

Trade Sophistication Indicators of Development Paths

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Abstract

Motivated by the important role of trade in driving and reflecting economic transformation, we focus on the export structure of two economies, Ireland and one of its trading partners, from the perspective of the sophistication of both economies' exports i.e. the extent to which high-value products characterise each country's export profile. The Product Space method is used as the basis of our comparison of the economies of Ireland and Switzerland in terms of their sectors, activities and structural transformation of the economies. The method focuses attention on the estimated density of the Product Space as evident in patterns of revealed comparative advantage in goods exports. Heterogeneity evident in Product Space maps points to the potential for upgrading the economies' productive capacity and productive structures through increasing the sophistication of their exports. The route towards transformation of productive capacity depends on available pathways in specific Product Spaces to nearby goods of higher value. The paper, therefore, reports on export performance, trade policy and geographical concentration of exports. The Chemicals and related goods sector, as a significant export sector for both economies, is examined in more detail to investigate its further export potential. The Product Space approach is shown to allow both business practitioners and policy makers a context within which to envisage possible development pathways.

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1. Introduction

This paper compares the export structure of Ireland and Switzerland by focusing on the sophistication of both economies' exports i.e. the extent to which high-value products characterise each country's export profile. The product space method is used as the basis of comparison of the economies' structural transformation and also more specifically in terms of the Chemicals and related goods sector and activities. The product space method, which has not been applied previously in the Irish context, focuses attention on the estimated density of the product space as illustrated by patterns of revealed comparative advantage in goods exports. Thus, this paper contributes to informing industrial policy makers and firms on potential growth areas for exports at both aggregate and sectoral levels.

Section 2 of this paper provides a brief history of Irish trade focussing on the role of chemicals and related products. This is followed by a discussion on the Product Space metric in Section 3. Section 4 of this paper presents the results of the Product Space metric for the Chemicals and Related Products Sector in Ireland and compares it to that of Switzerland. Implications of the findings for Irish policy makers are then discussed.

2. Brief History of Irish Trade

Foreign trade is of particular importance for small countries, and small countries, *ceteris paribus*, tend to participate in international trade to a greater extent than large countries, in order to experience the benefits of specialisation and exchange, which can be partly achieved by large countries through internal trade (Kennedy et al. 1988). This is particularly true in the Irish case. The Republic of Ireland was established when it gained independence from Britain in 1922. During the 1920's the ratio of exports plus imports of goods and services to GNP was about 80 per cent, which at the time was high relative to other countries. The high

figure arose from the limited resources available within the economy and since Ireland had free trade for a century prior to gaining independence from Britain (Kennedy et al. 1988).

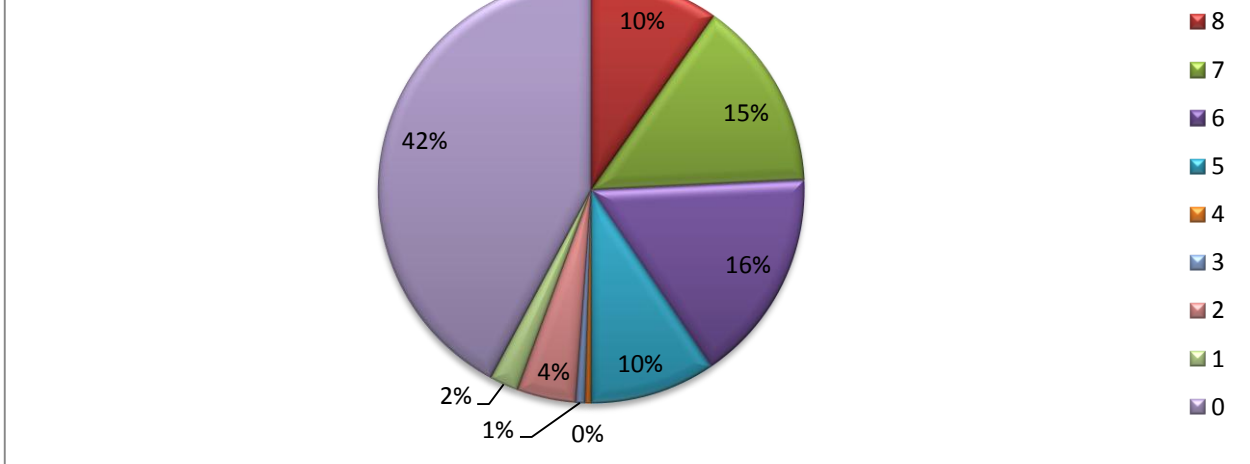
However, Fianna Fáil took over office on March 9th 1932 with a protectionist policy, which was partly motivated by nationalism, reducing economic dependence on Britain and also aimed at providing employment and reducing emigration (Kennedy et al. 1988). The Finance Act of May 1932 gave rise to the policy by imposing duties, which ranged from 15 to 75 per cent on 38 classes of goods, with specific duties on 5 other classes. In subsequent years, further duties were introduced (Kennedy et al. 1988). During the course of the 1930's the Irish economy was dominated by three factors, protectionism, the Economic War, which stemmed from a dispute from whether the Irish government or the British Government should receive land annuities collected from Irish tenant purchasers and the Great Depression; a combination of these three factors militated against trade (Kennedy et al. 1988). The volume of merchandise exports, declined by 29 per cent between 1931 and 1933 and the 1930 volume of merchandise exports was not reached again until 1960 (Kennedy et al. 1988). The volume of imports did not decline as much as the export volume, which was partly due to the need for imports of machinery for new industries as well as the fact that many of the new protected industries were involved in the assembly of goods that were formerly imported in finished form (Kennedy et al. 1988). Therefore, from 1931 to 1938, while imports of manufactured goods fell from £32.2 million to £24.1 million, imports of raw materials or simply prepared goods had risen from £13 million to £15.4 million (Kennedy et al. 1988). Ironically, despite the emphasis on self-sufficiency and protectionism the country became even more dependent on international markets for employment as well as consumption. Unsurprisingly, imports from the UK declined more than total outputs (Kennedy et al. 1988).

However, by the 1950's import-substituting industrialization and protectionism had petered out and the government instead opted for export-orientated industrialization which involved

attracting inward investment (Breathnach 1998). The 1950's marked an important transition in Ireland's economic development and there was continuous economic expansion from the late 1950's to the early 1970's, the pace of which had not been witnessed previously in Ireland for such an extended period (Kennedy et al. 1988). Total GNP almost doubled, the decline in population was halted, living standards increased, the structure of the economy was transformed and entry into the European Economic Community (EEC) in 1973 marked the final stages of the reopening of the economy (Kennedy et al. 1988). Following entry into the EEC, Ireland became less dependent on the UK market as a destination for exports and began to increase its exports to other EEC countries. The percentage shares of Irish merchandise exports to the UK had fallen from 62% in 1970 to 43% by 1980, while the percentage share of Irish merchandise exports to the rest of the EEC increased from 11% in 1970 to 32% in 1980 (Kennedy et al. 1988). The geographical shift in exports to regions with faster growth along with a compositional shift to goods with higher income elasticities boosted Irish growth, although this was masked at times by world recessions and domestic policy errors (Barry and Bradley 1997).

