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Structural Change Deconstructed: A Centre-Periphery Divide in Europe

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Abstract: After more than a decade since the outbreak of the financial crisis, overall economic growth in the Eurozone is still disappointing. An increasing group of economists attributes the inadequate economic performance to large and deeply engrained differences between the productive structures of the Northern and Southern Eurozone. To find out whether there is reason to believe this, we apply the Economic Complexity Index to a variety of European countries and map their structural differences over time. The Economic Complexity Index is usually recognized by the disadvantage that it can only explain us something about the structural change of the production of goods in an economy. Given the particularly high importance of trade in services in the Eurozone, this is a considerable disadvantage. Hence, we construct a new trade database that contains data for both goods and services. This allows us to derive a truly representative measurement of the productive structure complexity of the European countries. We conclude that there are indeed large and increasing structural differences between the Southern and the Northern Eurozone.

Key words: Centre-Periphery Eurozone, Structural Asymmetries, Services Economic Complexity Index

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List of Abbreviations

RCA:	Revealed Comparative Advantage
ECI:	Economic Complexity Index
PSM:	Product Similarity Matrix
EU:	European Union
NC:	Northern-Centre
SP:	Southern-Periphery
GC:	German-Core
AUT:	Austria
BEL:	Belgium
CHE:	Switzerland
CHN:	China
CZE:	Czech Republic
DEU:	Germany
ESP:	Spain
FRA:	France
GBR:	Great Britain
GRC:	Greece
HUN:	Hungary
IRL:	Ireland
ITA:	Italy
NLD:	The Netherlands
NOR:	Norway
POL:	Poland
PRT:	Portugal
ROU:	Romania
SVK:	Slovakia
SWE:	Sweden

1.0 Introduction

After more than a decade we can unambiguously state that the financial crisis has had a profound impact on Europe. Many countries around the globe were harshly affected by the crisis, but Europe developed a particularly virulent variant and was hit by a so called 'double dip'. The debt-laden Southern European countries were forced to adjust wages and implement austerity programs. This resulted in high unemployment rates, social unrest and a lot of human suffering. Anno 2019 growth returned and particular countries such as The Netherlands (2,9%) and Ireland (7%) grew quite impressively in 2017. Yet, this is not the case for the entire Eurozone. Greece showed a small growth rate of about 1,5% in 2017 and the year before the Greek economy still contracted. Italy's growth figures have also been quite unimpressive with just 1,5% in 2017 (World Bank, 2018). Could there be something fundamentally wrong with the way the Eurozone is structured?

For years a group of economists have been warning that the real reason for the severity of the crisis is not spend-thrifty Southern governments or the too high wages in the Southern Eurozone, but the lack of well diversified productive structures (Botta, 2014; Celi et al., 2018; Cirillo & Guarascio, 2015; Ginzburg & Simonazzi, 2017; Simonazzi, Ginzburg & Nocella, 2013). Moreover, these economists argue that the structural reforms that the Southern eurozone economies were forced to implement have only worsened the productive structures of the Southern countries making it much harder for them to recover. The asymmetries between the productive capabilities of Northern Eurozone and the Southern Eurozone are said to have been allowed to exist and increase, to the extent that we can now speak of an hierarchical relationship between the well-developed economies of the 'Northern European Centre' and the sluggish economies of the 'Southern European periphery'. The conundrum in question is whether it is really true that such large and deeply engrained asymmetries in productive structures exist

In a previous paper, an attempt was made to answer this question by the application of an innovative indicator: The Economic Complexity Index (Melles, 2018). This indicator is seemingly ideal to analyse this phenomenon. The Economic Complexity Index (ECI) applies a novel technique, derived from network analysis, to quantify the sophistication of a country's productive structure without having to use human judgement when deciding which product or sector is sophisticated and which is not. Through this technique, a robust relationship between a country's productive sophistication and its income has been established (Hidalgo et al., 2017; Hidalgo & Hausmann, 2009; Ricardo et al., 2011a).

The results of the paper applying this indicator to the phenomenon were both detailed and clear: the purported deeply engrained asymmetries in productive structures exist. Moreover, they have an historical origin and have been allowed to exist for decades. Although these results were straight forward and clear, there was also a considerable shortcoming of the technique: data for trade in services

was not available and therefore it could only express the sophistication of the productive goods-structure. Of course, one can try to argue that this is of minor importance for the analysis of structural asymmetries. However, a quick look at the ratio of trade in services to trade in goods reveals that this is not true, especially for the analysis of this phenomenon. According to own elaborations on trade data, the average ratio of trade in services to trade in goods was about 30% in the European Union from 2000 to 2014. Moreover, some Southern economies have been recognized far above average ratios, such as Greece with 63%. Could it be that the previous analysis missed such a large part of the story and therefore is irrelevant?

To find this out and serve the purpose of furthering our knowledge about differences in productive structures in the Eurozone, a balanced and unique database of both goods and services has been compiled and used in the application of the ECI. This could be considered as a major contribution the literature on productive structure asymmetries in the Eurozone and to the literature on the Economic Complexity Index. Through the application the ECI method to our unique goods & services dataset, we endeavour to answer the following research question: *Can we find evidence for the alleged large and deeply engrained structural asymmetries between the Northern-Centre and the Southern-Periphery?*

The paper is structured as follows; we start with a review of the literature and the research gap. In chapter 3, the theory behind the ECI and related indicators is provided. In chapter 4, an account of the used data and the process of compiling the dataset is given. Chapter 5 elaborates on the mathematical framework behind the methodology and in chapter 6 the results are presented and explained. Lastly, we reflect on our research question and other findings in the conclusion.

2.0 Literature Review

2.1 Previous research

The European debt crisis has frequently been interpreted as a standard balance of payments crisis. Southern peripheral countries had borrowed heavily to spend on imports and the non-tradeable sectors. This borrowed capital inflated wages and was not allocated efficiently into industries that would enhance national competitiveness. Once the financial crisis broke out, originating in the United States, capital soon started to flow away from the Southern European countries leaving banks with difficulties servicing their debt. Not having a pan-European fiscal authority, sovereign governments had to bail the 'too big to fail' banks out, causing the private debt crisis to turn into a sovereign debt crisis (Botta, 2014; Celi et al., 2018; De Grauwe, 2013; Ginzburg & Simonazzi, 2017; Simonazzi, Ginzburg & Nocella, 2013). Lacking the option of nominal exchange rate devaluation in order to restore competitiveness, two alternative remedies have been put forward. One of them is that Germany ought to increase demand, thus creating growth possibilities for the Southern Eurozone countries. Alternatively, it is suggested that the Southern Eurozone countries ought to embark on austerity programs and internal devaluation in the form of wage deflation. The lower wages in the Southern Periphery would then attract investment and reboot productivity. It is in fact the latter of the two that has been implemented (Ginzburg & Simonazzi, 2017; Simonazzi, Ginzburg & Nocella, 2013).

An increasingly large number of scholars, however, disagree with this point of view and see these developments in a long-term centre-periphery perspective. They point out that the European economic landscape has, historically speaking, always been recognized by large asymmetries in productive structures between the 'Northern Centre' and the 'Southern Periphery' (Botta, 2014; Celi et al., 2018; Dias, Robalo Marques & Richmond, 2016; Gambarotto, Rangone & Solari, 2019; Gambarotto & Solari, 2015; Ginzburg & Simonazzi, 2017; Simonazzi, Ginzburg & Nocella, 2013). The countries of the Southern Periphery (SP), that is Italy, Spain, Portugal and Greece, were relatively late in their post–World War II development. Hence, the Southern Periphery has allegedly always had less well-diversified productive structures and it has been specialized in the production of less technology-intensive products. According to these scholars, the reason behind the severity of the Eurozone crisis lies in these structural asymmetry differences, meaning that countries at varying levels of development have asymmetric capacity of adjusting to external shocks. Hence, the crisis has relentlessly exposed these deeply engrained structural asymmetries.

Interestingly, when the blueprint for the EMU was made, politicians were aware of these differences in productive structures. However, the belief was that a common currency would lead to greater economic integration and countries would then eventually automatically converge economically. Nonetheless, according to the above-mentioned scholars, this convergence never occurred. Even though, after the introduction of the Euro, income of the SP countries converged to that of the Northern Centre (generally indicating Germany and sometimes other developed Northern Eurozone economies), the

productive structures of these countries did not converge (Botta, 2014; Celi et al., 2018). On the contrary, the creation of these institutions has contributed to deeper productive structural asymmetries between the Northern Centre (NC) and SP. The EU and the EMU have made for a 'level playing field' by eliminating tariffs, capital controls, exchange rates and industrial policy. This has revealed the industrial and institutional heterogeneity across the Eurozone countries, and has given rise to a structure-based competition. However, since the countries had large differences in productive structures to begin with, the SP countries could not possibly keep up with the competition (Celi et al., 2018). The SP countries have historically been able to rely on state-led structural change or exchange rate devaluation to restore competitiveness, but as part of the free market ideal these measures had to be given up (Simonazzi, Ginzburg & Nocella, 2013). Consequently, due to the many structural advantages of the NC, the equal playing field is increasingly resulting in the clustering of high value added activities (Celi et al., 2018; Simonazzi, Ginzburg & Nocella, 2013). The economic geography of Europe has been fundamentally altered during the last two decades, which has become increasingly recognized by a centre-periphery divide (Botta, 2014; Gambarotto, Rangone & Solari, 2019).

