or impairing the move towards more sophisticated goods. The analysis draws on two main ideas: first, that a country' economic performance depends on the type and characteristics of the sectors wherein the country specializes; second, that the process of structural transformation (i.e, the process of shifting the specialization pattern towards goods with higher income content) is dependent on which industries the country already learned to operate.

The idea that a country' economic performance depends on the type and characteristics of the sectors wherein the country specializes has been stressed by many authors (for example, Prebisch 1950, Singer, 1950, Kaldor, 1966, Thirlwall, 1979, Grossman and Helpman, 1991). At the empirical level, a recent contribution is Hausmann et al. (2007). The authors proposed a quantitative measure that ranks traded goods in terms of their implied productivity. This measure (PRODY) is estimated as a weighted average of the per capita GDP of the countries exporting a product, where the weights are determined according to the revealed comparative advantage (RCA, Balassa, 1965) of each country in that product. Using the PRODY indexes, the authors constructed a measure of the *average sophistication* level of a country export basket (EXPY), which they found to be highly correlated with per capita incomes and also a good predictor of subsequent growth, controlling for standard covariates.

If the pattern of specialization indeed matters for growth, an obvious political question for an emerging economy is how to achieve a specialization pattern with higher growth potential. The theories of international trade emphasize the role of climate and natural resources, factor proportions, technology and economies of scale in determining specialization patterns. Acording to the neo-classical model, for instance, a move towards "rich country goods" will depend on the availability of the required endowments. Learning by doing theories (Arrow, 1962, Lucas, 1988, Young, 1991, Stokey, 1998), in turn, point to a mutual causality between specialization patterns and factor endowments. In light of that theories, as the stock of "knowledge" accumulates as a by-product of a country productive experience, the country becomes progressively more able to produce goods with higher quality. Hausmann and Klinger (2006, 2007) added that export patterns do not necessarily evolve smoothly across a continuous product space, as conveniently assumed in variety and quality ladder models. In a heterogeneous world, the technology, capital, institutions and skills needed to make newer products are more easily adapted from some products than from others. Because

industries differ in terms of the *specific* set of production capabilities they need, the ability of a country to start producing more sophisticated goods depends on the usefulness of the industry-specific learning generated by the particular basket of goods in which the country is currently specialized. This theory is consistent with a broad interpretation of capabilities, including technical knowledge, physical assets, intermediate inputs, labour skills, access to markets, public infrastructure and specific regulatory requirements.

Hausmann and Klinger (2006, 2007) illustrate the argument with the metaphor of a forest, where each tree represents a product and the forest represents the product space. In that forest, each tree is placed at some distance to the other trees, the distance capturing the degree to which the production capacities of one product can be used in other product. Moving to trees at larger distances involves the need for productive capabilities that have not been previously accumulated. Because some industries use skills that are common to a large number of industries, some parts of the forest are *denser* than others. In this metaphor, firms are monkeys that live on trees and the process of structural transformation involves the monkeys jumping around from tree to tree. Because some trees generate more income than others, each monkey would like to move to high productivity trees ("rich-country goods"). However, because smaller jumps are less costly than larger jumps, the ability of the "tribe" to engage in *upscale jumps* depends on having a path to nearby trees that are increasingly of higher value.

To test the theory, Hausmann and Klinger (2006, 2007) build a measure of revealed "relatedness" between pairs of goods, which intends to capture similarities in terms of the capabilities they use. This measure is estimated as the *conditional probability* of a country having relative comparative advantage (RCA, Balassa, 1965) in one product, given that it has comparative advantage in another. To compute this measure, the authors used cross-country export data at the SITC-4 level of desegregation. They then relate the likelihood of a country developing comparative advantage in a new product with a measure called "density", that summarises the "relatedness" of that product with the products in which the country already has comparative advantage. Empirically, they found that this "density" measure is highly significant in predicting RCAs in the future. In other words, they found that, as countries change their export mix, there is a tendency to move towards "related" goods rather than to goods that are "less related" to the current specialization pattern.

This paper draws on these findings and focuses on the Portuguese case. First, we compute PRODY indexes for 1245 goods and EXPY indexes for 96 countries, using 2005 trade data at the product (NC4) level. Then, we use the structure of international trade in 2005 to estimate a "revealed relatedness index" (RRI) for each pair of products. Finally, we use the estimated RRIs to asses how valuable is the current specialization pattern in Portugal in terms of paving the way for producing products with higher income content.

The estimation method departs from Hausmann and Klinger (2006, 2007) in that, instead of computing non-parametric conditional probabilities, we run a PROBIT model. In particular, we estimate a Revealed Relatedness Index (RRI), defined as the *increment* in the probability of a country having RCA in one product due to the fact that it has RCA in another product. This method brings three different features into the analysis. First, our method subjects the estimated RRIs to a statistical scrutiny. We show that a large proportion (84%) of RRIs is not statistically significant. Hence, according to our estimation, the experience achieved in producing any particular good

will be on average much more limited in terms of the range of goods to which it can be used than that estimated by Haussmann and Klinger. Second, our method allows the relation between each two goods to be either positive or negative. The later case captures the possibility of some capabilities used in the production of one good being unfavourable to the production of another. We find that 97,6% of the significant relations have a positive sign and 2,4% have a negative sign. Third, in contrast to Hausmann and Klinger, our matrix of RRIs is non-symetric: that is, we do not impose the increment in the probability of having RCA in good Y because of having RCA in good X to be equal to the increment in the probability of having RCA in good Y because of having RCA in good Y. Since we are interested in both the connections departing from each good in which a country already has RCA (outwards perspective) and the connections leading to each (upscale) good in which the country does not have RCA (inward perspective), dealing with a non-symmetric matrix enriches substantially the analysis.

The remaining of the paper proceeds as follows. Section 2 provides some descriptive analysis of the Portuguese change in the specialization pattern, using the PRODY and EXPY indexes. Section 3 presents our RRI estimates, based on the PROBIT approach. Section 4 uses the estimated RRIs to infer the extent to which the productive experience with some products in which Portugal is currently specialized is helpful to enter in other products. Section 5 investigates the extent to which upscale products which Portugal already exports but in which it didn't developed RCA are "related" to products in which the country already developed RCA. This information is used to assess the opportunities of Portugal in the process of structural transformation. Section 6 concludes.

2. On the productivity content of traded goods: the PRODY and EXPY indexes

To measure the income content of exports, Hausmann et al. (2007) proposed the PRODY index, which relates the degree of "sophistication" of each product with the level of development of countries that export it. Formally, the index is defined, for each product, as the weighted average of per capita incomes of countries exporting that product, where the weights are proportional to the country's RCA in that good (a formal explanation in Appendix 1). Sectors with high values of PRODY are, by construction, those where high income countries play a major role with respect to the other trading partners. The implied assumption is that the presence of higher wages is stronger where comparative advantage is determined by factors other than labour costs, such as technology, specific knowledge, public infrastructures, institutional development, geographical idiosyncrasies and so on.

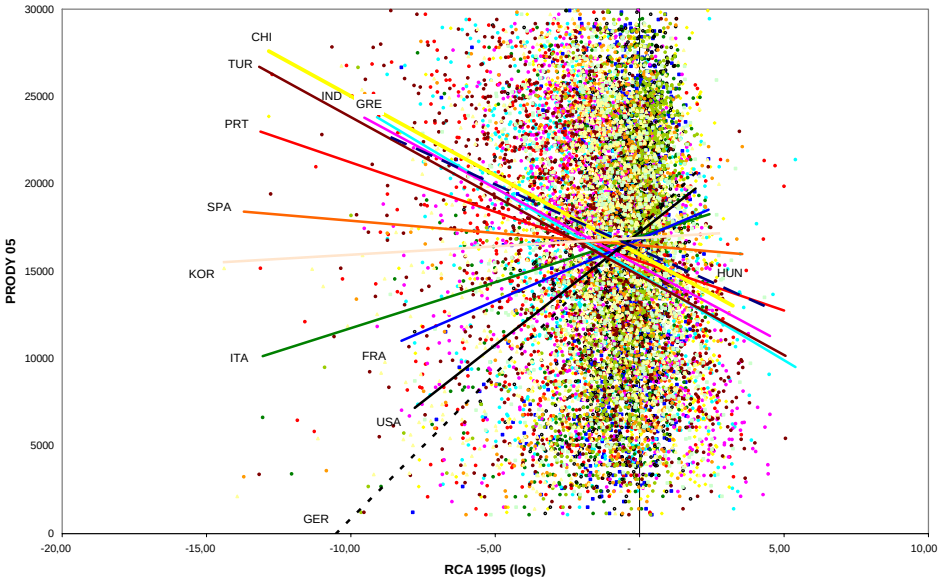
To compute the PRODY values, we use UN COMTRADE data for the year of 2005 at the product (NC4) level for 93 countries, and IMF figures for Per Capita GDP in 2005 (PPPs). Our estimates accord to Hausmann et al. (2007) in that manufactured products and equipment tend to have higher PRODY values than raw materials and agriculture goods.

Figures 1 and 2 cross our estimated PRODY indexes for 1235 products with the corresponding indexes of RCA for twelve countries as of 1995 and 2005, respectively[1]. In order to compare the different paths, the figure also displays, for each country, a simple regression line relating the PRODY indexes to the corresponding indexes of RCA in each country. Despite the high dispersion of the data, the slopes of these regression lines provide a stylized indication of the extent to which a country is more specialized in products with low (negative slope) or high (positive slope) income content. According to Figure 1, by 1995 China was the country in this sample with a more negative correlation between comparative advantage and PRODY values. Also negative slopes were found in Greece, India, Turkey, Hungary, Portugal and Spain. On the other hand, Italy, France, USA and Germany exhibited positive correlations between RCA and PRODY values, suggesting a tendency to be more specialized in "rich country goods".

Moving from a negative correlation towards a positive correlation involves becoming increasingly specialized in products with higher income content. This is what is meant by *structural transformation*. Comparing Figures 1 and 2, we see that the slopes of the regression lines for China, Greece, Hungary and Korea have moved considerably down, suggesting a quite successful process of structural transformation. The slope of the regression line for Portugal has also improved in this period, but less drastically than in these countries. In contrast, the slopes of the regression lines in Spain and USA did not change significantly. In the case of Italy, the slope actually declined.