There was still, however, a strong reliance on agriculture in the late 1970's. Figure 1 shows Food and live animals (0) making up 42% of the Irish export share in 1976 with manufacturing (6) and machinery and transport equipment (7) making up a major share of 31% (Table 1 in Appendix 1 outlines the SITC Rev 3 classifications).

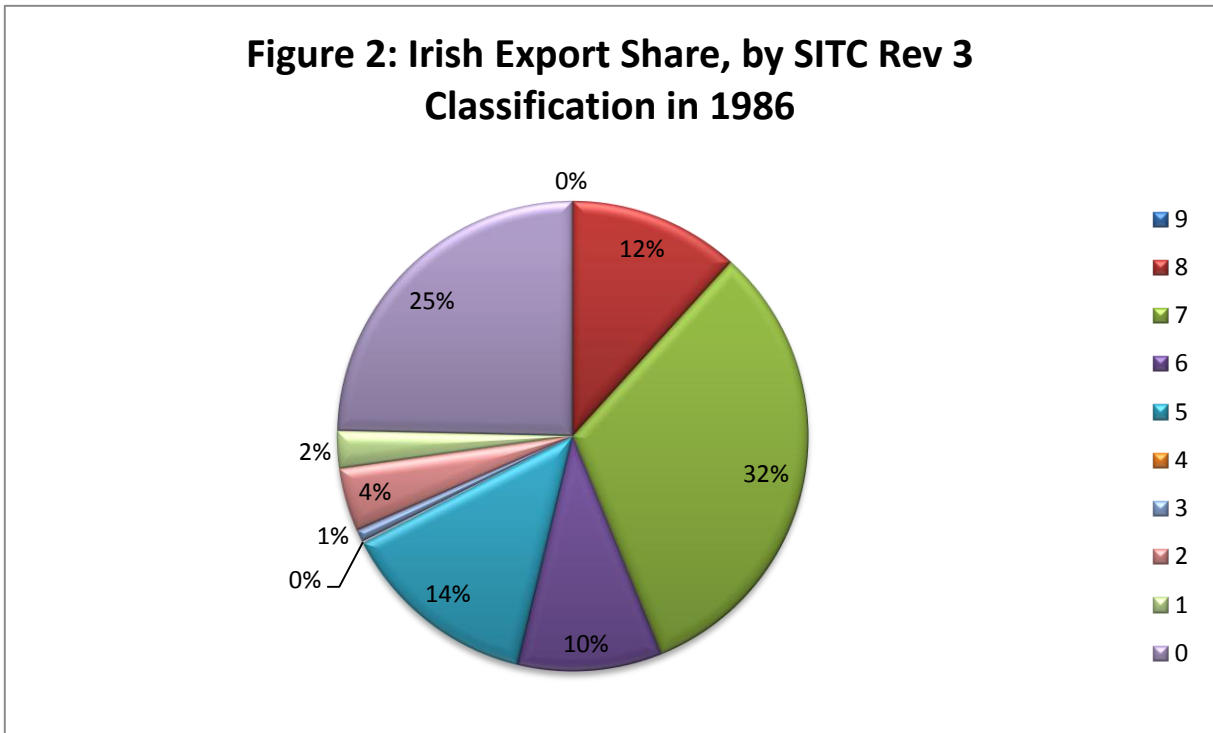
Figure 1: Irish Export Share, by SITC Rev 3 Classification in 1976



Source: Osorio-Rodarte et al. (2011)

The reorientation of Irish exports away from agriculture and toward machinery and transport equipment is shown starkly in the difference between 1976 and 1986. In ten years the share of Irish exports in Food and Live animals had fallen by 17% while machinery and transport equipment had seen a rise by the same figure (Fig 2).

Figure 2: Irish Export Share, by SITC Rev 3 Classification in 1986

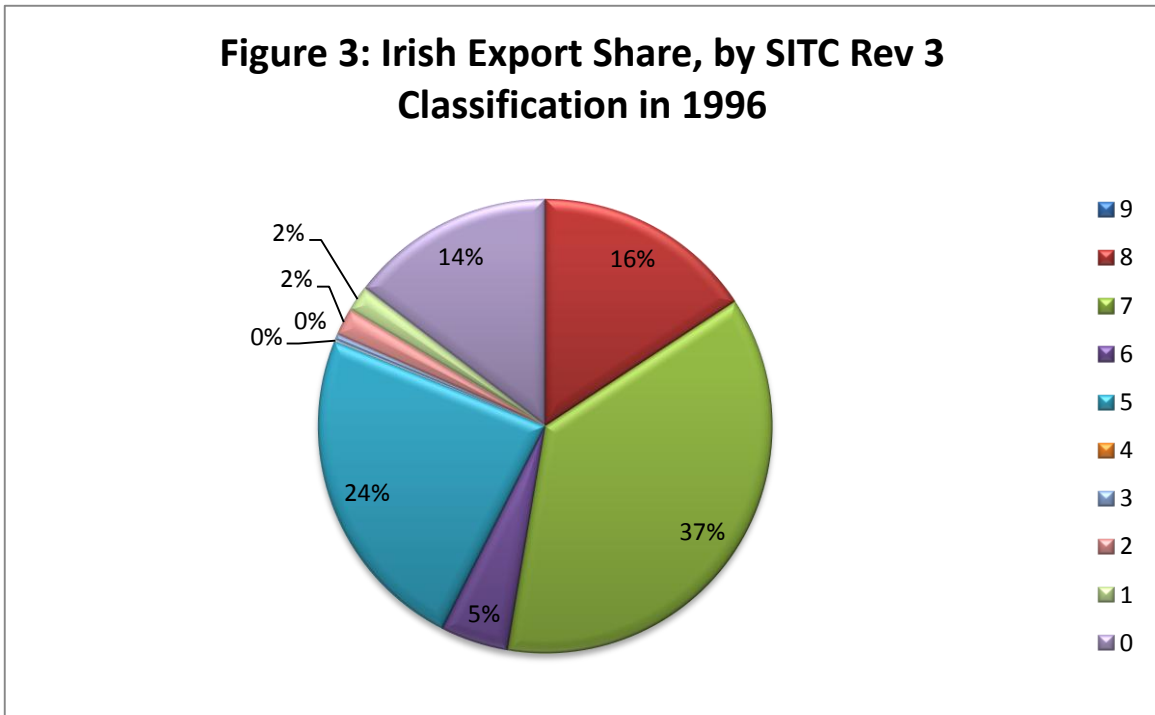


Source: Osorio-Rodarte et al. (2011)

After recession in the early 1980s, Ireland experienced a growth in employment of 26% between 1986 and 1996, compared to the EU average of 7% (Breathnach 1998). As a result of attracting Foreign Direct Investment (FDI), the Irish economy was no longer as heavily dependent upon the United Kingdom as a trading partner, particularly as a destination for exports. The geographical shift along with a compositional shift to goods with higher income elasticities boosted Irish growth (Barry and Bradley 1997).