Beside the purported structural flaws of the Eurozone and the EU, there are, according to the literature, several factors exacerbating the asymmetry in productive structures. Firstly, since the eastern enlargement of the EU, Germany has progressively integrated its value chains into the culturally close member states Austria, Hungary, Poland and the Czech Republic (Botta, 2014). The scholars describe this group of countries as the 'German Core' (GC), which forms a tightly knit German-led trade network. Due to German de-specialization into central European countries, these countries embarked on a path of innovative production whereas Southern Eurozone countries were left aside. As a consequence, the GC network has contributed significantly to the reshaping of geography of production in Europe. Thus, the GC has emerged from the crisis with a more developed productive base, while the SP has seen its productive base waning (Celi et al., 2018). The two groups of countries, the GC and the SP, are said to have emerged as two distinct production poles (Botta, 2014).

Moreover, a frequently recurring theme within the literature is that the emergence of China is said to have had an asymmetrical impact on the productive structures of NC and SP countries. On the one side, it is stated that Germany's productive structure is relatively complementary to the Chinese productive structure and that it therefore has benefitted greatly in the form of increased external demand. On the other side, the development of the Chinese productive structure is said to have been a harsh source of competition for the SP, since China has increasingly been producing products relatively similar to those of the SP. Since wages in China are simply not comparable to those in the SP, it is often impossible to compete based on price. In other words, one could say that the rise of China has the effect of a 'double-edged sword' on the productive structure of the Eurozone (Celi et al., 2018; Gambarotto & Solari, 2015; Ginzburg & Simonazzi, 2017; Simonazzi, Ginzburg & Nocella, 2013).

The scholars that support the above described point of view highly disagree with the offered solutions to remedy the economic crisis and reboot growth in the SP. Since they argue that the true

cause of the crisis lies in the deeply engrained structural differences between the NC and SP, the solution lies in improving these productive structures of the SP. They argue that trying to increase competitiveness through internal devaluation and austerity has had disastrous effects, weakening the productive structures of the SP even further (Celi et al., 2018; Gambarotto, Rangone & Solari, 2019; Storm, 2019). It simply leaves the SP countries in a situation in which they are not cost-efficient enough to compete with the developing countries, and not advanced enough to compete with the NC countries. Yet, since direct mass scale investment in productive structures funded on a national level is not possible, the SP countries are now facing structural asymmetries with the Northern Eurozone countries, without having the instruments available to overcome it (Simonazzi, Ginzburg & Nocella, 2013). Hence the scholars see only one solution: direct investment into the productive structures of the SP organized at a European level.

2.2 Evidence for structural asymmetries

Stating that there are asymmetries in productive structures is one thing, but identifying these asymmetries is another. To do this, one ought to deconstruct the productive structure and structural change over time. Different scholars have endeavoured to provide evidence for differences in productive structures between the Northern centre Southern periphery. This section offers an elaboration on the evidence that has been compiled. Since this work can be regarded as building on Melles (2018), and since the literature on structural asymmetries in Europe is extensive, this section is limited to new evidence that has been gathered during the past year. For an elaborate description of pre 2018 findings, we refer to (Melles, 2018). However, it is certainly no necessity to read this, because the parts that are relevant for this paper will be briefly explained.

In a recent academic book dedicated specifically to the centre-periphery and structural asymmetry discussion, scholars provide an extensive account of the developments of the European countries over time (Celi et al., 2018). The authors focus not just on productive structures but provide a comprehensive account of the economic developments of mainly Germany and the GC countries and the SP countries. A first piece of evidence for asymmetries in productive structures is found in an account of the trade relations since 2000. Where the SP, minus Italy, has been running current account deficits since the start of the Euro vis-à-vis the EU 27, Germany has constantly been running great surpluses. Another piece of evidence is provided through the indicators of aggregate industrial production, the production of capital goods and the industrial production of medium- and high- tech sectors. Here we clearly observe a trend of stark divergence between the SP and Germany plus EP.

Celi et al. show, through a wide variety of trade statistics, that the importance of the manufacturing industry in the SP has weakened significantly during the past two decades. For example, the manufacturing share in exports and the value added content of final manufacturing demand decreased significantly in the SP, whilst in Germany is recognized by the exact opposite trend. More

evidence is found by using the automotive sector paradigmatically for the strength of the manufacturing sector. They observe a diverging trend in R&D expenditure and employment dynamics between Germany and the SP, in favour of Germany. Lastly, they also contribute to the argumentation of the existence of a German Core trade network and that the rise of China has asymmetrical consequences for the SP versus Germany. First, they show that Germany's exports during the last two decades has reoriented to the GC and China, whilst it has diverted away from the SP. In addition, they show that the employment impact of German exports in the SP has remained the same, or decreased slightly, whilst the effect on the GC has increased. On the other hand, Italian impact of export on German employment has been increasing, indicating another asymmetry in the relationship. They conclude that Germany has become the undisputed leader of the European economy and that the lack of balance leaves Europe deeply polarized.

Another very recent contribution on the centre-periphery divide within Europe and the Eurozone focuses on the evolution of the manufacturing sector of different European economies over time. The authors provide evidence for a divergent trend in industrial production by depicting the share of manufacturing value added in GDP from 2001 to 2016. The paper also provides detailed information on the differences in trade balance and exports for 14 manufacturing products between 2009 and 2013. They conclude that Italy has a stronger industrial base compared with the other Southern countries, but also in the case of Italy the trend is not positive. All of the SP seem to have been hit hard by the crisis when it comes to industrial production, employment and comparative advantages (Gambarotto, Rangone & Solari, 2019).

The evidence for structural asymmetries described so far, has mainly focussed on indicators of the quality of a productive structure that were a-priori decided. Take for example, as said, the indicator used by Celi et al. of the evolution of industrial production of medium- and high- tech sectors (Celi et al., 2018). Although this certainly provides important descriptive evidence for the development of a country's productive structure, it is very much dependent on arbitrary judgment and this leaves a lot to explain. What are medium- and high- tech sectors, and why? Are the medium- and high- tech sectors of yesterday also the medium- and high- tech sectors of today? Is it reasonable to arbitrarily aggregate so many sectors into two variables and say something about their importance for a country's productive structure? An excellent example of the difficulty in arbitrarily deciding what a medium- and high- tech sector is, can be derived from the work by Celi et al. As mentioned, in their analysis of the productive structure, the authors use the automotive industry in Germany and the SP countries for illustrative purposes. After analysing the differences, they conclude that the German automotive industry has been recognized by a much higher development, higher R&D investment and more innovation. In other words, it might be fair to consider the German automotive industry a high- tech sector, whilst the SP automotive sectors are not. This analytical difficulty has led Melles (2018) to undertake the initiative to analyse the structural change of the constituent European countries endogenously by application of a novel method derived from network analysis: The Economic Complexity Index. The work focused on

the change in sophistication of the productive structure of the Eurozone countries, based on the output of goods that the constituent European countries produced and traded between 1995 and 2016. The evidence supported the conception of large and deeply engrained structural asymmetries and hence the line of argumentation as described above was supported (Melles, 2018).

2.3 A research gap

Although the above-mentioned literature has yielded great insights into the structural differences of the European countries, there is a major shortcoming. Very little attention has been paid to the role of the service sector in a country's competitiveness of the productive structure. A simple analysis of the ratio services in exports for 24 of the largest EU countries reveals that this is not something that can be overlooked. Table 1 shows the average ratio for the 24 largest EU countries from 2000 to 2014. The combined average share of all 26 countries was 29 %. Some individual countries, most markedly SP countries (in red), were above the average. Moreover, the 'German core' countries (in blue) were recognized by a lower than average share of services in total trade. Neglecting this information in an analysis of structural change will result in only an incomplete account.

AUT	BEL	BGR	CZE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	HRV
24%	26%	28%	15%	17%	43%	30%	17%	29%	42%	63%	34%
HUN	**IRL**	**ITA**	**LTU**	**LVA**	**NLD**	**POL**	**PRT**	**ROU**	**SVK**	**SVN**	**SWE**
19%	42%	18%	33%	44%	30%	21%	31%	33%	18%	17%	29%

Table 1; Average ratio of services/goods EU 24 exports from 2000-2014; source: own calculations, data from: (WIOD, 2016)

This paper will contribute by describing the differences in productive structures between different European countries with a focus on the relationship between the Northern Core countries and the Southern periphery. The different aspects described in the literature review, such as the role of China and the purported 'German Core', will also be investigated. This is achieved by computing and proving the Economic Complexity Index (ECI) based on both goods and service data. The next section of this paper will provide a theoretical background of the ECI and the limited role that services has played so far in the literature on this well-established indicator.