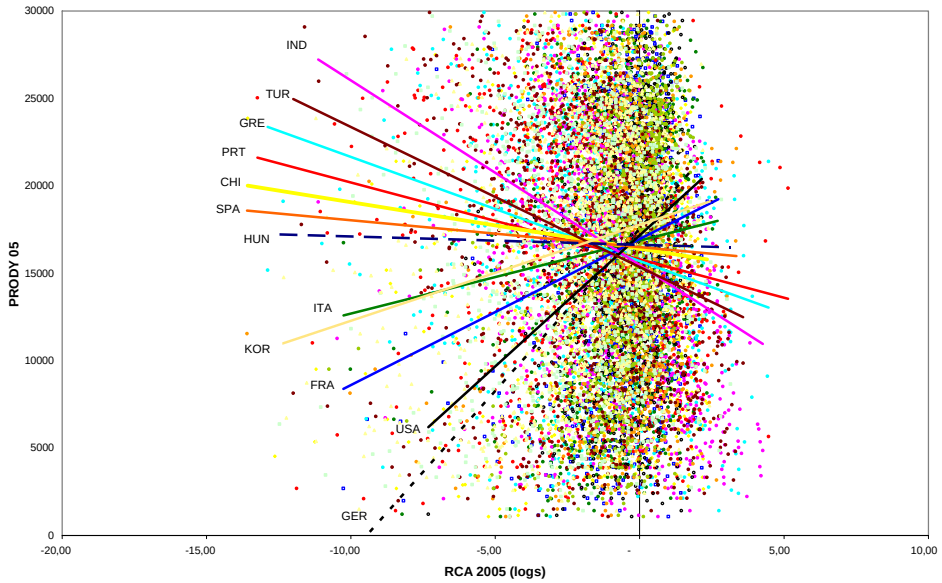
[1] The Balassa (1965) RCA indexes are in logs. Null coefficients of RCA became missing values. For comparative purposes, Balassa indexes were computed restricting the sample to 77 countries and 1235 products for which trade data is consistently available in 1995, 2000 and 2005.

Figure 1: PRODY and Revealed Comparative Advantage in 1995 (Portugal, Spain, India, Turkey, Greece, China, Germany, France, Korea, Italy, Hungary, USA)



Source: own calculations. Prody and RCA defined in Appendix 1.

Figure 2 : PRODY and Revealed Comparative Advantage in 2005 (Portugal, Spain, India, Turkey, Greece, China, Germany, France, Korea, Italy, Hungary, USA)



Source: own calculations. Prody and RCA defined in Appendix 1.

Table 2 describes the evolution of the Portuguese export basket between 1990 and 2005 at constant 2005 PRODY levels, by classes of PRODY[2]. The 5 classes considered range from the 20% products with higher PRODY values to the 20% products with lower PRODY values. According to this data, there has been a steady increase in the share of products with "High" and "Very High" income content (from a total weight of 27.8% in 1990 to 44.3% in 2005), at the cost of the classes "Low" and "Very Low" (from 57.9% to 39.5%). This move allowed the *average* PRODY value of the Portuguese export basket (EXPY) to increase consistently over time, from 14.041 USD dollars in 1990 to 16.603 in 2005[3].

Table 2 – The structure of Portuguese Exports by classes of PRODY

PRODY Class	1990		1995		2000		2005	
	Share on Exports	EXPY	Share on Exports	EXPY	Share on Exports	EXPY	Share on Exports	EXPY
Very High (top 20%)	6,2	1528	8,5	2118	9,4	2363	12,5	3097
High	21,6	4457	25,8	5392	32,8	6982	31,8	6727
Average	14,4	2390	14,2	2363	14,8	2460	16,3	2692
Low	32,1	3743	31,1	3673	27,0	3202	25,6	3049
Very low (20% lowest)	25,8	1923	20,4	1517	15,9	1195	13,9	1036
Total	**100**	**14041**	**100**	**15063**	**100**	**16202**	**100**	**16603**

Source: Own calculations using COMTRADE, IMF and the Portuguese National Institute of Statistics data.

Note: Prody and Expy defined in Appendix 1.

3. Product level RRIs and summary statistics

To assess how valuable is the productive experience with one good to produce other goods, Hausmann and Klinger (2006, 2007) develop an outcome-based measure of *relatedness* between pairs of goods, related to the likelihood that countries in the world have RCA in both. Using cross-country data on exports at the product level, they estimate, for each pair of products, the conditional probability of countries having revealed comparative advantage (RCA) on the first product, given that they have RCA on the second. The authors dubbed this measure as of "proximity". Because the conditional probability of a country having comparative advantage in a good *i* given that it has comparative advantage in good *j*, *P(i/j)*, is not necessarily equal to the conditional

[2] A major problem with the COMTRADE database is the presence of a sizeable category of miscellaneous products, "9999-Commodities not specified according to kind", which in 2005 accounted for 2,9% of the world trade and for 8,7% of Portuguese exports. This category cannot be ignored while computing RCA indexes, but there is no point in computing its PRODY value. In the case of Portugal, a major change in the statistical treatment of confidentiality has occurred in 2005, causing a large number of products previously classified elsewhere to be moved to the class 9999. To overcome this limitation, in Table 2 we use data from the National Institute of Statistics, which are available including confidential positions. From the qualitative point of view, similar conclusions are obtained using COMTRADE data.

[3] Actually, the change in EXPY between two periods at current PRODYs may be decomposed in a PRODY (value) effect and a Structural Transformation (changing composition of exports) effect. This analysis is undertaken by Di Maio and Tamagni (1987) for the case of Italy and by Lebre de Freitas and Mamede (2008), for the case of Portugal. In the table above, only the structural transformation effect is analysed.

probability of a country having comparative advantage in a good *j* given that it has comparative advantage in good *i*, *P(j/i)*, the simple application of conditional probabilities would lead to an asymmetric matrix. Arguing that these conditional probabilities may tend to extreme values in cases where only few countries have comparative advantage in one of the goods, Hausmann and Klinger imposed symmetry in their matrix of proximities. This was done by setting the proximity measure between each two goods *i* and *j* as the minimum of the two above mentioned conditional probabilities.

In this paper, we adopt an alternative method to estimate product relatedness. In particular, our Revealed Relatedness Indexes (RRI) are estimated using a PROBIT regression model, assessing whether the probability of a country having RCA in one product is conditional on having RCA in another product. For each pair of products, we then estimate the increment in probability - the marginal effect – of having RCA in one product due to the fact of having RCA in the other product. This is the RRI index (see Appendix 2 for details).

A novelty in our method is that it provides a significance test for the estimated RRIs. Hence, if only few countries have comparative advantage in one of the goods, our RRI measure will not be significant. As shown in Table 3, among the more than 1,5 million RRIs estimated, only 16,1% were found to be significant[4]. This evidence challenges Hausmann and Klinger (2006, 2007): because these authors considered all possible relations, they are likely to be overestimating the available options in the process of structural transformation[5].

Table 3: summary results of RRI estimation

	Number	**% Total**
Non Significant	1.299.014	83,9
Significant	249.766	16,1
of which:		
positive	243.803	15,7
negative	5.963	0,4
Total estimated	**1.548.780**	**100,0**

Note: Significance test: z (5%).

A second novelty with our estimation is that it allows RRIs to be either positive or negative. This captures the possibility of some capabilities used in the production of one good being unfavourable to the production of another. An obvious example is climate: it may be that the climate necessary to produce bananas is detrimental to the production of wine. Also a country abundant in skilled labour and hence specialized in highly sophisticated goods may find it difficult to develop competitiveness in products using unskilled labour intensively. In the Hausmann-Klinger framework, pairs of goods

[4] Since we use NC-4 classification encompassing 1245 products, we have a total of 1245x1244=1.548.780 cells estimated in the matrix of all possible relations between pairs of products.

[5] Hidalgo et al. (2007) represented the product space in a two dimension plan ignoring conditional probability values lower than a critical level, so they are not subject to this criticism. The authors considered only 1525 links out of the possible 750x750 pairs of products.

that are best produced in opposite economic frameworks are captured by positive but low indexes of revealed relatedness. In our framework, the corresponding measure will be negative. As shown in Table 3, among the 16,1% of significant RRIs, 15,7% were found to have positive value. Our analysis reveals that negative RRIs occur mostly with raw materials and other primary products, such as oil, gold and coffee. These products tend to be exported by countries with very low export diversification, in some cases affected by Dutch disease.

A third novelty in our estimation is that we do not impose symmetry in the matrix of RRIs. The rationale is that the increment in the probability of having RCA in product *i* because of RCA in product j does not need to be the same as the increment in the probability of having RCA in product j because of RCA in product i. As an example, take automobiles and carpets: a country having RCA in automobiles may explore a synergy, developing the activity of producing carpets for automobiles. However, producing carpets for automobiles does not necessarily increment the probability of having comparative advantage in the production of automobiles by the same amount that producing automobiles increments the probability of producing carpets.

The disadvantage of not assuming a symmetric matrix is that we will not be able to map the product space in a two dimension plan, as nicely done by Hidalgo et al. (2007). Working with a non-symmetric matrix, however, we tackle more accurately the two different perspectives we are concerned with: an "outward perspective", assessing, for each product in which a country already has RCA, the extent to which he is related to products with higher productivity content; and an "inward perspective", assessing the extent to which high PRODY products in which the country did not develop comparative advantage are related to products in which the country already has RCA.

4. Outward perspective

As for the outward perspective, we are concerned with the extent to which a country' current specialization pattern provides it with relevant productive experience to produce other goods. We start assessing, at the product level, the extent to which the production of a particular product prepares a country to enter other products.

At the product level, Hausmann and Klinger (2006, 2007) proposed a measure consisting in the raw sum in the matrix of conditional probabilities. Our corresponding measure is the "out-path" (column-total in our matrix of marginal effects)[6]:

$$outpath_i = \sum_j RRI_{ij} \qquad (1)$$

To assess the overall usefulness of a country productive experience, Hausmann and Klinger (2007) constructed a country level indicator, which they dubbed "centrality":

[6] Note that in our framework computing this measure may involve summing negative and positive values, corresponding to the estimated marginal probabilities. Hence, the possibility exists of these measures to be negative for some products.

$$Centrality_c = \sum_{i:RCA_{ic}>1} outpath_i \qquad (3)$$

We next turn to the question on the extent to which the goods in which Portugal developed RCA help or impair the process of structural transformation. To address this question, let's first analyze the estimated RRIs for one specific product corresponding to one line of our 1245x1245 matrix. We focus in a product in which Portugal already develop RCA, "*6302 – bed linen, table linen, toilet linen and kitchen linen*". These are displayed in Table 4. Column 1 in the table displays the estimated *outward* RRIs which correspond to the marginal effects, RRI_{ij} of the PROBIT model[7]. In particular, they measure the increase in the probability of having RCA in each ("arrival") product j given that the country has RCA in product 6302. For instance, the "arrival" product "more related" to bed linen is estimated to be the "6107 – Men's or boys' underpants, …". Column 2 of Table 4 displays the corresponding *z-test*s, consisting on the ratio between the estimated coefficient and the standard error, which in this case has a normal distribution (actually, in Table 4, the j-products are displayed by decreasing order of *z*). In this product, only one case of negative RRI was found: "7108 – Gold …". Column 3 display the PRODY value corresponding to each *j*-product.