Figure 3 shows this shift in export share exacerbated by 1996 where food and live animals had declined to 14% of exports and machinery and transport equipment had seen its share expand further to 37%. Importantly for the Irish economy, the commencement of another shift in Irish exports towards chemicals and related products had begun, as captured in Figure 3.

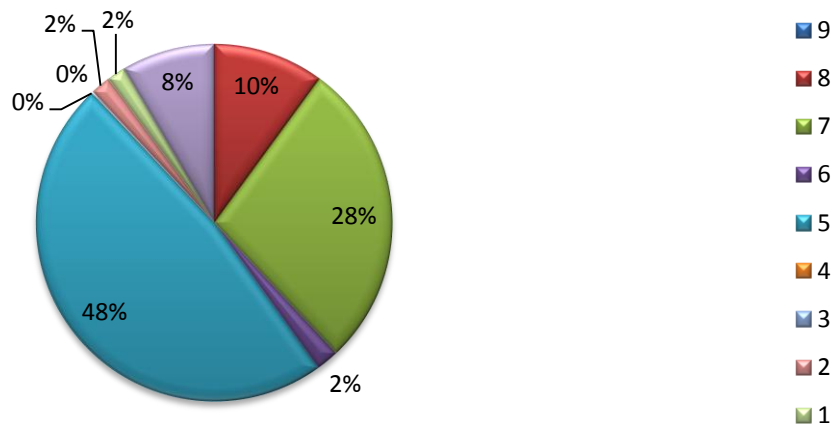
Figure 3: Irish Export Share, by SITC Rev 3 Classification in 1996



Source: Osorio-Rodarte et al. (2011)

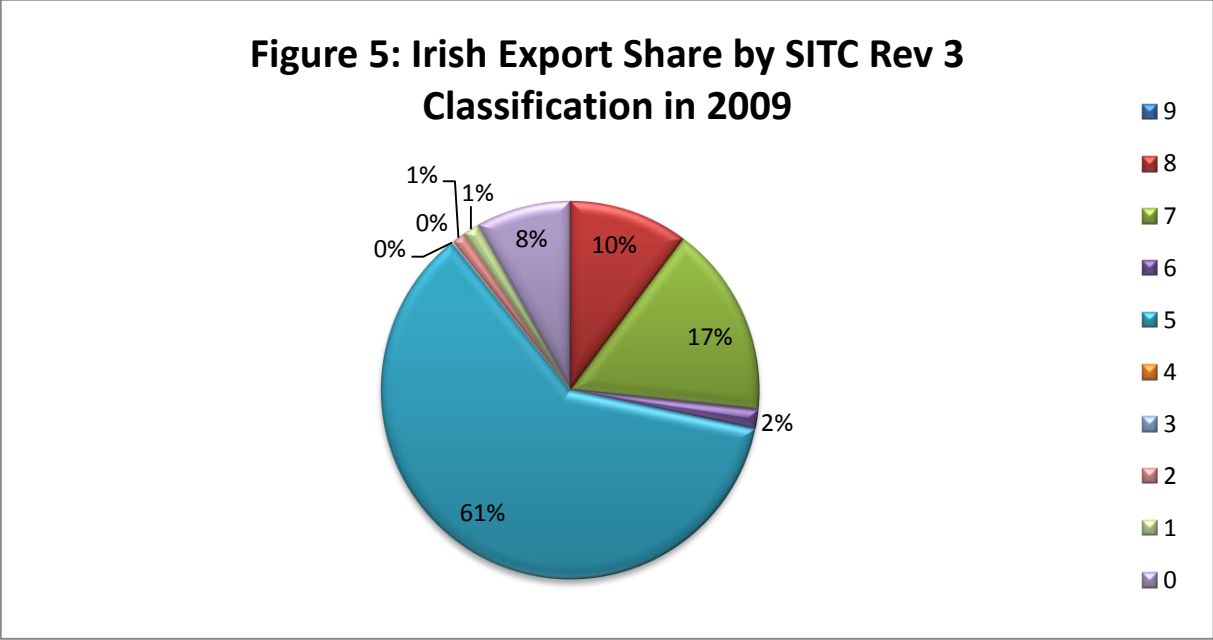
In contrast to later years, Galvin (1998) reports that there was no pharmaceutical industry in Ireland prior to the 1960s. Barry and Van Egeraat (2008) identify that the manufacturing of pharmaceuticals was too capital intensive and sophisticated for indigenous firms in an era of protectionism. Foreign owned pharmaceutical companies first began to invest towards the end of the 1950s in light of the new outward-looking economic policy (Barry and Van Egeraat 2008). By 2006, chemicals and related products accounted for 48% of the Irish export share. Figure 4 shows the decreasing role for low value agriculture and manufacturing sectors in Irish exports and an increase in higher value Chemical and chemical related products, rising from 48% of the export share in 2006 (Figure 4) to 61% of the export share by 2009 (Figure 5).

Figure 4: Irish Export Share, by SITC Rev 3 Classification in 2006



Source: Osorio-Rodarte et al. (2011)

Employment in the sector also grew substantially. When Ireland joined the Common Market in 1973 the pharmaceutical sector employed less than 2,000 people. Nowadays the sector directly employs 24,500 excluding those employed in spin-off industries (IPHA 2012). Figure 5 shows the rapid acceleration of growth in terms of export share of Chemical and related products during the late noughties, growing by 13% to make up a remarkable 61% of total Irish export share.