3.0 Theory behind the methodology

3.1 The Economic Complexity Index and Services

The division of labour is one of the most renowned concepts within economics. Through this concept, Adam Smith endeavoured to convey the idea that countries in which labour is highly divided, and hence highly specialized, are more productive, innovative and wealthy. From this line of reasoning, one could infer that countries with a more diverse and sophisticated set of capabilities can provide a larger variety of goods and services than countries that do not have the same capabilities. Moreover, these countries have more wealth than the ones that do not possess those capabilities. This perspective on economic development inspired Hidalgo, Hausmann and others to develop the Economic Complexity Index (Hidalgo & Hausmann, 2009).

The theory behind the ECI departs from the observation that countries that are considered developed economies are capable of providing a relatively large diversity of goods and services that require comparatively more sophisticated and specific capabilities. Conversely, poor countries make fewer products that are relatively simple. The production of different products requires different capabilities, and thus societies that are missing some of these capabilities cannot make more sophisticated products. Products are generally produced with more knowledge than any one person can hold. This tacit knowledge is therefore scattered among many individuals with different specializations who are connected through a highly complex network of relationships and together embed the knowledge and capabilities in the products they make. Hence, one could deduce that the products that a country produces reflect the sophistication of the productive capabilities that a country possesses. The ECI is expressed in the composition of a country's productive output and reflects the structures that emerge to hold and combine productive capabilities (Ricardo et al., 2011b).

The ECI is a relatively novel indicator that captures and quantifies the knowledge intensity of a country's productive structure. The relative sophistication of a productive structure is referred to as the degree of 'complexity'. The idea is that products that are relatively simple to produce are relatively common, whilst products that require a large amount of rather specific knowledge are relatively rare. An example of a relatively complex product would be a jet engine, whilst potatoes would be a product that a large variety of countries are capable of producing and therefore reflects a low degree of complexity. The ECI applies techniques derived from network analysis to correct a country's product diversity for the rarity (ubiquity) of these products. Hence, the ECI reflects the amount of knowledge that is embedded in the productive structure of an economy (Hidalgo et al., 2017).

A major advantage compared to traditional indicators is that the ECI captures the complexity endogenously and therefore avoids any a-priori assumptions about the knowledge intensity of certain types of productive knowledge (Hidalgo et al., 2017). By letting the data speak for itself, one can avoid human mistakes in judgement and the indicator adjusts automatically for change of complexity of an industry or product over time. The value of the ECI has been well-established in a large range of

academic contributions. For example, the ECI has been shown to not only be an expression of the prosperity of a country but is a driver of its prosperity. A robust causal relationship between a countries ECI and its economic growth has been established (Hausmann & Hidalgo, 2011; Hidalgo & Hausmann, 2009). This is well in line with the innovation literature, that the development of productive structures contains a path dependent element: innovation bequeaths innovation (Chaminade, Lundvall & Haneef, 2018). Altogether the ECI is seemingly the ideal indicator for analysing the evolution of productive structures of the Southern-Periphery, Northern-Centre and German Core over time. As said, it captures the productive sophistication of a country over time and therefore it can quantify the differences in productive capabilities of the European countries.

The ECI has been calculated by the Harvard Centre for International Development and the MIT Observatory for the Economic Complexity Index for highly disaggregated (HS4-6) datasets covering more than 120 countries and more than 83% of world trade in goods in 2010 (Ricardo et al., 2011b). Whilst trade data for goods is very well documents through custom procedures, the available data on trade in services is scarce. Hence there are no ECI indices available that include services data, which has been a clear impediment for the applicability of the ECI. Some scholars have endeavoured to capture the role of services in ECI and others have unsuccessfully tried to downplay its importance in the calculations (Bustos et al., 2012). Yet, most scholars agree that trade in services is not just important for the complexity of a productive structure but is, considering the increasingly decentralized value chains, increased mobility and speed of communication, more important than ever before (Stojkoski, Utkovski & Kocarev, 2016). Hence, it is not surprising that the Harvard Centre for International Development released an update of their interactive environments that allows one to see how large the role of trade in services is for individual countries (Harvard, 2019).

In a recent academic paper, the authors have made an attempt to investigate the role of services in the complexity of productive structures by computing ECI indices including service and manufacturing data on a very highly aggregated product level of in total 20 product categories (Stojkoski, Utkovski & Kocarev, 2016). The scholars found that services play an important role in the complexity of productive structure and that the service categories were generally more complex than the manufacturing categories. Although some general conclusion could be made, the scholars recognized that this type of highly aggregated data is not useful for the computation of actual ECI indices, since the ECI technique precisely relies on the disaggregated nature of the data so that the complexity of products are not overlapping (Stojkoski, Utkovski & Kocarev, 2016).

As stated in the literature review, an indicator of productive structure complexity that would include both the goods and services would be ideal for the analysis of the evolution of productive structures in Europe. Given the findings of the above mention papers and the high share of services in trade of most SP countries, investigating the sophistication of these services is imperative for a comprehensive account of the alleged centre-periphery divide. Hence, for the purpose of this paper we

construct a database from which one can accurately derive ECI including services for at least 45 countries including the entire EU. Details about the data will be provided in the data section.

3.2 The use of a Regional Complexity Index

At the fundaments of the ECI lies the computation of Revealed Comparative Advantages (RCA's) of different countries. The indicator is well established and has been proven to be a very useful tool in analysing the productive structures of countries. RCAs are usually calculated based on global parameters of trade. However, by comparing a country's trade specialization to all actors in the world, it does not account for geographically determined advantages of certain countries in relation to others. The Global-ECI therefore largely ignores the location (positions) and 'roles' within the network and treats the set of countries and products as a global network in which only the connections are important (Deardorff, 2014). However, from Social Network Analysis we know that not only the connections between different agents are important, but also the roles and positions (Scott, 2000; Scott & Carrington, 2011). In addition, confirmation of the importance of geographically determined properties can be found in one of the most well-established and robust empirical indicators within economics: the gravity equation in internal trade. The original equation states that there exists an inverse proportional relationship between distance and the size of trade between two countries (Chaney, 2017). Originally the equation depended only on distance but nowadays includes a variety of trade costs indicators.

Hence, it is, not surprisingly, argued that when the costs of trade are high, due to transaction costs such as transportation costs, exchange rate risks or trade barriers, the globally derived RCA measure hides the large advantages that regional players have over players located far away from the receiving country (Deardorff, 2014). This dynamic is highly relevant for any country, since features like distance and location still play a large role in trade, but especially relevant in case of the EU and Eurozone countries since the common currency and common trade area resulted in the decline or elimination of transaction costs and a high interdependency between the participating countries. Hence, these players are part of a local cluster within the global network of countries and have, within this cluster, large advantages and different (complementary) roles compared to countries that are not part of it (Porter, 2000). To attribute these differences, this paper does not only provide the ECI based on global RCA measures, but also contributes the ECI based on within Eurozone and within EU RCA measures. This approach could reveal different types of productive structures, namely one based on global competitiveness and one on high competitiveness within the cluster. The Eurozone-ECI is calculated in the same manner as the global ECI, except that the RCA measures are based on within Eurozone trade (see Methodology). This turns out to be an extremely useful indicator with high explanatory value with regards to the empirical differences in productive structures between different Eurozone countries.

3.3 Product Similarity Matrices[1]

Another indication for productive structure asymmetries is provided through product similarity matrices (PSM's). The PSM's are derived from the product-country matrices that are at the base of the ECI and show the similarity of production between two countries in terms of RCA's. The purpose of comparing productive structure similarities between different countries is to investigate the claim of the existence of a German-led Core versus a Southern periphery and the claim of asymmetric exposure to the emergence of China. The existence of a German core ought to be both a source of divergence and an argument against the interpretation that increased German internal demand would be a solution to the problem (Botta, 2014; Cirillo & Guarascio, 2015; Simonazzi, Ginzburg & Nocella, 2013; Stöllinger, 2016).

Another claim that will be investigated through PSM's is the idea that the SP and NC are asymmetrically exposed to the emergence of China, which ought to aggravate the productive structure asymmetries within the Eurozone (Celi et al., 2018; Gambarotto, Rangone & Solari, 2019; Gambarotto & Solari, 2015; Ginzburg & Simonazzi, 2017; Simonazzi, Ginzburg & Nocella, 2013)

[1] Both the 'regional ECI' and the PSM's have been applied in Melles 2018. The results had high explanatory value for the understanding of the relative positions of different countries. Naturally, for this analysis we will use the newly compiled good-services database.

4.0 Data

As described before, where it is relatively easy to find disaggregated quality data on trade in goods, it is very difficult to find the same for services. Hence, in the earlier mentioned paper in which it was endeavoured to construct this index based on trade in goods and services, the scholars used highly aggregated data from two different sources adding up to only 20 product categories (Stojkoski, Utkovski & Kocarev, 2016). The problem with this is that a large portion of the information is lost when using such highly aggregated data and this is not acceptable for our purposes. Hence, it is imperative to use the available data sources rather innovatively and compile a unique database. To compile a balanced goods-services database with sufficient product disaggregation we rely on secondary trade date from two sources.