Table 5 provides some summary statistics for 8 products in which Portugal had RCA in 2005. Columns 1 and 2 display the corresponding share on Portuguese exports and RCA index, respectively. Columns 3 and 4 characterize the good in terms of PRODY and PRODY rank, respectively. For example, the product 6109 "T-Shirts" has an estimated PRODY index of 8,8 thousand USD, corresponding to percentile 83,2% (i.e, only 16,8% of the 1245 products considered have lower income content). Column 5 of Table 5 displays the number of significant outward RRIs for each product. In the case of "6302 bed linen", we see that the number of significant outward RRIs is 161. In the case of "6403 Footwear", the number of significant outward RRI is 263. Columns 6 and 7 document the number of significant RRIs which are positive and negative, respectively. In the case of "6109 T-shirts", for example, 29 RRIs are negative, meaning that the probability of having RCA in T-shirts decreases the probability of having RCA in 29 other products.

Table 4: Outward RRIs for 6302 – "Bed Linen…. "

[7] Note that RRIs may be computed "departing" from a good in which the country has RCA (outward perspective) or "arriving" to a good in which the country still didn't develop RCA (inward perspective). At this stage, we are concerned with the former concept. In the following section we will address the latter.

NC - 4	6302 - Bed linen, table linen, toilet linen and kitchen linen. (Prody = 6,82)	(1) RRI	(2) z	(3) Prody j (10^3)
6107	Men's or boys' underpants, briefs, nightshirts, pyjamas, bathrobes	0,69	5,05	9,2
6108	Women's or girls' slips, petticoats, briefs, panties, nightdresses	0,66	5,00	8,9
6206	Women's or girls' blouses, shirts and shirt-blouses.	0,66	5,00	7,8
6204	Women's or girls' suits, ensembles, jackets, blazers, dresses, skirts	0,68	4,94	8,0
6115	Panty hose, tights, stockings, socks and other hosiery	0,62	4,86	11,6
6104	Women's or girls' suits, ensembles, jackets, blazers, dresses, skirts	0,62	4,86	7,5
6106	Women's or girls' blouses, shirts and shirt-blouses, knitted or crocheted.	0,59	4,70	7,9
6103	Men's or boys' suits, ensembles, jackets, blazers, trousers, bib and brace ...	0,56	4,66	6,1
6109	T-shirts, singlets and other vests, knitted or crocheted.	0,60	4,56	8,8
6203	Men's or boys' suits, ensembles, jackets, blazers, trousers	0,60	4,37	7,7
(…)	(…)			
908	Nutmeg, mace and cardamoms	0,19	1,99	4,5
9606	Buttons, press-fasteners, snap-fasteners and press-studs, button moulds	0,19	1,99	12,2
5106	Yarn of carded wool, not put up for retail sale.	0,19	1,99	21,5
8306	Bells, gongs and the like, non-electric, of base metal; statuettes and othe ...	0,19	1,99	19,2
3103	Mineral or chemical fertilisers, phosphatic.	0,19	1,99	9,2
7108	Gold (including gold plated with platinum)	-0,23	-2,04	3,9

Note: RRI (revealed relatedness index) represents the increment in probability of having RCA in one product due to the fact of having RCA in the other product (in this case 6302 – Bed Linen).

Table 5 – Summary statistics for some products

		(1) Share on PT exports (%)	(2) RCA	(3) Prody	(4) Prody Rank (%)	(5) ni	(6) ni> 0	(7) ni< 0	(8) Outpath	(9) Outpath by prody class VL	(10) L	(11) A	(12) H	(13) VH
8703	Motor cars and other motor vehicles principally designed for the transport ...	7,0	43,9	23,0	20,5	442	435	7	129,6	2,1	16,5	33,9	45,1	32,0
8708	Parts and accessories of the motor vehicles of headings	4,0	51,2	20,8	30,7	454	444	10	142,1	0,5	16,2	39,5	51,4	34,4
6403	Footwear with outer soles of rubber, plastics, leather or composition leath ...	3,3	48,6	12,4	70,2	263	259	4	73,0	17,1	23,0	16,6	13,4	2,9
8527	Reception apparatus for radio-telephony, radio-telegraphy or radio-broadcas ...	2,5	11,5	20,4	32,6	155	153	2	49,0	1,8	4,3	10,1	18,7	14,2
6109	T-shirts, singlets and other vests, knitted or crocheted.	2,0	32,8	8,8	83,2	176	147	29	36,8	19,6	13,3	4,2	1,1	-1,5
8473	Parts and accessories for use with machines of heading	2,0	11,5	23,2	19,3	229	226	3	68,8	2,6	7,7	12,1	20,8	25,6
2204	Wine of fresh grapes, including fortified wines	1,7	17,6	9,8	79,2	128	128	0	41,1	6,9	14,0	10,1	7,8	2,4
6302	Bed linen, table linen, toilet linen and kitchen linen.	1,7	31,9	6,8	89,1	161	160	1	51,3	21,9	18,8	8,6	1,8	0,2

Note: RCA and Prody defined in Appendix 1; ni = number of significant branches; Outpath defined in equation (1).

The number and the size of the significant relations for each "departing" product in Table 5 are summarized by the out-path measure, as described by equation (1). In column 8 of Table 5 we see that "8703: motor cars" has a larger out-path index (is more related to other goods) than "6109: T-shirts". The later has the lowest estimated out-path, which not only reflects a low number of significant RRI but also their sizes, some of which being negative.

Columns (9)-(13) in Table 5 break-down the out-path index for each "departing" product *i* by the PRODY class of "arrival" products *j*. For instance, most of the "6109: T-shirts" out-path is accounted for by segments conducive to products with Low and Very Low income content. In respect to products with Very High income content, the sum of estimated probabilities is negative. One interpretation is that the unskilled labour intensity required to produce T-shirts is highly inconsistent with the skilled labour required to produce highly sophisticated goods. In contrast, "9703 – Motor cars", "8527 – Reception apparatus" are mostly conducive to products with High and Very High income content.

Summing the out-path indexes for all product in which Portugal had RCA, we obtain the corresponding centrality index, as given by equation (3). In Appendix 3, centrality measures are displayed for all countries in the sample, for 1995 and 2005, holding the matrix of RRIs fixed[8]. Our estimates (not reported here) confirm the Hausmann and Klinger (2007) positive correlation between this measure and per capita GDPs. The rationale is that, other things equal, a country should be better off when specialized in goods which productive experience is helpful to produce a large set of goods than when specialized in goods which productive experience can hardly be adapted to produce other goods. According our estimates, by 2005, Portugal was ranked 21 (28 in 1995) out of 93 countries in terms of centrality, achieving an index of 17.4.

The centrality index ignores, however, the extent to which "arrival" products j are of low vale or of high value. Because RRIs are not equivalent in terms of the products they relate - as illustrated by columns 9-13 of Table 5 – some extra insight may be obtained by breaking down the centrality index by classes of PRODY of the "arrival" products *j*. This is done in Table 7 for 17 countries. For instance, in 1995 centrality was much higher in Germany (43,4) than in Turkey (10,9). The breakdown reveals that in 1995 roughly ¾ of the centrality in Germany was accounted for segments leading to products with High and Very High income content. In the case of Turkey, more than ½ of the centrality was accounted for by segments leading to products with Low and Very Low income content.

Table 7: Evolution of centrality by classes of PRODY

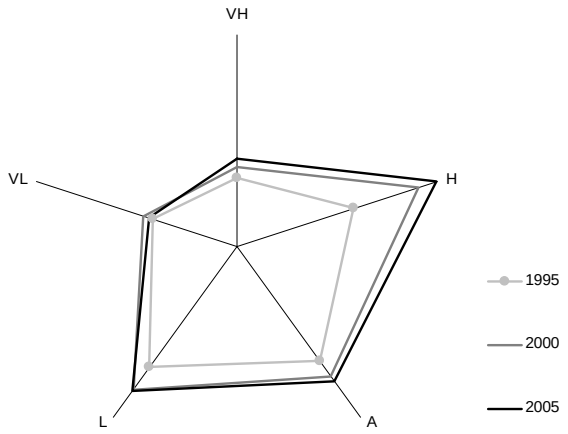
		1995						2005						95-05
		VL	L	A	H	VH	Total	VL	L	A	H	VH	Total	p.p.
Advanced	Germany	1,0	3,3	8,9	14,6	15,5	**43,4**	0,8	3,3	8,1	14,3	15,4	**41,9**	-1,4
	USA	1,3	2,4	4,7	8,4	12,1	**28,9**	1,7	2,6	6,2	11,3	13,8	**35,6**	6,7
	Australia	0,7	1,8	2,2	1,6	2,1	**8,4**	0,7	1,2	1,5	1,3	2,1	**6,8**	-1,6
	Japan	0,3	1,1	2,9	9,2	11,3	**24,8**	0,6	1,5	3,1	9,2	10,9	**25,4**	0,6
	France	1,7	3,8	7,9	10,8	9,9	**34,1**	1,9	3,3	8,1	10,6	9,5	**33,5**	-0,6
	Italy	1,9	5,0	7,7	9,7	8,8	**33,0**	2,4	5,4	8,7	10,5	9,3	**36,2**	3,2
Emerging European	Spain	1,8	3,7	5,4	7,4	4,0	**22,4**	2,0	4,7	7,0	9,6	4,3	**27,7**	5,3
	Portugal	**2,1**	**3,5**	**3,4**	**2,9**	**1,6**	**13,5**	**2,2**	**4,2**	**3,9**	**5,0**	**2,1**	**17,4**	**3,9**
	Turkey	2,4	3,4	2,7	1,8	0,5	**10,9**	2,4	4,1	5,0	3,8	1,0	**16,3**	5,4
	Hungary	2,3	3,5	5,2	5,7	2,8	**19,5**	1,0	2,4	4,4	6,0	2,0	**15,8**	-3,7
Emerging non-European	China	3,9	5,6	5,7	6,0	4,3	**25,5**	3,8	5,7	7,1	7,7	5,9	**30,2**	4,7
	India	2,9	3,3	2,8	2,9	2,2	**14,1**	3,4	3,8	3,9	4,0	3,3	**18,4**	4,3
	Rep. of Korea	1,5	2,8	3,6	3,9	2,8	**14,6**	0,8	2,0	2,8	3,9	3,5	**13,0**	-1,6
	Chile	0,8	1,3	1,1	0,5	0,3	**3,9**	0,8	1,0	0,9	0,5	0,5	**3,7**	-0,2
Commodity exporters	Saudi Arabia	0,2	0,3	0,9	0,6	0,1	**2,2**	0,1	0,4	0,4	0,5	0,3	**1,7**	1,7
	Malawi	0,8	0,5	0,3	0,1	0,0	**1,7**	0,7	0,3	0,2	0,4	0,0	**1,6**	4,3
	Mozambique	0,5	1,0	0,5	0,3	0,4	**2,7**	0,3	0,5	0,2	0,2	0,0	**1,1**	-1,6

Note: Centrality defined in equation (3). Both RRI and PRODY values refer to 2005.