Source: Osorio-Rodarte et al. (2011)

3. The Product Space Metric

Learning what a country is good at producing and making appropriate investments are key to economic development (Hausmann & Rodrik 2003). Hausmann and Klinger (2007) argue that ‘proximity’ is a measure of relatedness among products which allows countries to gain new comparative advantages. Hausmann and Klinger (2007) establish that shifts in revealed comparative advantage¹ (RCA) are directly linked to this product inter-relatedness at a global level. Therefore, countries’ future trade strategies are directly linked to the products they *already* produce and the position of these goods in the global product space (Hausmann & Klinger, 2007). Hidalgo et al. (2007) illustrate this idea simply using the metaphor of the forest:

“Think of a product as a tree and the set of all products as a forest. A country is composed of a collection of firms, i.e., of monkeys that live on different trees and

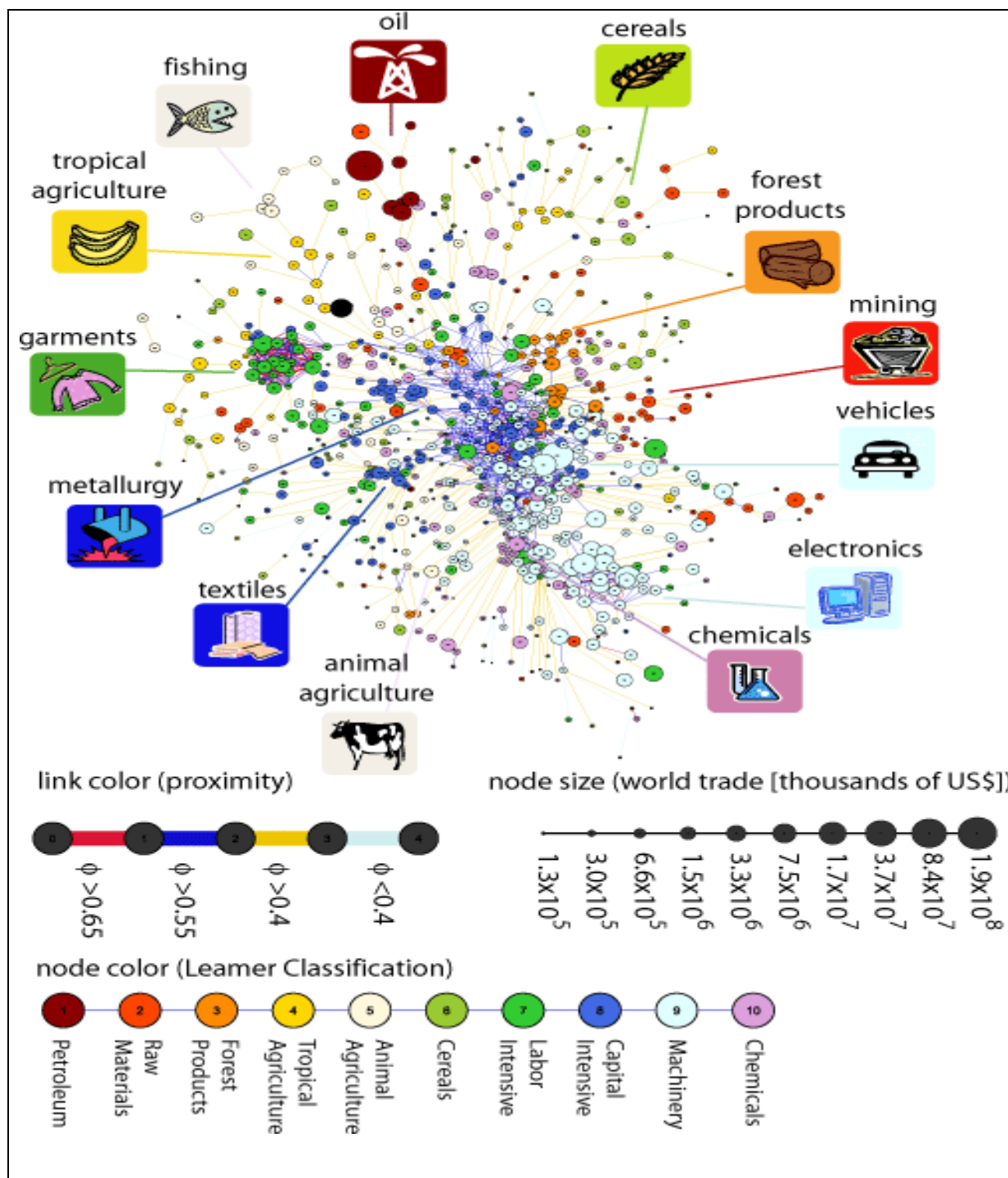
¹ Measured as a country’s share of world exports in the given product, divided by the country’s share of total world exports (Balassa, 1965).

exploit those products. The process of growth implies moving from a poorer part of the forest, where trees have little fruit, to better parts of the forest. This implies that monkeys would have to jump distances, that is, redeploy (human, physical, and institutional) capital toward goods that are different from those currently under production. Traditional growth theory assumes there is always a tree within reach; hence, the structure of this forest is unimportant. However, if this forest is heterogeneous, with some dense areas and other more-deserted ones, and if monkeys can jump only limited distances, then monkeys may be unable to move through the forest. If this is the case, the structure of this space and a country's orientation within it become of great importance to the development of countries.” (Hidalgo et al. 2007: 482)

Figure 6 is a graphical representation of the world product space (Hidalgo 2012). Product types are broken down by classification, the size of individual nodes represents world trade in that product in thousands of US\$ and Link colour between nodes represents the proximity of these products within the product space. Figure 6 illustrates the basic concept of the product space. The product space is more densely populated by smaller nodes toward the centre in products like forest products and textiles. On the other hand higher value good which may require certain factor endowments are on the edge of the product space (for example Oil, Chemicals and Electronics).²

² The product space uses the product classifications categorized in Leamer (1984) which resulted from his application of a clustering algorithm that organized into the same aggregates those products that tended to be exported by the same countries.

Figure 6: The Product Space



Source: Hidalgo (2012)

Trade theory has focused less on specialisation and more on relative factor endowments in the case of the Heckscher Ohlin model and technological differences in the Ricardian model (Hidalgo et al. 2007). Hausmann and Klinger (2007) suggest, however, that as countries develop they find a strong propensity to move to higher value goods related to those goods they already produce. Information and experience in producing one good well allows countries a greater chance of gaining a comparative advantage in related goods. In effect, this creates path dependency in terms of products a country has a high chance of developing an RCA in. Countries' specialisation in certain goods dictates their future ability to gain comparative advantage in other goods. Essentially, the product space metrics employed here recognise that related or similar products will require similar inputs in terms of skills and capital.

The implications of this for policy makers are interesting. As a country develops its firms have the capacities to utilise its human and physical capital to produce certain types of goods. For development it is possible to identify higher value goods which require similar inputs to goods already being produced by the country. Using a method similar to the World Bank (2011) Serbia Country Economic Memorandum, this product space analysis aids analysis of what products a country has strengths in producing: - Classics -, what goods it is becoming good at producing- Emerging champions- and what goods may be both related to these goods and higher up the value chain - Marginal/High PRODY.