World Input Output Database

The service data is derived from the World Input Output tables (WIOT) provided by the World Input Output Database (WIOD). WIOTs are sets of national input-output tables that are connected with each other by bilateral international trade flows. Since for the ECI computation only bilateral trade data is required, the tables undergo some heavy data cleaning. WIOD supplies a 2013 and 2016 release, which cover different time periods and country ranges. For the purpose of this paper, the preference goes out to the most disaggregate tables available, which are the WIOT 2016 tables. These tables cover a period from 2000 to 2014 and include all 28 EU countries plus 15 major economies[2]. The tables also provide a 'rest of the world' category for the countries that are not covered in detail. In total the WIOTs cover about 94% of world GDP at time of release at current exchange rates. The table cover detailed trade data for 56 sectors, classified by the NACE-2 classification system. 29 of the 56 categories are denominated as service categories. The others pertain to agricultural, forestry, fishing, mining and manufacturing goods (Timmer et al., 2016). For our purposes we cannot use all 29 service categories since a few of them are only relevant for domestic trade. A list of the 26 included services can be found in attachment 1. Additional information about the data can be found here: *http://www.wiod.org/home*

ATLAS - Centre for International Development at Harvard University

The goods data consist of secondary trade data from the Harvard Atlas of Economic Complexity. The data we use is the HS2 version, which is more aggregated than the version conventionally used of HS4/SITC4 data. The 4-digit disaggregated data contains about 900 products. The HS2 data contains 99 product categories. This means that some of the goods data resolution is lost. To gain insight into magnitude of this loss, we plotted the SITC4 goods-ECI scores and the HS2 goods-ECI against each other and it turns out that the R^2 of the of the function is over 0,80, which indicates that the data loss is minimal. For comparison we also check the differences between the SITC4 ECI and the HS4 ECI, and

[2] Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Norway, Russia, South Korea, Switzerland, Taiwan, Turkey and the United States

the R^2 is approximately 0,95. Thus, even the same aggregation has some data loss. Given that there is also a new HS6 dataset and that all datasets are conventionally used, we feel confident about the quality of our data. Additional information about the data can be found here: *http://atlas.cid.harvard.edu/data*

Merging

Merging two datasets requires utmost caution, since they might not be compatible. To get a feeling of compatibility we compute the ratio between the WIOD-goods data and the Atlas HS2-goods data. Although the ratio is of course not 100% similar, the ratio moves in between the 99% and 102%. Hence, the two datasets are highly similar when it comes to reported goods data. Another factor of attention is the ratio between goods and services product categories, which ideally represent the actual ratio of goods to services in trade. The average between rate of goods to services from 2000 to 2014 based on WIOD data is 30%. The average of our dataset is 26/99 > 26%. Although this is not 100% perfect, it is remarkably close to reality, which gives extra confidence about our results. The results, as published in chapter 6, are robust for changes in data and cut-off values. In addition, from an economic point of view the result makes complete sense, including the difference between the only goods data ECI and the newly constructed goods-services data.

Filter

In convention with the ECI literature, a few filters are applied to reduce noise, avoid the small number bias and exclude poorly reported data. Only countries with at least 1.5 million inhabitants in 1995 and an export of more than 1 billion USD that year are included. In the 'Global-ECI' calculations Chad (TCD), Iraq (IRQ), and Afghanistan (AFG) are also excluded. In addition, products that have a global export of less than 10 million USD are rounded to zero. After these filters, the 'Global-ECI' dataset contains 125 countries which adds to more than 96% percent of global GDP. For the Eurozone (and EU) regional ECI calculations we applied the same logic. Hence, we excluded 4 out of 19 countries with a population under 1,5 million inhabitants in 1995: Estonia (1,436,634), Cyprus (855,384), Luxembourg (408,625) and Malta (377,419) (The Worldbank). For the abbreviations of country names, we used the ISO 3166 standard which is commonly used by the United Nations. A list of the countries names and codes can be found here: *https://en.wikipedia.org/wiki/ISO_3166-1_alpha-3*

Weaknesses and caution

Although the results seem straight-forward, they have to be interpreted with some caution. Since service data is only included for 45 countries, the ECI is likely to be biased in favour of these countries with respect to the rest of the world. Yet, this caution is certainly smoothened by the fact that the trade dataset covers the countries that have a combined GDP of about 96% of world GDP. In addition, almost all developed economies and the most important developing economies such as China, India and Mexico are also included. The caution is certainly not valid in case of the within Eurozone or within EU ECIs since those are fully covered.

5.0 Methodology[3]

In this section we will elaborate on the mathematical methodology behind the ECI. The techniques behind the ECI stem originally from the scientific field of network analysis. Initially, the complexity indicators were defined through a mathematical method of reflections (Ricardo et al., 2011a). Recently, however, the mathematics behind the complexity indicators have been elaborated and redefined in matrix algebra form (Caldarelli et al., 2012; Mealy, Farmer & Teytelboym, 2018) . Although the math can be challenging, significant attention has been paid to describe and explain the procedures in a clear-cut manner that can be followed by anyone. For reason of simplicity we tend to describe the steps in terms of matrix notation. Both are mathematically identical. An easy to access elaboration the calculation of ECI can be found here: (http://atlas.cid.harvard.edu/learn/glossary)

Economic Complexity Index Calculations

To calculate ECI we first must define a countries' diversity and a products' ubiquity. These are mathematically defined as:

$$Diversity = k_c^{(0)} = \sum_p M_{cp}$$

Which is a summation over the rows of matrix M_{cp}, hence it represents the total amount of products that country c has a Revealed Comparative Advantage in. In terms of network theory this is knows as the out-strength. The idea behind a countries' diversity is that the more products a country has a RCA in, the more knowhow it contains and the more sophisticated their productive structure is.

$$Ubiquity = k_p^{(0)} = \sum_c M_{cp}$$

And a products' ubiquity is defined as a summation over the columns of matrix M_{cp} and represents the total amount of countries that have a Revealed Comparative Advantage in product p. In terms of network theory this is known as the in-strength. The idea behind product ubiquity is that the more countries can produce a product, the less complex it is.

The ECI corrects a countries capabilities (diversity) for the sophistications of those capabilities (ubiquity). Originally this was done through an iterative algorithm that corrected the one for the other, but more recent elaborations(Caldarelli et al., 2012) on the ECI have shown that is mathematically identical to:

[3] This section is highly similar to last year's thesis for the simple reason that the same (ECI) methodology is applied. Of course it is adapted to the new context where necessary.

$$\widetilde{M}_{cc\prime} = \sum_{p} \frac{M_{cp} M_{c\prime p}}{k_c^{(0)} k_p^{(0)}} = \frac{1}{k_c^{(0)}} \sum_{p} \frac{M_{cp} M_{c\prime p}}{k_p^{(0)}}$$

In matrix notation this matrix $\widetilde{M}$ is expressed as:

$$\widetilde{M} = D^{-1} M U^{-1} M'$$

If we deconstruct this to its constituent parts, matrix M represents the matrix pulled from RCA_{cp}. U^{-1} is the inverse of the diagonational matrix formed by the diversity verctor given by:

$$U = I * k_p^{(0)}$$

Where I is the Identity matrix with its appropriate dimensions and $k_c^{(0)}$ is a vector of diversity, which was calculated in step 1. Consequently, the inverse of matrix U is taken and we multiply matrix M by U^{-1}. This results in a matrix of the dimensions M_{cp} in in which the constituent products are divided by its total ubiquity. Now, we multiply the resulting matrix by M', which is the transpose of matrix M, resulting in matrix S. Matrix S is a symmetric similarity matrix with the dimension $S_{cc\prime}$ that represent the products that country c has in common with country c', weighted by ubiquity of the products it produces.

Next, we calculate D^{-1}, which is the inverse of the diagonal matrix formed by the diversity vector given by:

$$D = I * k_c^{(0)}$$

Where I is the Identity matrix with its appropriate dimensions and $k_c^{(0)}$ is a vector of the diversity by country, which was calculated in step 1. Consequently, we calculate the dot product of $D^{-1}S$, which leaves us with matrix $\widetilde{M}$. Matrix $\widetilde{M}$ is a row stochastic weighted similarity matrix with dimensions $\widetilde{M}_{cc\prime}$ that reflects how similar two countries' export baskets are.

The last step is to derive the ECI, which is defined as the eigenvector associated with the second largest eigenvalue. Since matrix $\widetilde{M}$ is row stochastic, the largest eigenvalue is per definition 1 and therefore non-informative. Hence, we take the eigenvector associated with the second largest eigenvalue, which is the eigenvector that captures the most variance. The ECI is expressed in terms of standard deviations for comparability over time.