In the case of Portugal, in 1995 the centrality index was roughly uniform across arrival income classes. Between 1995 and 2005, however, the Portuguese productive experience became increasingly biased towards products with High income content. This is illustrated in Figure 6, which also suggests that most of this change has occurred between 1995 and 2000.

Figure 6: Breakdown of centrality: Portugal, 1995, 2000, 2005

[8] In a parallel paper, we are estimating RRI matrixes for different years. As noted by Hidalgo et al. (2007), assuming a fixed matrix in the above analysis provides a reasonable approximation, as the dynamics of the matrix is supposed to be slower than that of countries RCA.

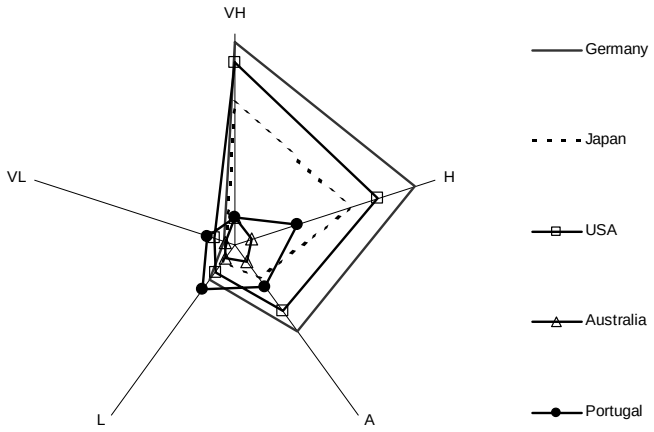


Note: Centrality defined in equation (3).

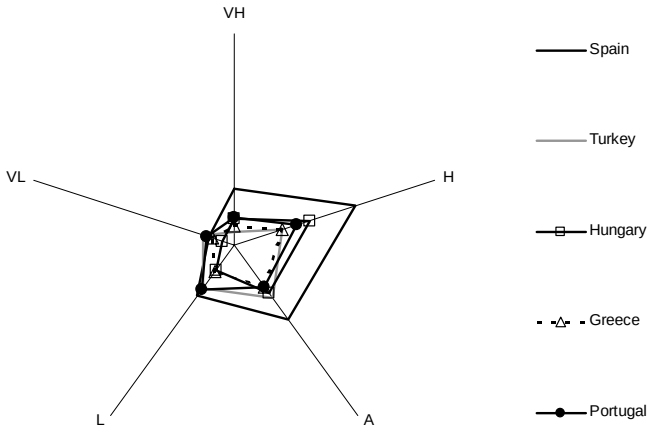
Figure 7 compares the breakdown of the centrality in Portugal to that of other countries as of 2005. The figure is divided in three panels, each one comparing Portugal to 4 other countries. The top panel compares the Portugal with other 4 industrial countries. In general, we see that Portugal has lower centrality with respect to goods with High and Very High income content and a slightly higher centrality to goods with Low and Very Low income content. The exception to this rule is Australia, which exhibits a roughly uniform and very low centrality level, probably due to the high dependency on exports of raw materials. The middle panel of Figure 7 compares the centrality in Portugal to that of other 4 emerging European countries. The figure suggest some similarity between the Portuguese pattern and those of the other countries, with exception of Spain, which has a centrality path much closer to that of developed countries. Finally, in the bottom panel of Figure 7, we compare the path of centrality in Portugal to that of 4 other emerging economies outside Europe. In this group, there are two outliers, Chile, which has a very small centrality index similar to Australia, and China who is in general more central than Portugal. Portugal is slightly less biased towards poor country goods than India and more biased to poor country goods than Korea.

Figure 7: Breakdown of centrality in 2005: Portugal compared to other countries

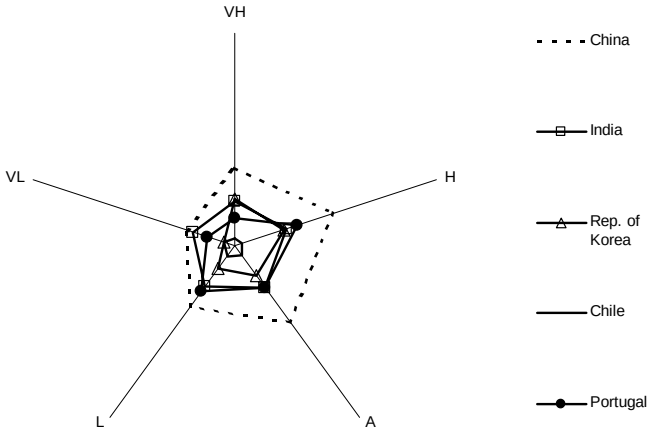
Portugal versus 4 advanced economies



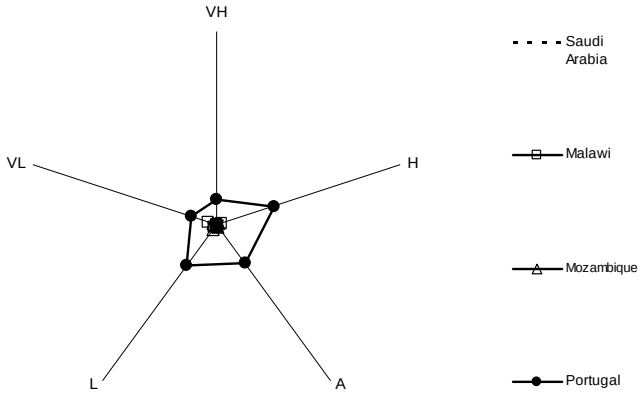
Portugal versus other 4 emerging European



Portugal versus 4 Emerging non-European



Portugal versus 4 commodity Exporters



5. Inward perspective

As for the in-path perspective, we are concerned with the extent to which up-scale products in which Portugal didn't develop comparative advantage are related to products in which the country already has comparative advantage. To capture this, Hausmann and Klinger (2006, 2007) propose a measure of *density* for each product, which basically consists in the "average relatedness" of the potential product j to a country's current productive structure:

$$\omega_{j,c} = \frac{\sum_j RRI_{ij} x_{cj}}{\sum_j x_{cj}}, \ \forall \beta_{ij} > 0 \text{, where } x_{cj} = \begin{cases} 1 & if \quad RCA_{cj} > 1 \\ 0 & if \quad otherwise \end{cases} \qquad (4)$$

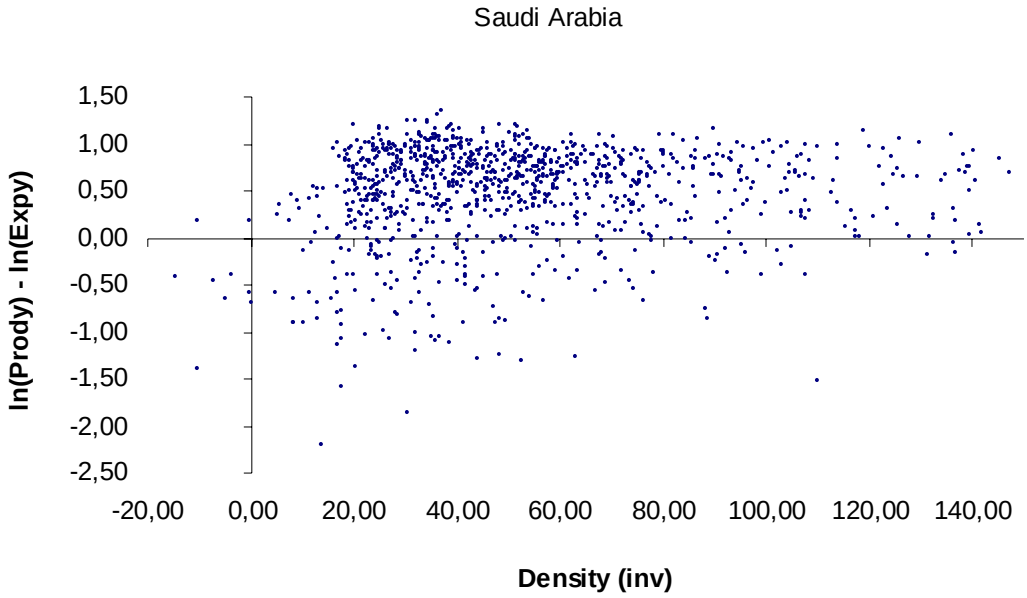
We can interpret this measure as capturing the extent to which goods in which a country already has RCA generate specific knowledge that is useful to produce the particular new product *j* under consideration. Higher density values indicate that the country developed capabilities that are useful to produce this new good and therefore is more likely to develop RCA in this good. If product relatedness influences comparative advantages, then the probability of developing RCA in a particular product in the future should be affected by the ease with which a country' current capabilities can be adapted to the new product. Hasumann and Klinger (2006, 2007) and Hidalgo et al. (2007) perform different tests which confirm this idea.

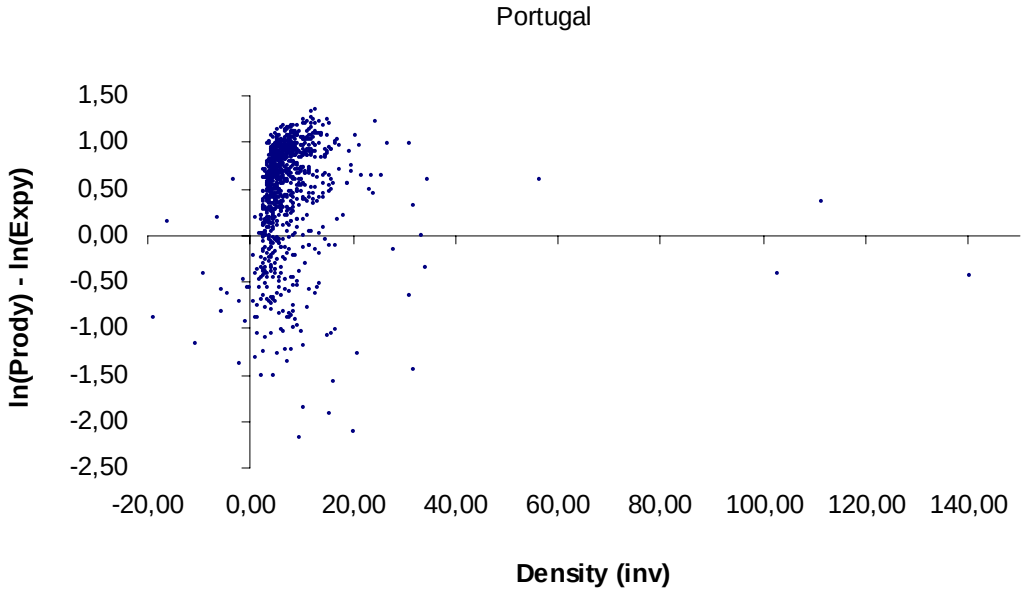
Following Hausmann and Klinger (2006), we thus investigate how reachable are upscale products in which Portugal didn't develop comparative advantage. This question is explored by graphing for each country the difference between Ln(PRODY) and Ln(EXPY) against the inverse of the density measure (4) for each product in which the country didn't develop comparative advantage.