Using measures based on panel data on global trade and GDP per capita, the product space metric can offer insights into possible priorities for industrial and export development. These

measures were constructed by the World Bank using cross-country patterns of RCA and the income (value-added) levels associated with exporters of the products in the product space.

$$RCA_{c,i,t} = \frac{xval_{c,i,t} / \sum_i xval_{c,i,t}}{\sum_c xval_{c,i,t} / \sum_i \sum_c xval_{c,i,t}} \quad (1)$$

Utilizing a stepwise approach and employing Irish and Swiss data for the period 2000 -2009 we generate recommendations on possible options for export diversification and expansion. First, on the basis of the RCA data, products are categorised into four groups according to shifts in RCA: classics, emerging champions, marginal, and disappearing. Relating RCA and products, *Classics* are products with RCA >1 in both periods 2000–2005 and 2005–09. *Emerging champions* are products with RCA >1 from 2005-09, but not earlier. *Disappearing products* had RCA>1 during the period 2000–2005, but RCA<1 by 2005-09. *Marginals* did not have RCA >=1 in either period, but have relatively high *PRODY* and *density*. *Excluded* products had an RCA < 1 in both periods as well as either low *PRODY* or low *density*.

The Product Space (PS) metrics (i.e. characteristics of density, path and PRODY) are used to identify the best prospects for export diversification. ‘Density’ is a measure of the probability of acquiring an RCA>1 in a product given the products a country currently produces. Higher ‘density’ represents the fact that a country produces products which are close to a given product. Products with a higher ‘path’ are products which are closer to the product space core i.e. those which are close to a lot of products. A higher ‘path’ implies that factors of production, skills and technology can be more easily deployed to this product from other products. A Product’s ‘path’ is measured as the extent to which countries that export product X, are likely to export other products. Finally, a higher ‘PRODY’ (a measure, proxied by

GDP per capita of countries that already export this product) suggests that a country capable of exporting this product will generate a higher income (Record and Nghardsaysone 2010)

‘PRODY’ is calculated as the ratio of the export share of product i in country j to the sum of export shares of i across all countries that export the product, weighted by country incomes:

$$PRODY_{i,t} = \sum_c \left[\frac{(xval_{c,i,t} / \sum_i xval_{c,i,t})}{\sum_c (xval_{c,i,t} / \sum_i \sum_c xval_{c,i,t})} * GDP_{percapita_{c,t}} \right] \quad (2)$$

It is important to note when interpreting Ireland’s PS metrics that there is often a ‘trade off’ between products which are high density and those with high PRODY. Higher value products have fewer products close to them and products which can be ‘reached’ easily in an industrial development sense are usually not of high value.

5. Sectoral Product Space Analysis – Chemicals and Related Products

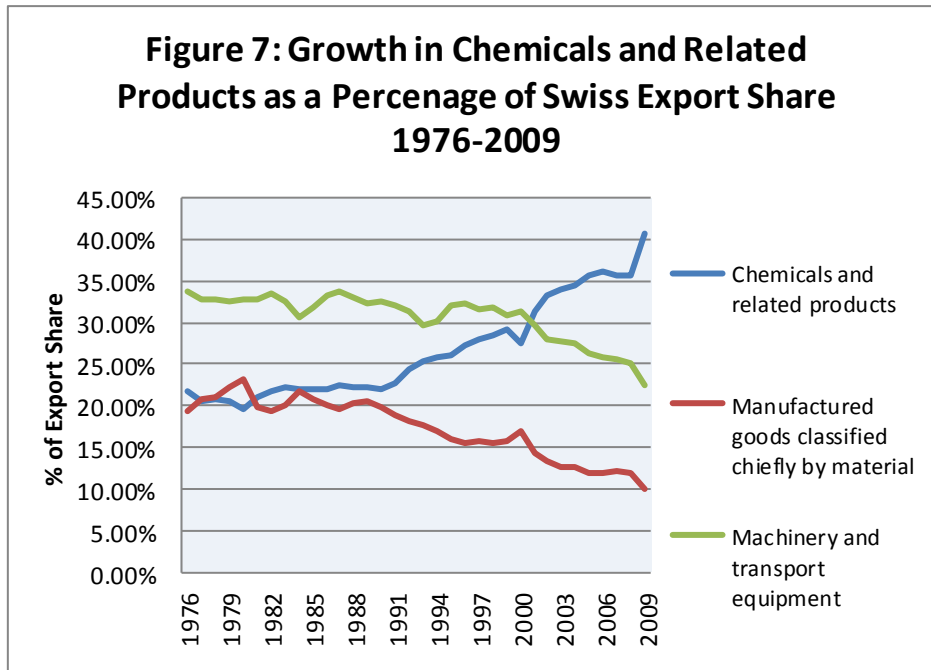
To understand opportunities for Irish export policy in the immediate future it is interesting to not only provide and overall but also a sectoral view of the Irish product space. This section provides a product space analysis of a key sector for the Irish economy namely Chemicals and related products

Barry and Van Egeraat (2008) identify the US, the UK, Switzerland and Germany as traditional pharmaceutical exporting countries. For the purposes of this study the Swiss Chemicals and Related Products product space is analyzed and compared to the Irish product space for the same category of products. Switzerland is chosen as a comparator country to Ireland for as of the four countries identified by Barry and Van Egeraat (2008) it is the most

comparable to Ireland in terms of country size and population. Similar to Ireland, the Swiss economy also boasts a low corporation tax rate. According to Ball and Bryan-Low (2010) low taxes have been beneficial to Switzerland in attracting the operations of multinational companies. The federal corporate tax rate is 8.5%, though when cantonal and municipal taxes are included this average corporate tax rate can rise to approximately 21.2%. However, this rate can vary as Swiss cantons enjoy much autonomy; for example in 2008 the canton of Schaffhausen halved its corporation tax to 16% (Ball and Bryan-Low 2010). Due to the size of the country, the population and low corporation taxes, Switzerland is the best comparator country for Ireland of the four traditional pharmaceutical exporting countries identified by Barry and van Egeraat (2008).

The pharmaceutical industry has traditionally been a pillar of the Swiss economy (Paris and Docteur 2007). Through the production of high value added products the sector has made a significant contribution to economic growth in Switzerland throughout the 1990s. 416 manufacturing firms were operating within Switzerland in 2005, producing 3.1% of pharmaceutical production worldwide (Paris and Docteur 2007).

The significance of chemical and related products industry to Swiss exports as a whole can be seen in Figure 7 which displays the growth in share of total Swiss exports of the three main export classifications in Switzerland from 1976 – 2009. It is clear from Figure 7 that chemicals and related products have become an increasingly important section of Switzerland's export basket since the early 90's and especially since 2000. There is an inflection point in the volume of Swiss exports of chemical products in 2000 resulting in a large and sustained rise in exports from this sector until 2008. This change can be attributed to the fact that EU-27 imports in pharmaceutical products from Switzerland increased by 174 % over the period from 2000 to 2009; by 2007 Switzerland had overtaken the United States as the leading import partner in this market (European Commission 2010).