Product Similarity Matrix

Various scholars made the statement that one of the causes for the demise of Southern Eurozone productive structures the ascend of China is. Another statement is that the productive structures of Germany and Southern Eurozone countries are increasingly diverging in similarity. Hence in the empirical section this will be investigated through the provision of Product Similarity Matrices(PSM's). The PSM's are derived from the product-country matrix that is at the base of the RCA calculations. Hence, this measure is not a measure of economic complexity, but rather a side product. Even though the PSM doesn't calculate economic complexity, it is still a useful measure for comparing the similarity of productive structures and can help us in our argumentation with regards to the expose of Eurozone countries to the emergence of China. The formula in matrix notation for the calculation of the PSM is:

$$P = D^{-1}MM'$$

At the base of the calculation of the PSM's is the multiplication of the the country-product matrix M by the transpose matrix M'. This results in the symmetric similarity matrix A with the dimensions $A_{cc'}$ which describes the number of products that different countries have in common. Consequently, we obtain the dot product of matrix A and D^{-1}, which results in matrix P that shows which percentage of products a country has in common with the export basket of another country.

Weaknesses of methodology

A research would not be complete without acknowledging the weaknesses of the methodology used. Here is a sum up of the weaknesses that we recognize:

- The RCA measures are based on a contradiction; the more heterogenous a country's export base is, the larger the denominator is, which lowers the relative RCA's (Botta, 2014).
- The Method captures the complexity of an economy as a closed system based on country borders and hereby neglects any kind of transcendence of knowhow between countries.
- The ECI does not distinguish between different subtleties of product sophistication (a German car versus a Chinese car), although this should be somewhat expressed in terms of trade value.

6.0 Results

In this chapter we will discuss the results of the computation of different ECI parameters, calculated based on the compiled database with both goods and services. To exploit our findings optimally we will compare the findings regularly to the finding in Melles 2018. In this paper, similar indicators were constructed for similar purposes, but only based on data covering goods and not services. Differences between the two results could potentially be important and tell us a lot about the characteristics of different productive structures. Due to the limited space and to maintain focus on the new results, comparison occurs only verbally. It is certainly not necessary to read Melles (2018), but if one prefers to compare the results graphically or to obtain additional background, the paper can be found in the bibliography or in a link in the footnote[4].

6.1 Global Economic Complexity Index

Table 2 shows the Global-ECI ranking of selected Eurozone and Eastern Peripheral countries. The Global-ECI ranking includes 125 countries covering a period from 2000 to 2014. The alleged German Core (GC) countries are depicted in blue and the Southern Peripheral (SP) countries in red.

Exporter	2000	2004	2008	2011	2014
IRL	6	2	1	1	2
FIN	9	9	5	6	6
DEU	7	7	10	11	8
AUT	8	8	8	8	9
FRA	12	10	12	7	11
HUN	18	21	14	15	14
NLD	15	17	20	14	15
SVN	20	20	13	18	16
ESP	14	14	17	19	18
SVK	25	29	22	29	19
CZE	11	16	28	16	20
POL	17	24	26	27	23
BEL	23	25	30	22	24
ITA	19	19	23	24	28
PRT	30	32	31	33	31
LVA	29	26	32	32	32
GRC	27	18	16	34	33
LTU	35	34	41	46	34

Table 2; Global-ECI ranking based on goods & services; source: own calculations, Data from (Harvard, 2019) *&* (WIOD, 2016)

We observe different patterns for different groups of countries. The SP countries all dropped in ranking in between 2000 and 2014. Greece ranks second lowest of all Eurozone countries in 2014. Although this seems bad, Greece ranks significantly better than in the ranking that was observed when ECI was

[4] *https://lup.lub.lu.se/student-papers/search/publication/8948996*

computed based just on trade in goods, which was 56th in 2016 (Melles, 2018). This indicates a higher complexity of trade in services. Greece hiked significantly from 2000 to 2008. This has, however, completely been reversed since. This could well be evidence for the disastrous effects of the austerity policies and structural reforms on Greece's productive structure, that have been carried out in response to the financial crisis.

Italy's productive structure has worsened significantly and dropped from a top 20 country to a country just in the top 30. However, when this exactly started is not clear from this graph but will become clear later in this chapter. Although Spain has dropped as well, it achieves markedly better than the other SP countries. It is mention worthy that Italy and Spain behaved roughly opposite in Melles (2018), which indicates quite a complex Spanish service structure and vice versa. Generally speaking, SP countries rank at the bottom half of the Eurozone countries. Yet, globally speaking all Eurozone countries are not achieving poorly.

The German Core countries are generally not quite achieving as well as was observed with the 'goods-ECI' in Melles (2018), indicating that these countries are highly specialized in manufacturing but not as complex when it comes to their service structure. When it comes to the complexity of their 'goods-structure', the German Core countries included the four highest ranking countries of all the Eurozone. Yet when service data is included, Germany and Austria drop a few places, but especially Hungary, The Czech Republic and Poland score significantly lower in the global ranking. This observation could well indicate that the German Core is not extended to complex services, but are only based on the production of goods.

Although the ranking is useful, it can misrepresent the actual differences when the true differences in complexity are not as large. Hence, in figure 1 we display the evolution of the Global Economic Complexity of the SP and Austria-Germany from 2000 to 2014. Before we dive into these results, it is important to explain what the precise ECI score entails. The score is expressed in standard deviations from the mean and is a relative score. Since complexity is a relative term, it can only be expressed in relation to other countries. For example, in the 1960s, having a car industry was likely to be considered a high technology and complex industry, only existent in the most developed countries. Nowadays many countries have a thriving car industry including many developing countries such as India and China. This indicates that the relative complexity of a car industry decreased. When, for example, many developing countries expand into industries that before were only existent in developed economies, it will drive the relative ECI score of developed countries down. For further elaboration on the ECI, the reader can check the theory section or read the glossary of the Atlas for Economic Complexity.

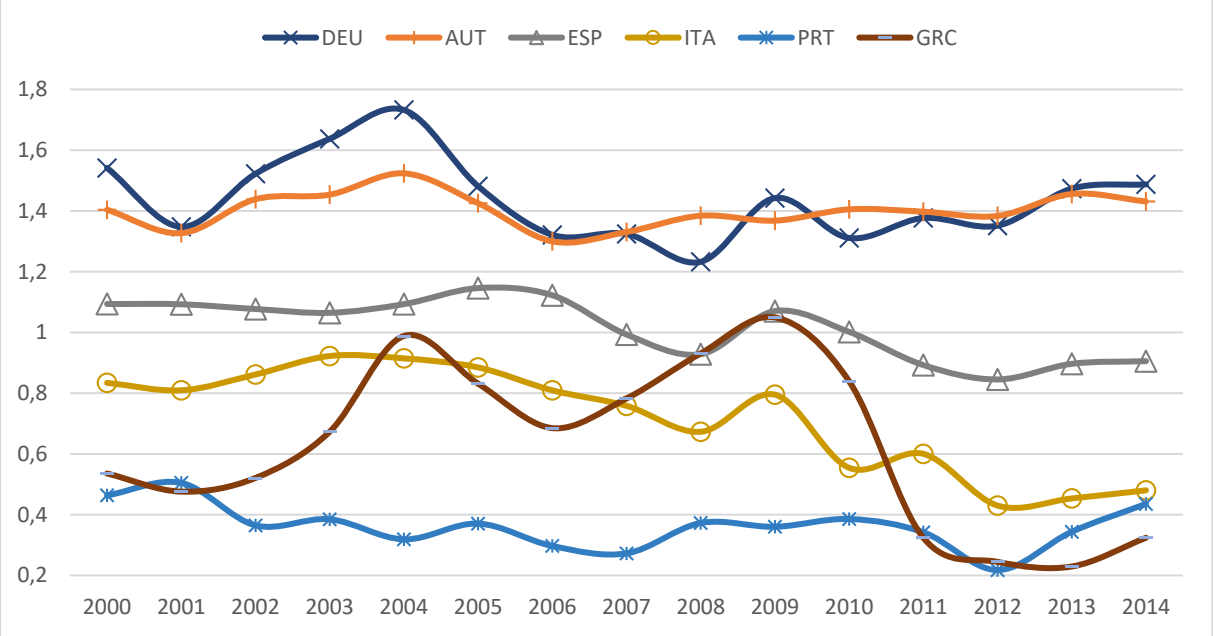

Figure 1; Global-ECI based on goods & services; source: own calculations, Data from (Harvard, 2019) & (WIOD, 2016)

Figure 1 shows that since 2000 the Global-ECI of the SP countries has worsened. From the above graph it becomes clear that Spain's and Italy's slide down already started around 2005 and hence before the financial crisis. Portugal on the other hand has remained relatively stable but has always been recognized by a low complexity of its productive structure. When contrasting these three countries with Germany and Austria, we see that there has always been (since 2000) a gap in productive structure complexity. Therefor it seems, as far as we can see, fair to say that the differences in productive structures have an historical origin. The asymmetries since the beginning of the 2000s is reason for concern.