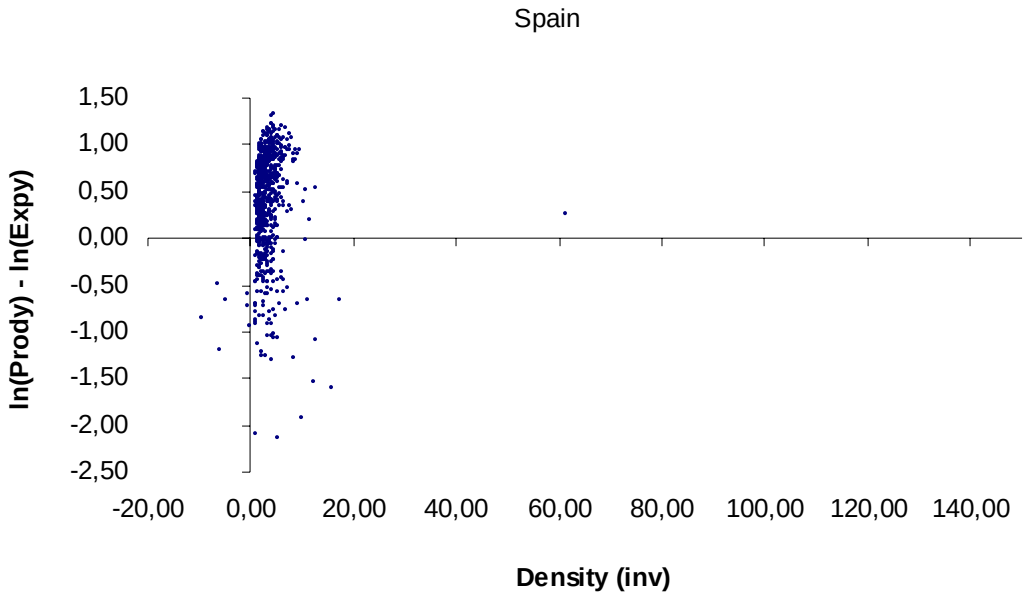
Figure 8 compares the case of Portugal with Spain, China and three countries highly dependent on commodity exports (Saudi Arabia, with more than 75% of exports in 2005 being Petroleum oils; Benin, with 58% of exports being unprocessed cotton; and Malawi, with 53% of exports being unmanufactured tobacco). Not surprisingly, the figures reveal that up-scale opportunities for the three commodity exporters are much lower than in the case of Portugal, Spain and China. Comparing to two Iberian

countries, we observe that the Spanish picture is much denser and closer to the origin that that of Portugal. This suggests that Spain is much better endowed than Portugal to face the process of structural transformation. Comparing to China, Portugal appears to better prepared to develop comparative advantage in most goods. As will see in a minute, however, China has a small set of high valued products nearby, while in the case of Portugal the "closest" products are of lower value.

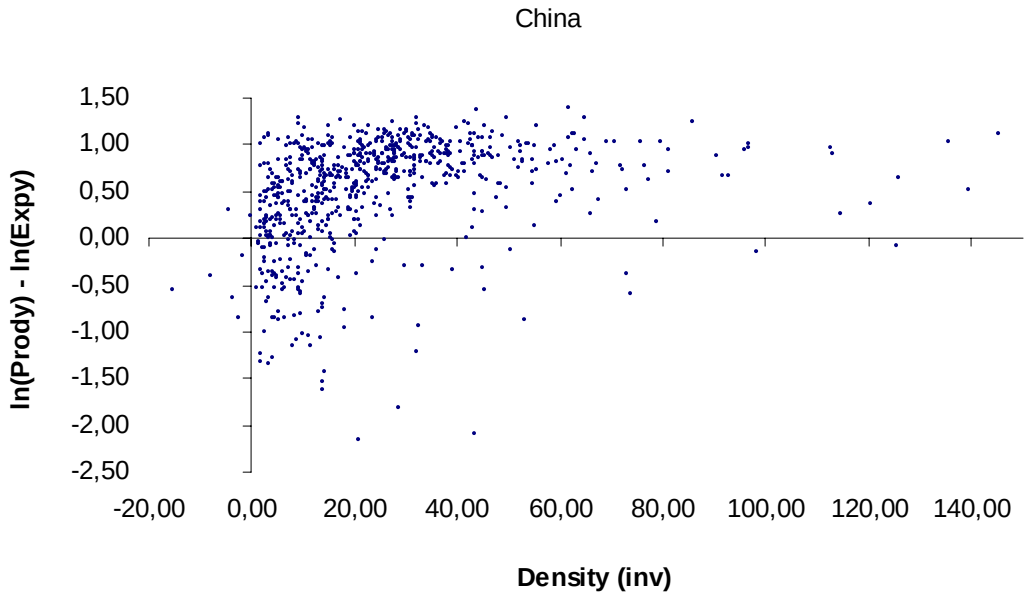
Figure 8 - Visual representation of the under-occupied "products, 2005: Saudi Arabia, Portugal, Spain, China, India, Germany, Greece and Turkey



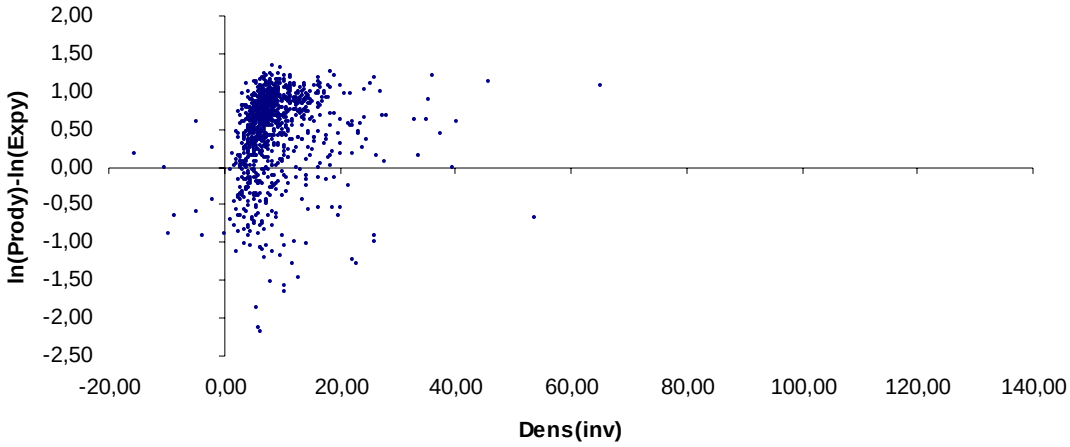




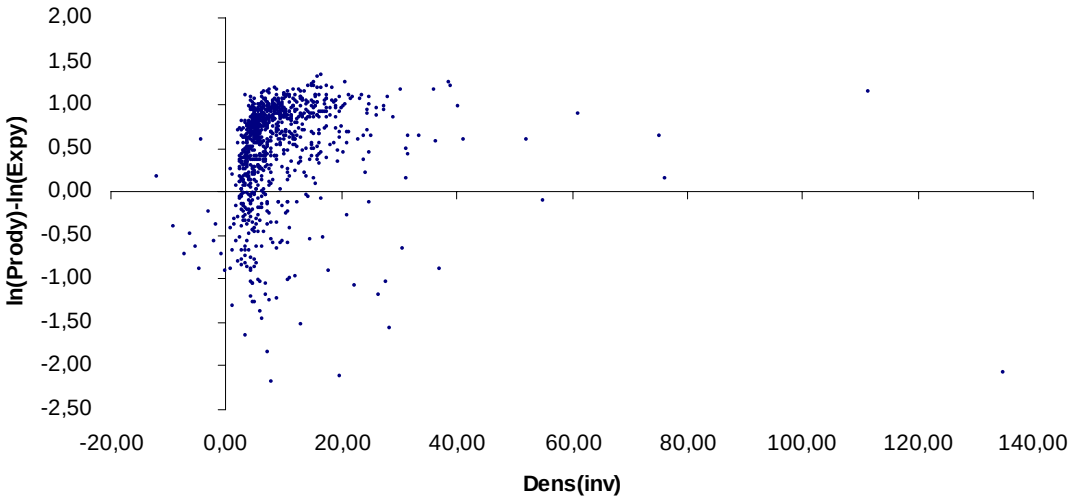
Note: Prody and Expy defined in Appendix 1; Density defined in equation (4).