Source: Osorio-Rodarte et al. (2011)

Importantly when comparing the historical view of Swiss exports in chemicals and related products with Ireland's we can see similarities in that both countries have developed much larger industries in these sectors over the years to the point where they make up significant shares of the total exports of each of the two countries today. However, it is also clear that Ireland, despite being a later developer in terms of starting to expand its chemical exports, has become more reliant on these exports than Switzerland in later years.

6. Chemicals and related products

This section presents the results of the product space analysis for the chemicals and related products sector in Ireland and Switzerland. The sectoral product spaces for these countries are then compared by product space classification with specific interest in classics, emerging and marginal products. See Appendix 1, Tables 2, 5 and 6 for a list of products in each category.

Table 3: Irish Chemicals and Related Products Product Space 2009

Product classification	Number of Products	Exports (% of Total Irish Exports)	Average PRODY	Average Path	Average Density
Classics	15	53.95%	25777.39	123.3752	0.1236123
Emerging	2	5.61%	32862.75	81.37997	0.1049897
Marginal	11	0.12%	24294.86	130.5599	0.1657793
Disappearing	2	0.26%	24961.33	95.376	0.1114791
Excluded	64	1%	16640.89	125.9256	0.119433
Total	94	60.93%	19516.7	124.4631	0.1250469

Source: Calculations Authors Own based on data from Osorio-Rodarte et al. (2011)

Table 3 presents product space data for Chemicals and Related Products (SITC REV 5 sector) in Ireland in 2009, for the sector and also by product classification within the sector. The 94 products within the Chemicals and Related Products sector accounted for a substantial 60.93% of the Irish export share in 2009 with 53.95% of this being made up by 15 classic products. Table 3 shows the average PRODY for the sector is 19516.7, with higher value goods in the classics and importantly in the emerging category.

Table 4: Swiss Chemicals and Related Products Product Space 2009

Product Classification	Number of Products	Exports (% of Total Irish Exports)	Average PRODY	Average Path	Average Density
Classics	40	38.56%	21496.12	129.8215	0.3153292
Emerging	1	0.09%	35226.88	95.95146	0.3522469
Marginal	7	0.12%	23996.51	101.7158	0.2957269
Disappearing	5	0.70%	17608.66	138.0436	0.2617588
Excluded	41	1.22%	16670.22	122.1584	0.2321354
Total	94	40.69%	19516.7	124.4631	0.2753734

Source: Calculations Authors Own based on data from Osorio-Rodarte et al. (2011)

Table 4 presents a product space analysis of the chemicals and related products sector in Switzerland. Just over 40% of total Swiss exports is comprised of chemicals and related products, which although a significant proportion of total exports is much less than Ireland's 60.93% (Table 3). Similar to Ireland, a large proportion of exports within the sector are in the form of classic products. However, it is important for our analysis to note that while Ireland has 15 classic products making up 53.95% of total exports, Switzerland has 40 separate products making up 38.56% of its total export share. This suggests a difference in the development of the Irish and Swiss chemical and related product sectors over time. While both countries have a large share of their exports coming from this sector the Irish export

basket within the sector is from a narrower section of products whereas in comparison Switzerland's export basket is relatively diverse with its classic products being made up of over 40 products.

6.1 Classics

Fifteen products, which are defined as classics, accounted for 53.95% of the total Irish export share in 2009 and 89% of the export share within the chemical and related products sector; see Table 3. The average PRODY for classics within the sector in Ireland is 25777.39. This is notably higher than the average PRODY for the total Chemicals and Related Products sector, which is 19516.7 suggesting that Ireland can generate high incomes from the classics. The average PATH and the average density are slightly below average. The Swiss export a much broader range of chemicals and related products than Ireland, with the country having 40 'classics' compared to Ireland's 15. These classics are the greatest contributor to exports within the Chemicals and Related Industries Sector, accounting for 38.65% of the total Swiss export share in 2009; see Table 4. Although Switzerland has more classics than Ireland, the average PRODY is much lower than the Irish PRODY for classics. This suggests a trade off between the degree of diversification of products and the average PRODY. The Swiss average PATH, is however, greater than Ireland's suggesting that Switzerland is more capable of producing new products related to its classics more easily.

Table 7 shows the classics for Ireland and Switzerland with the highest total export share. 47.5% of the total Irish Export Share in 2009 was comprised of five classics, within the Chemicals and Related Products Sector. Medicaments (including veterinary) accounted for 21.79% of the Irish Export Share in 2009, heterocyclic compounds, nuclei acid accounted for 13.94% of exports. Mixtures of two or more odoriferous substances accounted for 6.42% of

total Irish Export share in 2009 while Chemical products and preparations made up 4.07% of the total Irish export share, followed by Sulphonamides, sultones and sultams at 1.28%. These products also have high PRODY's implying that they are produced by high income economies.

Table 7: Classics for Ireland and Switzerland with the highest total export share

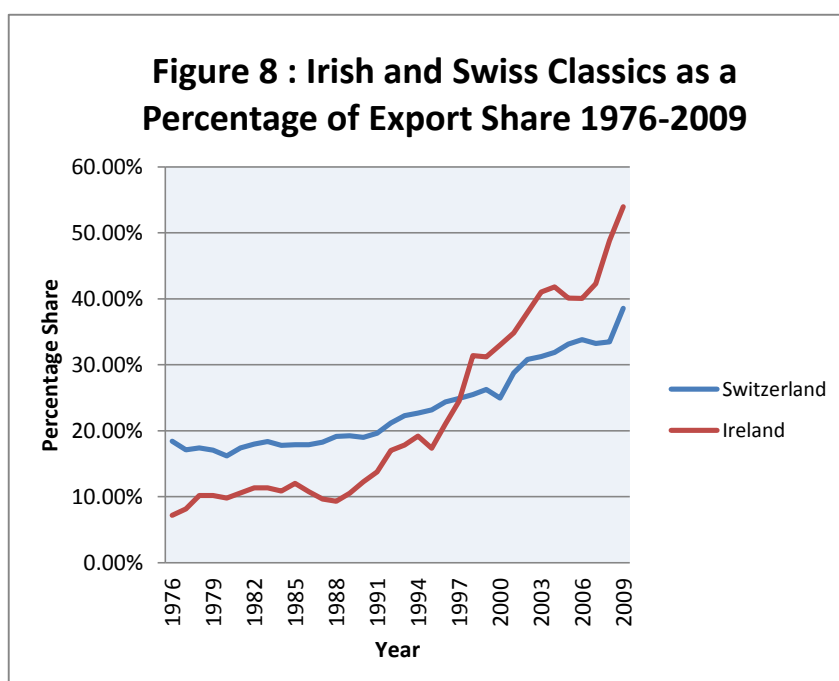
Product	PRODY	Export Share
<u>Ireland</u>		
Medicaments(including veterinary)	24806.03	21.79%
Heterocyclic compounds;nucleic acid	29865.62	13.94%
Mixtures of two or more odoriferous substances	16914.75	6.42%
Chemical products and preparations, n.e.s	23592.38	4.07%
Sulphonamides,sultones and sultams	34631.59	1.28%
<u>Switzerland</u>		
Medicaments(including veterinary)	24806.03	15.81%
Glycosides;glands or other organs	30935	8.72%
Other nitrogen-function compounds	30822.41	2.45%
Heterocyclic compounds;nucleic acid	29865.62	1.63%
Carboxyamide-function compounds	29459.49	1.45%