The big story of this graph is clearly Greece, which shows the most volatile development of all countries. We see that from the moment of joining the Euro in 2001 until the start of the Eurozone Crisis in the end of 2009, Greece's productive structure complexity rose significantly. Ever since, the complexity of Greece's productive structure has fallen markedly to a level lower than it started with in 2000. Hence, it seems like the crisis has of all countries had the most devastating effect on Greece. This is not surprising, but what is important to note is that regardless of the many austerity programs and structural reforms Greece has carried out in the years since the outbreak of the crisis, the productive structure has not benefitted. This evidence clearly supports the point of view described in the literature review that what is necessary are not austerity programs and structural reforms, but direct investment into the productive structure of the SP.

The results are strongly contrasting with the well-developed Austrian and German productive structures. Although their ECI hasn't increased since 2000, it has remained relatively stable and high compared to the SP. There is no evidence that the financial crisis has had a significant impact on the Global complexity of their productive structures. When contrasting this with Greece, it seems reasonable to argue, like the scholars do, that these countries are not equally capable of coping with a financial stress.

To elaborate our analysis and add perspective we display another graph in figure 2. From this graph it becomes clear that, although Austria and Germany have very well-developed productive structures on the global level, there are countries that have even more developed globally oriented productive structures. Within the Eurozone, Ireland is one of these countries and within the EU there are several others such as Sweden, Switzerland, Finland and Norway. Interestingly, when comparing this to Global-ECI based on trade in goods in Melles (2018), we find that Germany and Austria trump all these countries when the analysis is limited to goods data, but not when service data is included.

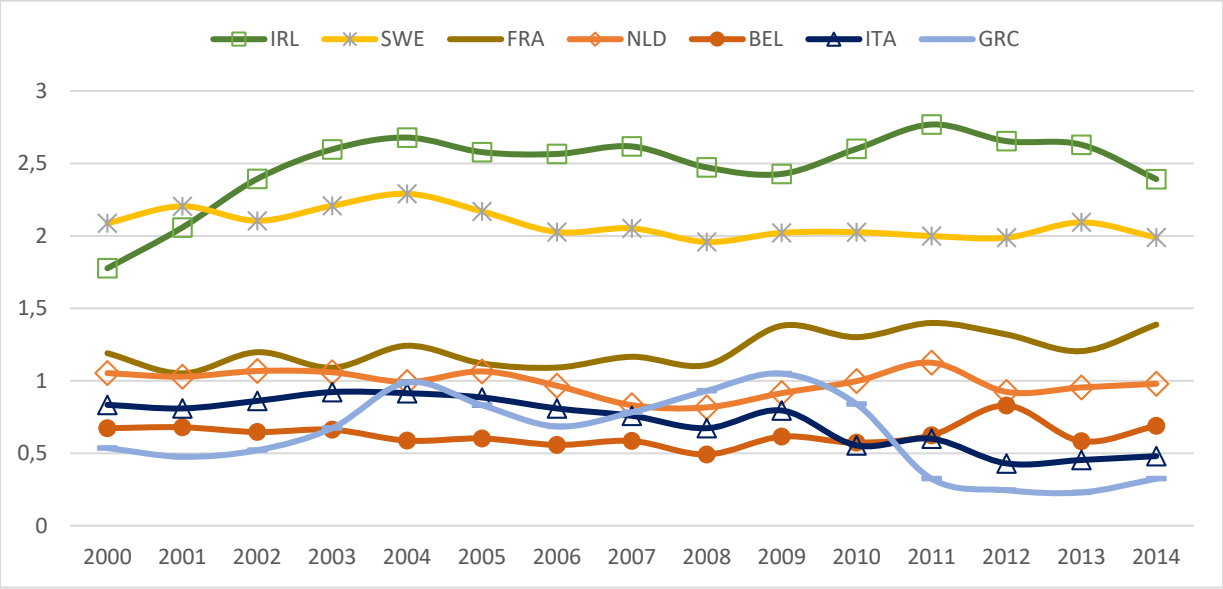

Figure 2; Global-ECI based on goods & services; source: own calculations, Data from (Harvard, 2019) & (WIOD, 2016)

Figure 2 does not only add perspective to the relative complexity of Germany and Austria, but also of the SP. The Netherlands and Belgium are two countries that historically speaking fall within a close range of the SP, but over time show a very different development path. Where Italy and Spain (figure 1) show a trendline of decreasing global complexity, The Netherlands and Belgium show a relatively stable development and seem unaffected by the financial crisis. The contrast with Greece's responds to crisis is large and tells something about its ability to cope with such economic stress. The downward trendline is something specifically pertaining to the SP countries and even when analysing the development of other countries that are not included in the graph such as the German Core countries, we don't observe the same pattern.

Given the relatively high level of development and living standards of the Netherlands and Belgium it is perhaps surprising that those two countries have these respective levels of Global-ECI. Although the score is not low, one might expect a more complex productive structure. The next section will explain where the relatively high levels of development come from and how the productive structure of these two countries is differently oriented compared to some others.

6.2 Eurozone Regional Complexity

We recognise the importance of regional economic dynamics for the economic wellbeing of countries. Thus, here we provide an index of economic complexity based on within Eurozone trade. Theoretical justification for this has been provided in paragraph 3,2.

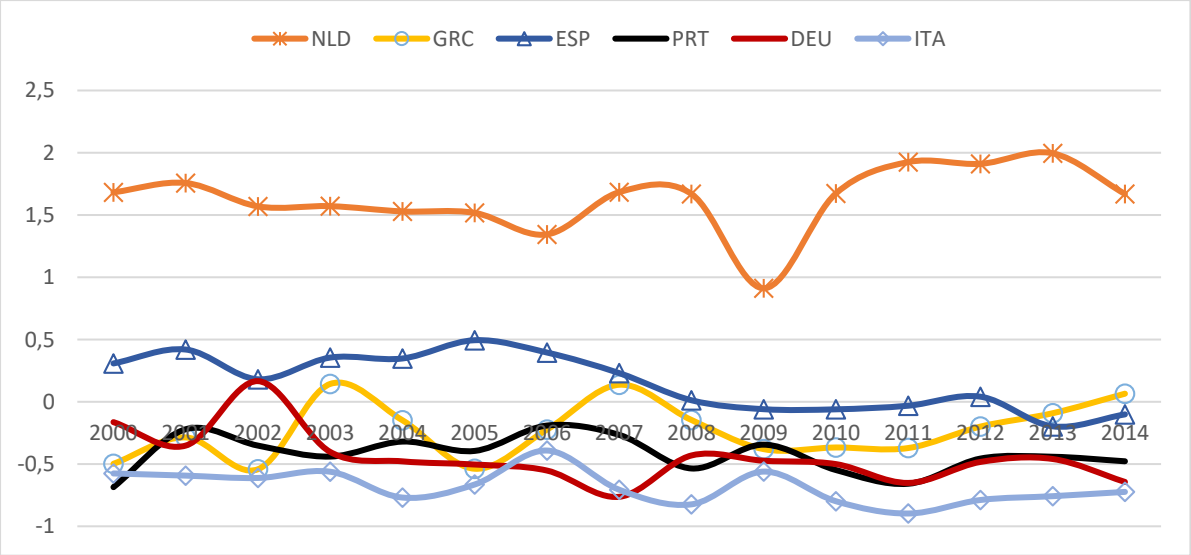

Figure 3; Eurozone-ECI based on goods & services; source: own calculations, Data from (Harvard, 2019) & (WIOD, 2016)

Figure 3 shows the development of within Eurozone-ECI of Germany, the SP and The Netherlands. We can observe that productive structure of The Netherlands is very well diversified for servicing regional needs. This explains us the moderate ranking of Global-ECI of The Netherlands. Germany has a surprisingly low within Eurozone ECI which indicates that it's highly dependent on the competitiveness of its global productive structure.

The poor achievement of the SP countries in the Global-ECI ranking is not offset by the within Eurozone rankings. This is quite disturbing because the objective of the structural reforms and internal devaluation that the SP countries underwent, was to increase their competitiveness based on price competition. One might expect this to result in increased competitiveness and the attraction of more complex industries from other Eurozone countries. However, the policies seems not to have had a large impact before 2014. Hence this gives us all the more reason to believe that there are large and deeply engrained structural asymmetries in the Eurozone.

6.3 EU Regional Complexity

Since within Eurozone-ECI could potentially be biased in favour the geographically more centred countries and biased against countries that lie on the outskirts of the Eurozone, we decide to calculate an ECI based on within EU trade in figure 4.