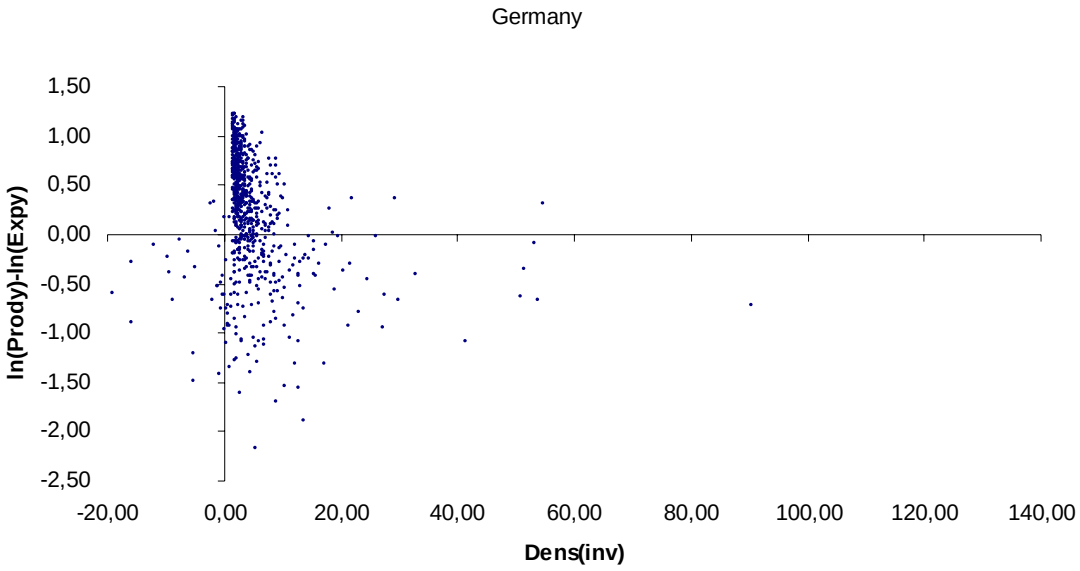


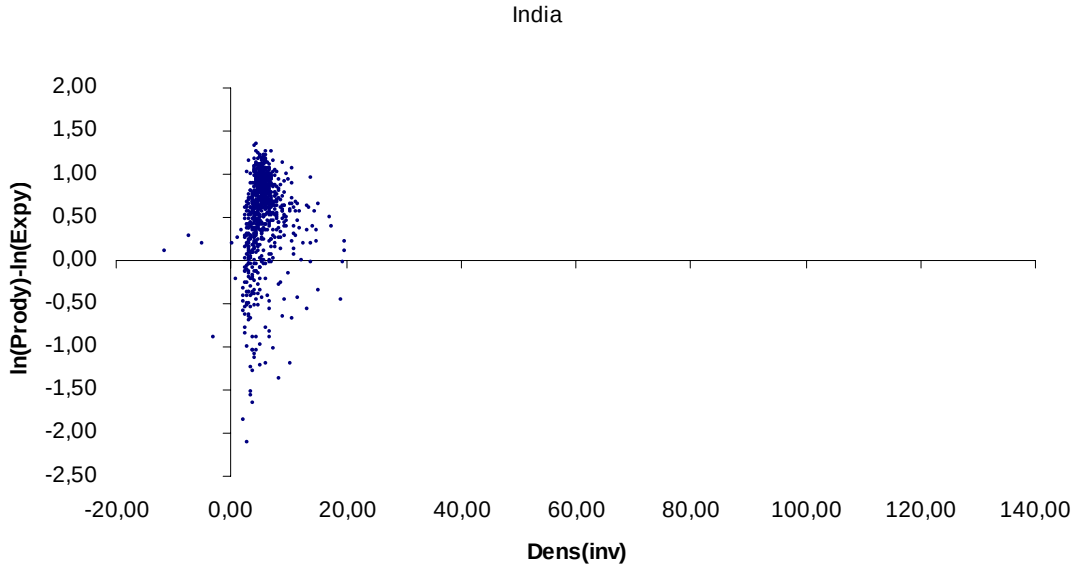
Greece



Turkey







An obvious question is which *type* of products are more related to each country current specialization pattern (that is, those closer to the origin in Figure 8). This question is addressed in Table 13 and Figure 9. For each country, we break down the number of upscale products at an inverse density up to 3, by category. The table considers only upscale products which the country already export but in which it still didn't developed RCA (i.e, products not appearing in the figure are those which the country does not export at all). The reason to focus on products which the country already exports is that it should be easier for a country to develop comparative advantages in products in which it already accumulated some productive experience.

This data reveals two types of facts. First, developed countries have a larger number of goods nearby than poorer countries. In this respect, Spain is more similar to the group of more advanced countries than Portugal. Second, the distinctive feature of the developed countries in the sample is that they reveal relatedness to new goods in the

classes of “Miscellaneous manufactured articles”, “Machinery”, “Ores and Metals”, “Chemicals”. In this respect also, Spain is closer to the group of developed countries than Portugal.

Figure 9 – Products which the country already exports but it has no RCA, at inverse densities up to 3.

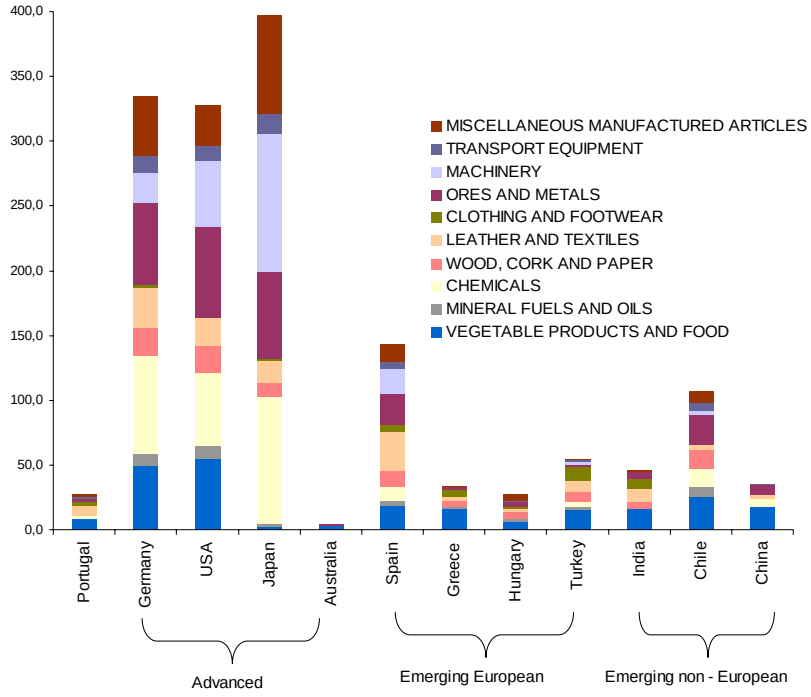


Table 13 – The efficiency frontier

		VEGETABLE PRODUCTS AND FOOD	MINERAL FUELS AND OILS	CHEMICALS	WOOD, CORK AND PAPER	LEATHER AND TEXTILES	CLOTHING AND FOOTWEAR	ORES AND METALS	MACHINERY	TRANSPORT EQUIPMENT	MISCELLANEOUS MANUFACTURED ARTICLES	Total (number)
	Portugal	**29,6**	**3,7**	**3,7**	**3,7**	**29,6**	**11,1**	**7,4**		**3,7**	**7,4**	**27**
Advanced	Germany	14,6	3,0	22,7	6,3	9,3	0,6	19,1	6,9	3,9	13,7	**335**
	USA	16,8	3,0	17,1	6,4	6,7		21,3	15,5	3,4	9,8	**328**
	Japan	0,5	0,8	24,7	2,5	4,5	0,3	16,9	27,0	3,8	19,1	**397**
	Australia	75,0						25,0				**4**
Emergind - EU	Spain	13,3	2,1	7,7	9,1	21,0	3,5	16,8	13,3	4,2	9,1	**143**
	Greece	50,0	2,9		11,8	8,8	17,6	5,9			2,9	**34**
	Hungary	22,2	7,4	3,7	18,5	11,1	3,7	11,1		3,7	18,5	**27**
	Turkey	29,1	3,6	5,5	14,5	16,4	20,0	3,6	1,8	3,6	1,8	**55**
Emerging non-EU	India	34,8		2,2	8,7	23,9	17,4	8,7			4,3	**46**
	Chile	23,4	7,5	13,1	14,0	3,7		21,5	2,8	5,6	8,4	**107**
	China	50,0		16,7		8,3		22,2		2,8		**36**

Note: Density defined in equation (4).

A different question is whether the “closest” products are with high or low PRODY value. In Table 10, we compare the cases of Portugal and Spain in this respect. For each country, the table shows the number of products appearing in Figure 8 grouped by value increment and classes of inverse density up to 5. In the Table, we see that

Spain, has more upscale under-occupied products in the neighborhood of products in which it has already developed RCA than Portugal. In particular, in the case of Portugal, only one product is available and of almost no increasing value at an inverse density lower than 2. At an inverse density up to 3, Portugal has only 27 products, with values that are at most 80% above the current country EXPY. For a similar distance, Spain has 143 products, 26 of which with values at least 80% higher than the Spanish EXPY index[9].

Table 10 – Products with high density per classes of value (frequencies)

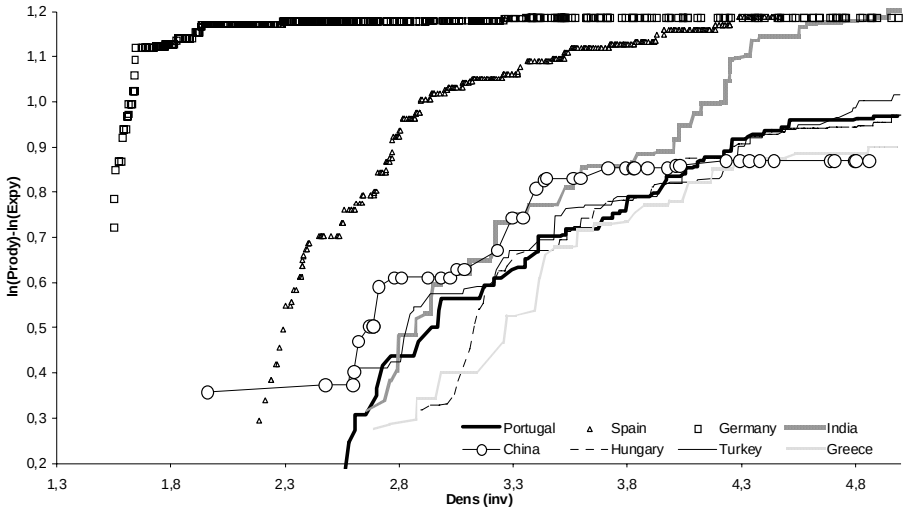
	ln(prody) - ln(expy)	Density (inv)								
		1-1.5	1.5-2	2-2.5	2.5-3	3-3.5	3.5-4	4-4.5	4.5-5	Total
Portugal	**<0.2**	1		6	5	6	7	5	6	**36**
	0.2-0.4			1	5	8	11	7	7	**39**
	0.4-0.6				5	5	23	10	8	**51**
	0.6-0.8				4	8	11	28	25	**76**
	0.8-1					1	3	12	16	**32**
	1-1.2							1	1	**2**
	1.2-1.4									**0**
	Total	**1**	**0**	**7**	**19**	**28**	**55**	**63**	**63**	**236**
Spain	**<0.2**	1	2	12	7	8	3	6	4	**43**
	0.2-0.4	1		10	20	9	14	11	5	**70**
	0.4-0.6			7	16	17	13	11	4	**68**
	0.6-0.8			13	28	22	13	14	10	**100**
	0.8-1				21	32	36	22	13	**124**
	1-1.2				5	9	17	12	8	**51**
	1.2-1.4						2	3		**5**
	Total	**2**	**2**	**42**	**97**	**97**	**98**	**79**	**44**	**461**

Note: Prody and Expy defined in Appendix 1; Density defined in equation (4).

An assessment similar to that in Table 10 is made in Figure 10, but now for more countries. The figure measures the average PRODY value of the 10 products with higher income content at an inverse density up to x, where x is the horizontal axes. In the figure, Germany appears as the country more prepared to enter new goods and among these are some with very high PRODY values. Spain appears is an intermediate case, with the 10 products allowing for low value increment, but converging rapidly to its maximum potential. The path for Portugal is very similar to that of Turkey, better than Greece and superior at small inverse densities to that of Hungary. China is an interesting case, as it exhibits a quite sparse forest (Figure 8) but it has at least 10 products nearby that are of high income, so that its upscale opportunities appear to be superior to that of Portugal. Comparing to India, China has more products nearby but because of its sparcest forest it converges to maximum potential at a slower pace.