Source: Calculations Authors Own based on data from Osorio-Rodarte et al. (2011)

Similar to Ireland, Medicaments (including veterinary) also account for the Irish percentage of total Swiss exports within the classics at 15.81%. This is followed by Glycosides; glands

or other organs at 8.72%. The third, fourth and fifth greatest contributors to the Swiss export share are other nitrogen-function compounds, heterocyclic compounds; nucleic acid and carboxamide-function compounds.

Figure 8 shows Irish and Swiss classics as of the year 2009 as a percentage of their country's export share over time.



Source: Osorio-Rodarte et al. (2011)

Figure 8 shows that Ireland's export share is dominated by classics in the chemical and related products sector has increased over time. From 1996, an inflection can be observed in the share of Ireland's export share accounted for by what were its classics in 2009. This is indicative of a growing importance of a these classics to Irish exports over time. This added

to the fact that Ireland's classics come from a narrow base of good types means that Ireland's total exports are heavily reliant on a small base of goods from the chemical and other products sector. Switzerland is less reliant on these classics by comparison despite the industry constituting a significant share of total Swiss exports. The Swiss experience further differs from the Irish one in that Swiss classics are spread over a much broader range of goods. While it could be suggested that there are efficiencies and comparative advantage to be gained from the specialised manner in which Ireland's chemicals and related products sector has developed, this specialisation could also be seen as a potential weakness given that Ireland's export sector is heavily driven by multinationals and that multinationals in this sector may be facing extreme challenges with patent losses and competition from generic drug manufacturers. Van Egeraat in Mullen (2012) estimates that as much as 19 billion euros of Irish exports might be at risk from this patent cliff.

6.2 Emerging champions

5.61% of Ireland's export share in 2009 was comprised of two emerging products within the sector; hormones, natural or reproduced and other nitrogen-function compounds. The two emerging products accounted for 9% of the total export share within the Chemicals and Related Products sector; see figure 9. The average PRODY for emerging products, is much higher than the average PRODY for the total Chemicals and Related Products Sector, at 32862.75; see table 3. The high PRODY suggests that Ireland can generate a high income from the production of these products. The average PATH for emerging products, at 81.38, is lower than the average path for the sector meaning Ireland is diversifying into high value products which are further away from the product space core.

Switzerland has one emerging product within the sector, organo-sulphur compounds. Similarly to Ireland this emerging category of products has a high average PRODY, relative to the other categories of products. Interestingly, the average PATH for this category is the

lowest in the sector for both countries; suggesting that products within these categories are further from the product space core than all other categories of products.

6.3 Marginal

Marginal products have the highest average PATH, implying that they are closer to the product space core than each of the other categories within the sector. Importantly, the average PRODY for marginal goods is also greater than the average PRODY for the sector or the average PRODY for classics in Ireland and Switzerland. However, the 11 marginal products accounted for just 0.12% of Irelands total export share in 2009, the lowest percentage of each of the categories within the sector. This would suggest there are high value products which Ireland should have the competencies to produce but are currently not producing on any great scale. Seven products fall into the marginal category, which make up 0.12% of Swiss exports. With the average PRODY for the category being much higher than the average PRODY for the sector, or indeed classics. The results of the product space analysis suggest that both Ireland and Switzerland are not producing a number of good which are higher value than the goods they currently produce and which both countries have the competencies to produce.

6.4 Disappearing

Two disappearing products, salts of metallic acids etc. and carboxyamide-function compounds; amide-function compounds of carbonic acid (excluding urea) accounted for 0.26% of Irelands total export share in 2009. While the average PRODY, at 24961.33, is above average for the sector the average PATH is lower, suggesting that these products are further from the product space core. The average DENSITY is also lower than the sectoral

average at 0.1114791. Switzerland has 5 disappearing products making up 0.70% of total exports. With an average PRODY of 17608.66 these products are lower than average value.

7. Conclusions

This paper uses the product space method as the basis of comparison of the chemicals and related products sectors in Ireland and Switzerland. The product space method, which has not been applied previously in the Irish or sector specific contexts, focuses attention on potential growth areas for Irish industry through patterns of revealed comparative advantage in goods exports.

The use in this paper of the product space method has resulted in some interesting findings. It is clear the Chemicals and related products sector in both Ireland and Switzerland has seen tremendous growth in the past decade and indeed over a longer sustained period. It is fair to say industrial policy and business development in both countries has led to a situation where chemicals and related products is now the primary export sector in both economics both in terms of share and in value. Our use of the product space method, however, shows that this development over time has followed two very different routes within the sectors themselves. Ireland, for example, has developed a sector characterised by specialisation in a small number of very high value goods.

In the Irish chemicals and related products sector 15 classic products make up 53.95% of total Irish exports in 2009, whereas in Switzerland a more diversified sector is in evidence where 40 classic products make up 38.56% of total exports. Even more illustrative of the degree of Ireland's specialisation is that medicaments constitute over a fifth of its total exports in 2009. With patents in many medicaments products ending over the next decade, this leaves Irish exports in a potentially precarious position. On a more positive note, however, we see Ireland

has 11 high value marginal products which it could produce based on their place within the overall product space. These potential growth areas for Irish industry can be seen in Appendix 1.

The results of this paper show the product space as a useful tool for both industry and policy makers in mapping potential development paths for an economy both at an aggregate and, novel to this paper, at a sectoral level. It is however important to exercise caution before advocating this method as a way for policy makers or indeed industry to ‘pick winners’. This paper shows the product space method as a very useful tool in understanding the development of countries exports aggregately and sectorally. It is also shown to be a useful tool in developing a snapshot of sectors and countries export baskets at any particular time. It must be noted however that the measures used in this method are based in current values. The product space does not account for future tastes, changes in the value of goods in the future, goods which may be new to market or indeed goods which may be rendered obsolete. The product space is interesting in observing and understanding Schumpeterian creative destruction and sectoral change in exports over time, however, the method is not an estimator of future change. It is therefore necessary industry and policymakers exercise caution when interpreting results from this paper as indicators of future exports rather than as a indicator of potential future development paths.