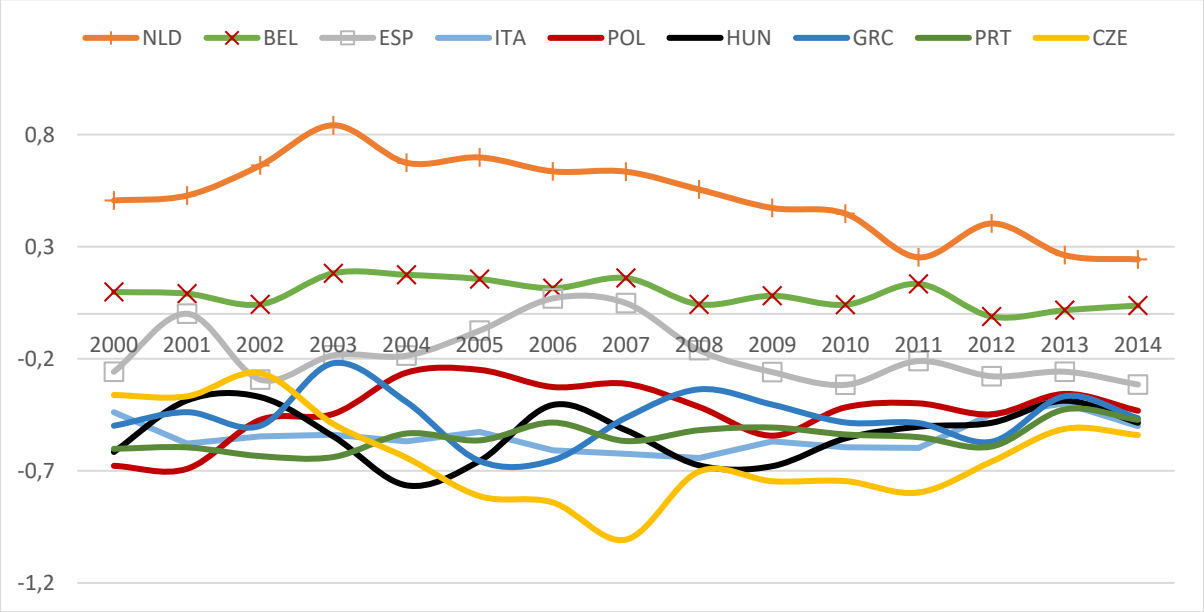

Figure 4 EU ECI based on goods & services; source: own calculations, Data from (Harvard, 2019) & (WIOD, 2016)

Although the lines at the bottom of the graph become quite intertwined an difficult to distinguish, interpretation of the results is rather straight forward. The bottom lines are all the SP countries and all the GC minus Austria and Germany. The graph makes it very clear that within Europe, all these countries belong to the economic periphery. Given the previous results of Global-ECI and within Eurozone-ECI, it gets clear that the SP countries are far less well positioned that the GC countries, because the GC countries score relatively well in the Global-ECI. The SP on the other hand, scores in neither of the three indexes particularly good. Lastly, although Spain is also part of the lower ranked countries, it is noteworthy that Spain, just like in the other two indices, performs slight better than the other SP countries.

6.4 The German Core

In this section we zoom in on the alleged German Core and how that differs from the Southern Periphery. The literature describes a situation in which Germany has, especially since the eastern enlargement of the EU, extended its value chains into the culturally close central and eastern European countries. This has allegedly had strongly beneficial effects on the GC countries, whilst it has had detrimental effects on the SP since they are increasingly left out from the German value chains and therefore do not benefit as much from Germany's strong global position and innovative productive structure. In addition, it is used as an argument that event if German domestic demand will increase, it will mainly drive up demand for products from the GC countries and not from the SP.

Figure 5 shows the development of Global-ECI of the GC countries and the SP countries. Greece and Poland are left out because both countries, unlike with goods-ECI as shown in Melles (2018), show no clear sign of productive structure complexity convergence with either the GC or the SP respectively. Including these countries would make the graph messy and therefore draw attention away from the bigger picture.

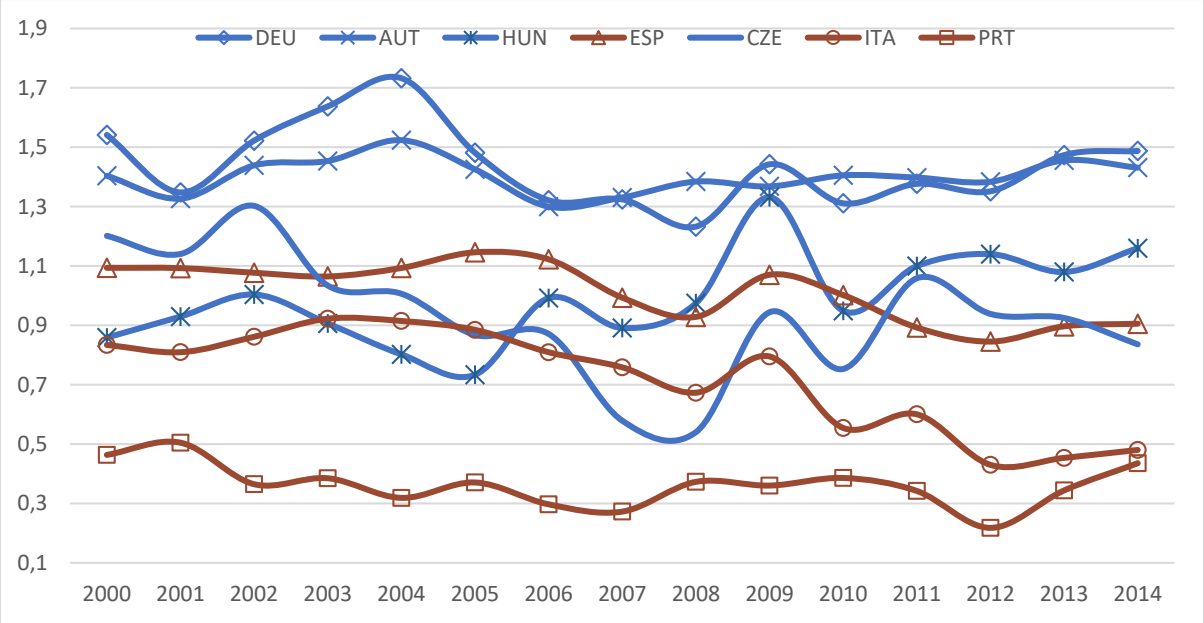

Figure 5; Global-ECI based on goods & services – German Core versus Southern Periphery; source: own calculations, Data from (Harvard, 2019) & (WIOD, 2016)

From figure 5 we can clearly find evidence for the existence of a German Core. The GC countries tend to converge with the German productive structure. It is noteworthy that the shown developments are in line with the literature, which states that this convergence took place especially after the eastern EU enlargement in 2004. We observe that pre 2004 Hungary and the Czech Republic do not show any convergence and have a very distinct development of their respective productive structures. However, short after the enlargement the Czech Republic immediately converges towards Germany and Hungary

follows soon after. The SP countries seem to show rather mild to strong divergence away from Germany and seem to converge on a downward trend with each other. Thus, this graph forms clearly supportive evidence for the existence of a German Core and Southern Periphery.

	AUT	CZE	HUN	POL	ESP	GRC	ITA	PRT	BEL	FRA	IRL	NLD
2000	57%	54%	38%	45%	45%	28%	50%	45%	54%	59%	68%	50%
2001	59%	54%	34%	44%	44%	35%	47%	38%	62%	57%	58%	50%
2002	55%	56%	32%	40%	46%	36%	47%	38%	56%	56%	57%	50%
2003	55%	48%	38%	39%	43%	38%	50%	38%	46%	49%	42%	44%
2004	58%	49%	38%	39%	45%	37%	52%	39%	41%	49%	45%	43%
2005	61%	56%	44%	49%	48%	39%	52%	42%	43%	53%	50%	48%
2006	59%	58%	46%	48%	48%	42%	49%	40%	45%	52%	55%	46%
2007	60%	60%	53%	51%	50%	38%	52%	37%	44%	53%	48%	43%
2008	65%	67%	62%	53%	53%	38%	53%	41%	55%	57%	58%	53%
2009	63%	69%	64%	58%	56%	42%	51%	44%	51%	57%	55%	49%
2010	60%	71%	65%	57%	53%	48%	52%	42%	51%	55%	57%	48%
2011	61%	72%	70%	62%	54%	41%	54%	44%	53%	54%	54%	49%
2012	65%	71%	71%	61%	52%	45%	49%	44%	53%	54%	52%	51%
2013	61%	67%	60%	55%	52%	44%	47%	39%	52%	53%	52%	48%
2014	57%	63%	62%	57%	51%	41%	48%	38%	47%	55%	52%	45%

Table 3; Product Similarity with Germany, source: own calculations, Data from (Harvard, 2019) & (WIOD, 2016)

Table 3 depicts the product similarity[5] with Germany of different European countries based on the global productive structure and is generally a confirmation of the findings in graph 5. It is noteworthy that in 2014 the top 4 countries with the highest productive similarity to Germany were all GC countries. This was very different in 2000 when there were multiple countries that showed a higher degree of similarity. The SP countries show relatively low rates of product similarity in 2014, only Spain scores above 50%. Table 3 and figure 5 together show evidence that certainly supports the idea of a German Core that is discussed in the literature.