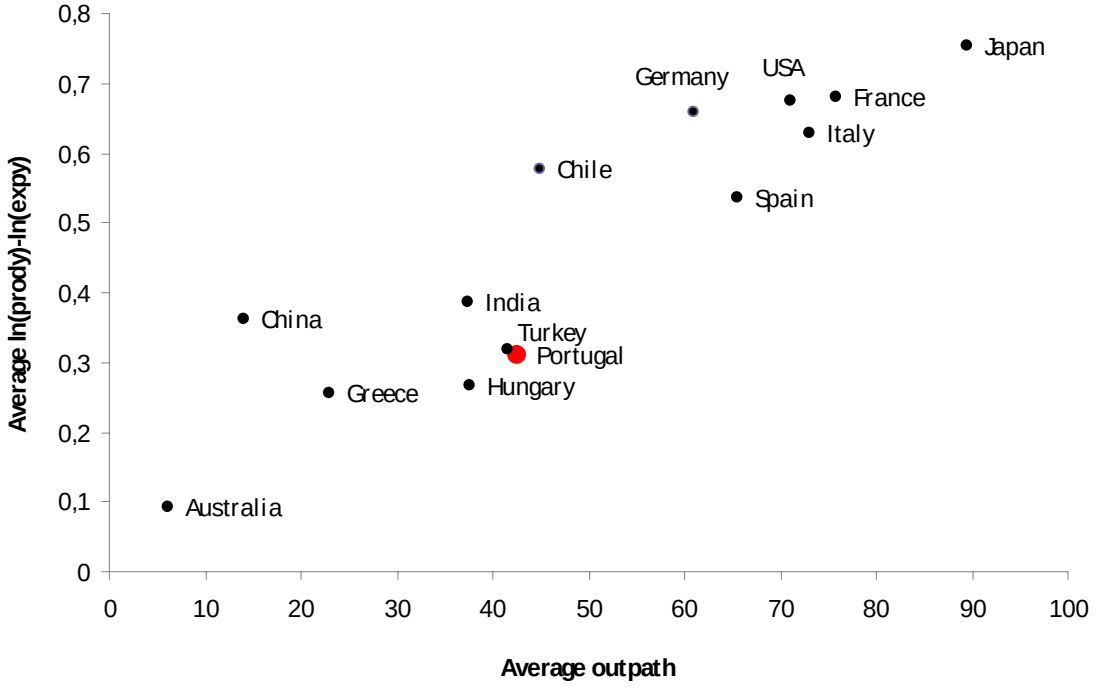
Figure 10 – Average Ln(PRODY/EXPY) of the 10 products with highest PRODY value, at an inverse density up to x, where x varies from zero to 5.

[9] In Appendix 4 we rank all countries in accordance to the number of upscale movements up to a distance of 3. For instance, Spain is in 11th position and Portugal in the 21st. Note however, that most of the movements in the case of Portugal (18 out of 27) are conducive to products of at most 40% higher than the current country EXPY. Sweden, also has 27 upscale products in its neighborhood, but most of these (17 out of 27) imply value increments higher than 60%.



As a final question, we assess how valuable are the closest products in terms of preparing a country enter (in a second round) other products. Figure 11 relates the average out-path of the under-occupied products in each country up to an inverse density of 3 to the corresponding value increment. The figure reveals that, in general, the advanced countries have more valuable products nearby, both in terms of capabilities they generate and productivity potential.

Figure 11 – Average value increments and out-paths of the under-occupied products at an inverse density up to 3.



6. Conclusions

In this paper, we build and estimate a new measure of product relatedness, to assess the extent to which the current Portuguese specialization pattern is helping or impairing the process of structural transformation.

In terms of the overall usefulness of the country productive experience (as measured by the centrality index), Portugal ranks 21rd, out of 73 countries. Investigating the upscale products more related to the country current productive experience, we find that most of them belong to the classes "Vegetable products and food" and "Leather and textiles". Comparing to other countries, we see that upscale opportunities of Portugal are more similar to those of emerging markets than to those of developed countries. In this perspective, Spain appears to be more advanced in the process of structural transformation.

In the case of Portugal, most upscale opportunities consist in products belonging to categories of intermediate value and that have being subject to increasing competition by emerging economies, thus risking loosing value in term of implied income content. Taking into account relatedness and value increment, we observe that the current specialization pattern does not favor a fast structural transformation. Spain, being more prepared to develop comparative advantages in machinery, for instance, is likely to have better opportunities than Portugal in this process.

Hidalgo et al (2007) argue that, having a specialization pattern less favorable the adoption of richer technology may impair the process of structural transformation. The difficulty in redeploying physical, human and institutional capital to the production of goods that are different from those currently under production implies that countries with similar levels of development may face different opportunities in terms of improving the sophistication level of their exports. The idea that market forces alone may not be sufficient to induce structural transformation lead is likely to be generating an industrial policy revival[10]. However, the fact that new capabilities are difficult built from nothing also holds for policy induced technological changes. This paper is silent in respect to this contention. The main message is that the Portuguese current specialization is not particularly favorable to a fast improvement in per capita income. Whether policies have a role in changing this is a different question.

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[10] Other market-failures emphasized by the authors include the free-riding of late entrants on information spillovers and on the mobility of workers trained by first movers and coordination failures arising from insufficient demand, that impairs the development of product-specific services and managerial skills (Hausmann and Rodrik, 2003, Morris and Shin, 2000).

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Appendix 1: Definitions of PRODY and EXPY

PRODY: measures the "income content" of each product, as a weighted average of per capita incomes of the countries that export it. For each product i, the PRODY index is computed as:

$$PRODY_i = \sum_{c \in C} \sigma_{ci} Y_c \text{ , where } \sigma_{ic} = \frac{RCA_{ic}}{\sum_{d \in C} RCA_{id}},\ RCA_{ic} = \frac{X_{ic}/X_c}{X_i/X},\ C = \{1,2,....,M\},$$

where Y_C is real GDP per capita in the c-th country, M is the number of countries and the the weights σ_{ci} normalize the Balassa index of Revealed Comparative Advantage (RCA) of the c-country with respect to all the countries exporting in the same sector.

EXPY: measures the "sophistication level" of a country export basket, as an weighted average of the PRODYs of the products exported by that country. The income content of a country export basket, EXPY, is computed, for each country, as:

$$EXPY_c = \sum_i s_i PRODY_i ,$$

where $s_i = \frac{X_{ic}}{X_c}$ is the share of product i in the exports of country c.

Appendix 2 – Estimating RRIs

Estimates of revealed relatedness indexes are based on trade data for 1245 products and 96 countries, using the UN – COMTRADE 2005 database. For each pair of goods, a PROBIT model is estimated, to assess whether the probability of having RCA in product *Y* is conditional on having RCA in product *X*. Formally, let *y* be a dummy variable equal to 1 if country *i* has RCA in product *Y* and 0 otherwise and *x* a dummy variable equal to 1 if country *i* has RCA in product *X* and 0 otherwise. For each possible pair of products (x,y), the following model is estimated across the 96 available observations:

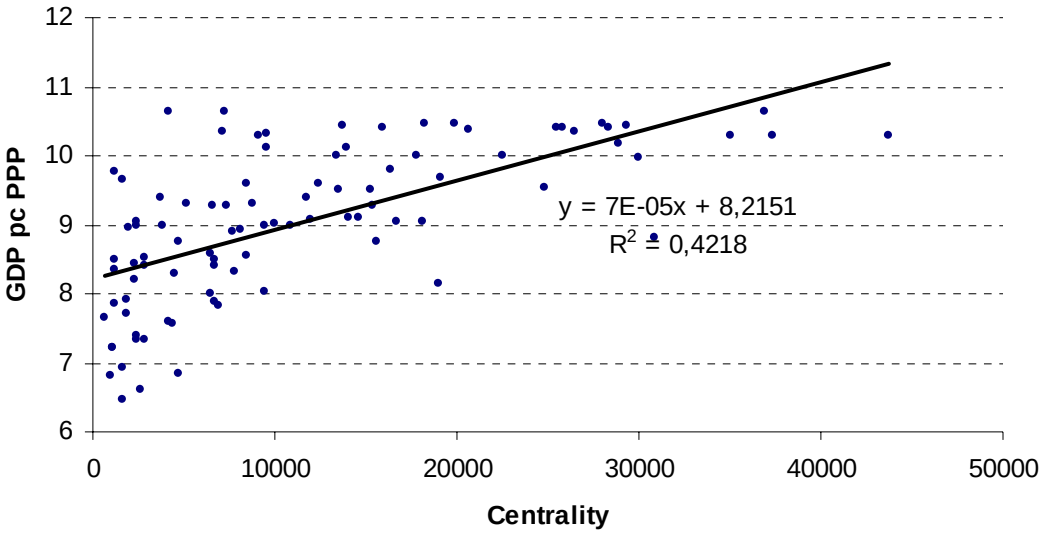
$$P(y=1|x)=G(\alpha_0+\alpha_1 x),$$

where *G*(.) is assumed to be the standard normal cumulative distribution function. The case with $\alpha_1=0$ means that the probability of having RCA in product *Y* does not depend on having RCA in product *X* (actually, when $\alpha_1=0$, the estimate $P(y=1|x)=G(\alpha_0)$ gives the percentage of countries having RCA in product *Y*). Whenever the estimated relationship is significant (that is $\hat{\alpha}_1\neq 0$), we report the marginal effect $RRI_{YX}=G(\hat{\alpha}_0+\hat{\alpha}_1)-G(\hat{\alpha}_0)$. This estimated marginal effect gives the effect on $P(y=1|x)$ of having RCA in product *X* and is our RRI index. Since we have 1245 products, there are 1245x1244 measures of revealed synergy to estimate, that form our 1245x1245 non-symmetrical matrix of RRIs.