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Appendix 1.

Table 1: Standard International Trade Classification, REV 3

- 0 Food and live animals
- 1 Beverages and tobacco
- 2 Crude materials, inedible, except fuels
- 3 Mineral fuels, lubricants and related materials
- 4 Animal and vegetable oils, fats and waxes
- 5 Chemicals and related products
- 6 Manufactured goods classified chiefly by material
- 7 Machinery and transport equipment
- 8 Miscellaneous manufactured articles
- 9 Commodities and transactions not classified elsewhere in the SITC

Source: United Nations (2012)

Table 2: PRODY values for Chemicals and Related Products in Ireland by Product Classification

CLASSICS	PRODY
Sulphonamides,sultones and sultams	34631.59
Single or complex oxygen-function a	31801.81
Glycosides; glands or other organs &	30935
Heterocyclic compounds; nucleic acid	29865.62
Other organo-inorganic compounds	28572.58
Amine-function compounds	28168.94
Antibiotics n.e.s., not incl. in 541	27215.26
Carboxylic acids with alcohol, pheno	25746
Other chemical derivatives of cellu	25125.07
Medicaments (including veterinary me	24806.03
Chemical products and preparations,	23592.38
Pharmaceutical goods,other than med	21929.9
Albuminoidal substances; glues	20672.05
Mixtures of two or more odoriferous	16914.75
Perfumery, cosmetics and toilet prep	16683.87
EMERGING CHAMPIONS	
Hormones, natural or reproduced by synthesis	34903.09
Other nitrogen-function compounds	30822.41
MARGINAL	
Organo-sulphur compounds	35226.88
Ethers,alcohol peroxides,ether pero	30208.17
Epoxide resins	25639.33
Alkyds and other polyesters	23100.15
Inorganic esters,their salts,& thei	22909.76
Aldehyde-,ketone-,& quinone-functio	22812.29
Halogen and sulphur compounds of no	22597.23
Aminoplasts	22163.58
Phenoplasts	21182.81
Polyurethanes	21026.69
Oth.inorg.bases & metallic oxid.,hy	20376.61
DISAPPEARING	
Carboxamide-function compounds;& o	29459.49
Salts of metallic acids; etc.	20463.18

Source: Osorio-Rodarte et al. (2011)

Table 5 : PRODY values for Classics in the Chemicals and Related Products in Switzerland by Product Classification

CLASSICS	PRODY
Hormones,natural or reproduced by s	34903.09
Sulphonamides,sultones and sultams	34631.59
Single or complex oxygen-function a	31801.81
Glycosides;glands or other organs &	30935
Other nitrogen-function compounds	30822.41
Heterocyclic compounds;nucleic acid	29865.62
Carboxamide-function compounds;& o	29459.49
Amine-function compounds	28168.94
Printing ink	27288.4
Antibiotics n.e.s.,not incl. in 541	27215.26
Carboxylic acids with alcohol,pheno	25746
Epoxide resins	25639.33
Medicaments(including veterinary me	24806.03
Provitamins & vitamins,narural/repr	23841.01
Vegetab.alkaloids,natural/reproduce	23297.51
Inorganic esters,their salts,& thei	22909.76
Aldehyde-,ketone-,& quinone-functio	22812.29
Polyamides	22605.68
Pharmaceutical goods,other than med	21929.9
Phenoplasts	21182.81
Polyurethanes	21026.69
Albuminoidal substances;glues	20672.05
Salts of metallic acids; etc.	20463.18
Colour.preptns of a kind used in ce	19887.56
Phenols & phen.-alco.& their haloge	19490.02
Synthetic organic dyestuffs	17991.55
Polyvinyl acetate	17475.83
Weed killers (herbicides)packed for	17092.04
Mixtures of two or more odoriferous	16914.75
Perfumery,cosmetics and toilet prep	16683.87
Fungicides packed for sale etc.	16025.05
Synth.organic luminophores;optic.bl	15452.21
Varnishes and lacquers;distempers,w	15385.79
Disinfect.,anti-sprouting prod.etc.	15356.12
Cyclic.alcohols & their halogenated	14629.82
Safety fuses,detonating fus.;percus	14254.45
Cellulose nitrates	13160.11
Insecticides packed for sale etc.	12989.63
Propellent powders and other prepar	12332.14
Essential oils,concretes & absolute	2700.05

Source: Osorio-Rodarte et al. (2011)

Table 6 : PRODY values for Emerging Champions, Marginals and Disappearing Products in the Chemicals and Related Products in Switzerland by Product Classification

EMERGING CHAMPIONS	PRODY
Organo-sulphur compounds	35226.88
MARGINALS	
Natural resins modified by fusion;a	32913.16
Ethers,alcohol peroxides,ether pero	30208.17
Other organo-inorganic compounds	28572.58
Anti-knock preparations,oxidation i	28045.45
Other chemical derivatives of cellu	25125.07
Halogenated derivatives of hydrocar	24729.24
Regenerated cellulose	23347.68
Other colouring matter,inorganic pr	23242.76
Silicones	23127.42
Ion exchangers of polymerization/co	23041.99
Halogen and sulphur compounds of no	22597.23
Acrylic polymers,metacrylic polymer	22534.15
Other polymerization and copolimeri	22240.63
Aminoplasts	22163.58
Other condensation,polycondensation	21917.73
Monocarboxylic acids & their anhydr	21546.9
Cyclic hydrocarbons	21112.93
Cellulose acetates	19961.53
Other artificial plastic materials,	17908.82
DISAPPEARING	
Chemical products and preparations,	23592.38
Organic chemical products,n.e.s.	21978.71
Organic chemicals,n.e.s	16887.02
Polishes & creams,for footwear,furn	14052.63
Sulphon.nitrat./nitrosat.derivativ.	11532.57

Source: Osorio-Rodarte et al. (2011)

Appendix 2: The Product Space Metric – Ireland

Table 8 provides the results of the Product Space analysis for all products in Ireland in 2009.

Table 8: Irish Product Space for all Products Exported; 2009

Product classification	Number of Products	Exports (percent of total)	Average PRODY	Average Path	Density
Classics	55	77.7	19719.65	126.3746	.1523158
Emerging	13	6.7	17677.5	126.8113	.1542404
Marginal	398	5.5	14326.27	121.0489	.094442
Disappearing	16	4.2	17763.78	112.4246	.1133161
Excluded	292	5.9	15908.62	120.5998	.1187242

Source: Calculations Authors Own based on data from Osorio-Rodarte et al. (2011)