[5] *The Product Similarity Matrices are computed with respect to one country and show the percentage similarity of Revealed Comparative Advantages between that one country and the other countries in the matrix. A more detailed description of the theory is given in paragraph 3,3 and the methodology is described at the end of chapter 5,0.*

6.5 Exposure to China

Lastly, we contribute to the debate of the asymmetrical effect of China on the productive structures of the SP compared to Germany. The literature prescribes a situation in which Germany benefits greatly of the emergence of China, since Germany's productive structure is highly complementary to the Chinese productive structure. On the other side, the SP is supposed to be affected negatively by the emergence of China, since their constituent productive structures are rather similar and have to cope with the low price competition from China. Table 4 shows the Product Similarity Matrix (PSM) between China and the constituent Eurozone countries. More information on the theory behind the PSM is provided in paragraph 3,3 and the methodology is described at the end of chapter 5,0.

	AUT	DEU	ESP	GRC	ITA	PRT	BEL	FIN	FRA	IRL	NLD
2000	33%	22%	35%	39%	39%	50%	30%	29%	24%	12%	16%
2001	33%	24%	40%	41%	42%	51%	31%	27%	22%	8%	18%
2002	39%	31%	40%	42%	45%	54%	28%	26%	24%	14%	19%
2003	35%	25%	38%	41%	43%	55%	22%	28%	22%	17%	16%
2004	32%	30%	35%	37%	45%	56%	27%	27%	22%	14%	22%
2005	31%	33%	33%	32%	40%	52%	31%	34%	22%	18%	22%
2006	35%	37%	36%	35%	43%	54%	35%	36%	27%	18%	22%
2007	37%	35%	33%	31%	46%	47%	35%	42%	25%	13%	20%
2008	35%	42%	35%	31%	48%	48%	33%	43%	31%	17%	23%
2009	29%	31%	29%	35%	43%	48%	25%	36%	22%	14%	19%
2010	33%	33%	34%	39%	48%	50%	26%	35%	28%	17%	23%
2011	30%	36%	34%	41%	48%	48%	25%	39%	26%	15%	26%
2012	35%	36%	33%	38%	48%	48%	21%	35%	28%	13%	20%
2013	33%	33%	32%	41%	45%	47%	18%	31%	29%	20%	23%
2014	35%	34%	31%	30%	51%	46%	22%	32%	27%	12%	18%

Table 4; Product Similarity with China, source: own calculations, Data from (Harvard, 2019) *&* (WIOD, 2016)

From table 4 we can clearly see that, indeed, Italy and Portugal have very similar productive structure to China. Given the fact that both countries seem to have a low complexity service sector and compared to the results of Melles (2018), the problems for these countries seem to mainly originate in the competition on goods and not so much in competition on services. Indeed, the countries that have a relatively well developed service structure tend to have very low product similarity with China. Germany and Austria have also shown to heavily rely on the complexity of their productive structure for goods. Although both countries show a much lower product similarity with China than Italy and Portugal, they both have slightly higher similarities than Greece and Spain, which is understandable given their more developed service structure. The fact that Germany's similarity with China has increased from 22% in 2000 to 34% in 2014 is certainly reason for caution. Given the high dependency many European countries, most noticeably the GC countries, on the global competitiveness of Germany's productive structure, it could be detrimental for the European economy at large if China increases to expand their productive similarity to Germany.

Conclusion

In this paper we have endeavoured to analyse the evolution of the goods-and-services sides of the productive structures of the Eurozone countries. This was done in responds to a phenomenon described in the literature, regarding that the Eurozone has been recognized by a Northern Centre that has well developed productive structures, and a contrasting Southern Periphery in which the countries have relatively poorly diversified productive structures. More specifically, this research aimed at answering the following research question : *Can we find evidence for the alleged large and deeply engrained structural asymmetries between the Northern-Centre and the Southern-Periphery?* Answering this question has been achieved by applying the Economic Complexity Index to a newly constructed database containing data for in total 125 countries: 45 countries covering both goods and services and for the remaining countries only goods.

Although the we realize that it is a strong statement, we don't hesitate at all to conclude with conviction, that for the period covered in our data there indeed exist large and deeply engrained structural asymmetries between the Northern Centre and the Southern periphery. These differences do indeed have a historical origins, but seem to have worsened slowly but steadily for most Southern Peripheral countries and significantly in the case of Greece. In what follows we will deal with each Southern Peripheral country individually and describe how their productive structure has been oriented during the past two decades. Consequently we will ascertain whether we found evidence for a 'German Core'. Lastly, we will discuss our evidence pertaining to the alleged 'double-edged sword effect' of China on the productive structures of the Eurozone.

Portugal

The situation of Portugal is seriously worrisome, since it consistently ranks among the poorest performing countries in the Eurozone in any index. In chapter 2 we saw that Portugal has a slightly above average ratio of service exports to goods exports. Regardless of this fact, Portugal seems not to excel in any of the categories. It shows a very steady performance, no trend upwards nor downwards, which is not a good thing when one is ranking lowly. When taking the goods-ECI results from Melles (2018) into account we see a rather similar pattern. Overall, we can say that the gap between Portugal and the Northern Eurozone countries is significant and hence we can talk about an asymmetry.

Greece

Greece shows the most remarkable development of all countries. Since a very large portion of its trade consists of services, Greece was pre-eminently a country for which it certainly wouldn't suffice to focus just on the complexity of it's goods-structure, as typically done with ECI. It was expected that Greece would score significantly better than the poor performance observed in the previous research. We

observed that since the entrance into the Eurozone until the start of the crisis, Greece climbed markedly on the Global Economic Complexity Index surpassing countries like Belgium and Italy. Since the crisis, however, Greece has experience just as sharp a fall down the 'ECI ladder'. This could indicate two important phenomena that were described in the literature. First that the Greek productive structure is indeed not as capable in coping with external economic shocks and/or secondly that the structural reforms carried out after the outbreak of the crisis are very detrimental for the productive structure of Greece or at least not helping. To find this out, future studies could use the ECI in econometric studies.

Spain

The productive structure of Spain shows improvement compared to the goods-ECI, indicating that the inclusion of service data has uncovered a more detailed picture of its productive structure. Spain shows the most optimistic productive structure complexity of all Southern Peripheral countries. Although Spain ranks during the latter years consistently with a group of lower ranking countries, it seems to rank at the upper levels of the lowly ranked countries, not only on a Global level but also on a EU regional and Eurozone level. However, also the evolution of Spain's productive is not per say reason for unbridled optimism because the structure shows a slow but steady decline and an increasing gap with countries like Germany and Austria, which is reason for concern.

Italy

Italy shows the opposite of Spain in terms that it scored relatively well in the analysis of the goods-ECI, but a lot worse in this paper, when service data is included. Italy's development is also reason for concern, because it has been sliding down since before the financial crisis. The gap with countries like Germany has increased significantly and in 2014 it joined the ranking of the lowest scoring countries; Portugal and Greece. Moreover, Italy's poor Global-ECI performance is not compensated for by a sophisticated regional orientation.

The German Core

Although the German Core is slightly less pronounced than it was in the goods-ECI, it is still very much apparent. We observed that Hungary, and the Czech republic indeed converged with Austria and Germany since the enlargement of the EU in 2004. At the same time, the Southern Peripheral countries show since the financial a divergence away from the German productive structure. In case of Greece and Poland we observed very distinct patterns. Since, Poland shows more convergence when only goods are taken into account, it hints that services are reason for the different trend. Greece is clearly not converging with the GC and converges only in the end with the SP.

Exposure to China

Although evidence about the effect of the emergence of China on the productive structure of the Germany and the Southern Periphery could not be directly observed, it was clear that Italy and Portugal have been the countries with by far the highest product similarity with China (around 50%). This could indicate that the emergence of China has had a particularly detrimental effect on the competitiveness of these countries. Another interesting observation is that Germany's similarity, although not the highest, has increase from 22% in 2000 to 34% in 2014. Given the fact that Germany is highly dependent on its complex Global value chains and many other European countries in turn on Germany, it is perhaps a development to consider when making policy.

The Euro

Altogether, one can certainly have its doubts about the sustainability of a common currency area when countries continue to diverge. Constant internal devaluation to gain a bit more competitiveness seems not a long-term solution. In addition, regardless of their many structural reforms, we don't observe any significant improvements of the productive structures of the Southern Periphery. Hence, it is not unreasonable to say that a real solution must come from a different angle. Whether the solution lies in industrial policy on a European level is largely a political question and really depends on one's political objectives.

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Attachments – 1: included Services

G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I	Accommodation and food service activities
J58	Publishing activities
J59_J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
J61	Telecommunications
J62_J63	Computer programming, consultancy and related activities; information service activities
K64	Financial service activities, except insurance and pension funding
K65	Insurance, reinsurance and pension funding, except compulsory social security
K66	Activities auxiliary to financial services and insurance activities
L68	Real estate activities
M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74_M75	Other professional, scientific and technical activities; veterinary activities
N	Administrative and support service activities
O84	Public administration and defence; compulsory social security
P85	Education
Q	Human health and social work activities
R_S	Other service activities