Appendix 3 – Countries' rank in accordance to centrality

Ranking	Country	1995	2000	2005	Growth 95-05
1	Germany	43363,9	42052,1	41936,2	-3,29
2	Italy	32962,3	35018,3	36200,1	9,82
3	USA	28920,9	33505,9	35589,4	23,06
4	France	34074,4	33869,0	33466,7	-1,78
5	China	25511,2	27934,1	30185,9	18,32
6	Czech Rep.	33552,4	31297,6	29304,4	-12,66
7	Austria	30160,6	28003,7	28663,4	-4,96
8	Spain	22368,5	27552,6	27656,6	23,64
9	United Kingdom	32071,9	29392,8	27358,6	-14,70
10	Switzerland	29570,9	28477,8	26582,5	-10,11
11	Japan	24805,8	25136,6	25394,0	2,37
12	Belgium-Luxembourg	25217,5	27539,1	25317,8	0,40
13	Netherlands	22277,5	22228,6	24925,4	11,89
14	Poland	18168,4	23325,2	23657,3	30,21
15	Slovenia	22322,7	23649,0	22273,0	-0,22
16	Sweden	20055,8	20668,3	20105,2	0,25
17	Denmark	17303,5	19628,3	19195,7	10,94
18	Slovakia	18046,4	18426,0	18624,0	3,20
19	India	14064,8	18515,4	18386,7	30,73
20	China, Hong Kong SAR	18739,9	18503,4	17746,7	-5,30
21	**Portugal**	**13513,5**	**16692,9**	**17381,4**	**28,62**
22	Thailand	15696,6	15374,1	17206,4	9,62
23	Turkey	10871,5	14547,5	16298,5	49,92
24	Hungary	19506,0	16974,7	15762,4	-19,19
25	Finland	14272,3	14177,0	15260,7	6,93
26	Croatia	14000,2	13196,2	15147,7	8,20
27	Mexico	13753,5	13484,8	14619,4	6,30
28	Romania	13042,0	12120,2	14482,6	11,05
29	Estonia	14541,0	13117,4	13976,5	-3,88
30	Canada	12466,6	13844,3	13739,0	10,21
31	Greece	9439,7	12077,7	13368,1	41,61
32	Rep. of Korea	14629,5	14016,0	13028,7	-10,94
33	Latvia	11392,8	10168,8	12856,8	12,85
34	Lithuania	13315,4	11076,5	12022,2	-9,71
35	Brazil	12792,3	13331,9	11955,8	-6,54
36	So. African Customs Union	7671,1	10717,6	11622,3	51,51
37	Singapore	8238,2	8812,0	9435,0	14,53
38	New Zealand	9087,9	8712,4	9270,5	2,01
39	Israel	12039,4	9747,9	9052,8	-24,81
40	Malaysia	7803,2	8075,7	8531,5	9,33
41	Argentina	7480,7	9309,3	8371,2	11,90
42	Jordan	6914,1	14200,3	8346,5	20,72
43	Colombia	7567,6	8473,5	7801,3	3,09
44	TFYR of Macedonia	10870,1	9317,5	7608,2	-30,01
45	Guatemala	7461,4	8130,8	7549,0	1,17
46	Costa Rica	6139,2	6465,5	7135,5	16,23
47	Ireland	10989,0	7609,7	7085,8	-35,52
48	Australia	8437,1	9072,9	6835,9	-18,98
49	Rep. of Moldova	6994,0	7223,3	6436,9	-7,97
50	Honduras	2879,8	4154,6	6384,9	121,71
51	Uruguay	7131,1	7028,7	6321,2	-11,36
52	Mauritius	4185,6	4003,8	6126,4	46,37
53	Cyprus	6640,9	6770,3	5686,0	-14,38
54	Malta	4657,3	4015,1	5533,6	18,82
55	Peru	4061,3	5642,5	4710,6	15,99
56	Madagascar	2133,9	4629,1	4661,5	118,46
57	Kyrgyzstan	5976,7	5442,1	4242,5	-29,02
58	Norway	6461,4	4472,4	4140,0	-35,93
59	Chile	3945,0	5290,9	3717,4	-5,77
60	Paraguay	2603,7	2764,7	2880,2	10,62
61	Uganda	1851,1	1993,6	2776,9	50,01
62	Kazakhstan	6390,1	2733,7	2451,6	-61,63
63	Ecuador	2167,2	2174,8	2380,3	9,83
64	Nicaragua	2582,3	2775,9	2379,4	-7,86
65	Panama	3042,0	3397,3	1919,7	-36,89
66	Dominica	2122,1	1959,0	1897,3	-10,59
67	Bolivia	1789,9	2866,2	1894,4	5,84
68	Iceland	1597,6	2181,0	1844,3	15,45
69	Trinidad and Tobago	2844,5	2406,3	1825,4	-35,83
70	Saudi Arabia	2152,4	1745,3	1690,0	-21,49
71	Zambia	2343,6	4336,7	1652,6	-29,48
72	Malawi	1683,2	2138,8	1539,7	-8,53
73	Maldives	430,2	527,5	1523,2	254,08

Figure 5: Centrality versus per capita GDP in 2005



Note: Centrality defined in equation (3).

Appendix 4 – Countries' rank in accordance to the number of upscale movements up to a distance of 3 (classified by "ln(Prody)-ln(Expy)")

Ranking	Country	< 0,2	0,2 - 0,4	0,4 - 0,6	0,6 - 0,8	> 0,8	Total
1	France	25	43	43	62	130	303
2	USA	18	40	46	69	112	285
3	Germany	19	40	58	71	92	280
4	China, Hong Kong SAR	36	67	57	53	45	258
5	Italy	29	38	36	59	92	254
6	Colombia	21	33	32	56	68	210
7	United Kingdom	7	10	21	42	104	184
8	Switzerland	9	3	18	58	78	166
9	Austria	10	23	26	39	55	153
10	Czech Rep.	11	17	25	41	57	151
11	Spain	22	31	23	41	26	143
12	Japan	2	6	17	35	76	136
13	Chile	12	23	20	28	25	108
14	Netherlands	9	11	19	13	31	83
15	Belgium	9	7	13	17	31	77
16	Slovenia	4	15	15	21	14	69
17	Poland	8	14	12	22	9	65
18	Thailand	10	8	7	5	6	36
19	Slovakia	8	6	7	6	5	32
20	Turkey	12	9	3	4	1	29
21	**Portugal**	**12**	**6**	**5**	**4**	**0**	**27**
22	Sweden	2	2	6	10	7	27
23	India	5	8	5	4	1	23
24	China	11	5	1	2	2	21
25	Denmark	6	5	3	4	2	20
26	Cote d'Ivoire	8	5	3	1	1	18
27	Greece	10	2	3	2	0	17
28	Romania	3	6	5	2	0	16
29	Hungary	8	3	3	0	0	14
30	Croatia	8	1	2	2	0	13
31	Bulgaria	4	2	3	2	1	12
32	Serbia	6	1	1	4	0	12
33	Viet Nam	1	4	2	1	1	9
34	Lithuania	6	1	0	0	0	7
35	TFYR of Macedonia	3	4	0	0	0	7
36	Tunisia	3	4	0	0	0	7
37	Costa Rica	2	1	2	1	0	6
38	Latvia	3	1	1	1	0	6
39	Guatemala	0	5	0	0	0	5
40	Argentina	1	1	1	0	1	4
41	Australia	4	0	0	0	0	4
42	Honduras	1	3	0	0	0	4
43	Jordan	0	4	0	0	0	4
44	Morocco	2	2	0	0	0	4
45	Pakistan	1	2	1	0	0	4
46	Mexico	2	1	0	0	0	3
47	New Zealand	1	2	0	0	0	3
48	Singapore	0	3	0	0	0	3
49	South Africa	1	1	0	1	0	3
50	Sri Lanka	0	3	0	0	0	3
51	Syria	0	2	1	0	0	3
52	Albania	0	2	0	0	0	2
53	Iran	0	2	0	0	0	2
54	Israel	1	1	0	0	0	2
55	Peru	1	1	0	0	0	2
56	Rep. of Moldova	0	2	0	0	0	2
57	Russian Federation	0	0	1	0	1	2
58	Togo	1	1	0	0	0	2
59	United Rep. of Tanzania	2	0	0	0	0	2
60	Azerbaijan	0	1	0	0	0	1
61	Belarus	1	0	0	0	0	1
62	Benin	0	1	0	0	0	1
63	Bosnia Herzegovina	1	0	0	0	0	1
64	Brazil	0	0	0	1	0	1
65	Ecuador	0	1	0	0	0	1
66	Finland	0	0	0	1	0	1
67	Jamaica	0	1	0	0	0	1
68	Malaysia	0	0	0	0	1	1
69	Niger	0	1	0	0	0	1
70	Panama	1	0	0	0	0	1
71	Paraguay	0	1	0	0	0	1
72	Rep. of Korea	0	1	0	0	0	1
73	Uganda	0	1	0	0	0	1

Appendix 5

Table 11 – Portuguese Upscale Opportunities (up to a distance of 3) and Efficiency Frontier

Inv(dens)	ln(prody)-ln(expy)	Code	Commodity	Group
1,25	**0,17**	**2709**	**Petroleum oils, crude**	**MINERAL FUELS AND OILS**
2,20	**0,18**	**1704**	**Sugar confectionery, not containing cocoa.**	**VEGETABLE PRODUCTS AND FOOD**
2,28	**0,18**	**709**	**Other vegetables, fresh or chilled.**	**VEGETABLE PRODUCTS AND FOOD**
2,35	0,15	2007	Jams, fruit jellies, marmalades, fruit or nut pastes	VEGETABLE PRODUCTS AND FOOD
2,38	0,01	6303	Curtains (including drapes) and interior blinds; curtain or bed valances.	LEATHER AND TEXTILES
2,41	0,00	2001	Vegetables, fruit or nuts	VEGETABLE PRODUCTS AND FOOD
2,44	**0,29**	**2008**	**Fruit, nuts and other edible parts of plants**	**VEGETABLE PRODUCTS AND FOOD**
2,48	0,08	707	Cucumbers and gherkins, fresh or chilled.	VEGETABLE PRODUCTS AND FOOD
2,55	**0,44**	**809**	**Apricots, cherries, peaches (including nectarines), plums and sloes, fresh.**	**VEGETABLE PRODUCTS AND FOOD**
2,57	**0,37**	**4115**	**Composition leather with a basis of leather or leather fibre**	**LEATHER AND TEXTILES**
2,58	**0,59**	**6117**	**Other made up clothing accessories, knitted or crocheted**	**CLOTHING AND FOOTWEAR**
2,61	0,25	4407	Wood sawn or chipped lengthwise, sliced or peeled	WOOD, CORK AND PAPER
2,61	0,28	6503	Felt hats and other felt headgear, made from the hat bodies	CLOTHING AND FOOTWEAR
2,61	0,31	5209	Woven fabrics of cotton, containing 85 % or more by weight of cotton	LEATHER AND TEXTILES
2,65	0,08	2202	Waters with added sugar	VEGETABLE PRODUCTS AND FOOD
2,65	0,10	3923	Articles for the conveyance or packing of goods, of plastics	CHEMICALS
2,70	0,59	8901	Cruise ships, excursion boats, ferry-boats, cargo ships, barges and similar …	TRANSPORT EQUIPMENT
2,70	0,34	7321	Stoves, ranges, grates, cookers	ORES AND METALS
2,73	**0,69**	**6004**	**Knitted or crocheted fabrics of a width exceeding 30 cm**	**LEATHER AND TEXTILES**
2,76	0,46	4114	Chamois (including combination chamois) leather	LEATHER AND TEXTILES
2,86	0,13	5109	Yarn of wool or of fine animal hair, put up for retail sale.	LEATHER AND TEXTILES
2,89	0,60	7016	Paving blocks, slabs, bricks, squares, tiles	MISCELLANEOUS MANUFACTURED ARTICLES
2,94	0,60	4303	Articles of apparel, clothing accessories and other articles of furskin.	LEATHER AND TEXTILES
2,97	0,01	6307	Other made up articles, including dress patterns.	LEATHER AND TEXTILES
2,97	**0,67**	**7322**	**Radiators for central heating, not electrically heated, and parts thereof**	**ORES AND METALS**
2,98	0,61	9406	Prefabricated buildings.	MISCELLANEOUS MANUFACTURED ARTICLES
2,99	0,14	6113	Garments, made up of knitted or crocheted fabrics of heading	CLOTHING AND FOOTWEAR

Note: Prody and Expy defined in Appendix 1; Density defined in equation (4).