

Structural asymmetries at the roots of the eurozone crisis: what's new for industrial policy in the EU?

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1. Introduction

Several economists describe the eurozone crisis in terms of three main facts. First, before the 2007-2008 financial crash, the process of monetary and financial integration allowed most peripheral eurozone countries to benefit from considerable capital inflows (Perez-Caldentey and Vernengo, 2012). Accordingly, their economies expanded rapidly, often faster than central economies, giving rise to a sort of centre-periphery convergence (see figure A.1 in the appendix to the paper). Housing booms took place in Ireland, Spain and (to a lesser extent) Greece in the first half of the 2000s, and increasing external imbalances emerged much in the same way as they did historically in several developing countries after financial liberalisation (Stockhammer, 2012).¹ Second, the worldwide financial dislocation induced by the subprime crisis threw all of the eurozone into a deep recession, forcing national governments to come in to bail out close-to-bankruptcy private financial institutions and provide relief against recession. A prevalently private sector problem became a public concern (De Grauwe, 2010). The loss of monetary sovereignty by eurozone countries constitutes the third piece of the story, since it has increased the fear of sovereign debt default and the floor to speculative attacks, as well as capital flights away from externally indebted peripheral countries.

Despite the external and exogenous origin of the crisis as due to the 'imported' consequences of the subprime crisis, part of the above

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¹ See figure A.3 in the appendix on this point.

problems have a domestic endogenous nature linked to long-lasting structural asymmetries between peripheral and central economies. According to the most recent European Commission *Industrial Structure Report* (2013), Greece and Portugal stand out as relatively closed economies (at least compared to other small European countries), and are characterised by poorly diversified productive and export structures. Perhaps more relevantly, their economies are concentrated in resource-intensive and labour-intensive low-tech sectors that provide scarce opportunities for introducing product and process innovation. In the case of Ireland, the development of a restricted bunch of high-tech industries has fed past remarkable growth performances. This fact notwithstanding, its dynamic export sector is scarcely integrated with the rest of the economy, and a relatively small part of Irish exports' value effectively originates inside the Irish economy (European Commission, 2013; Foster *et al.*, 2013). Further, the Irish productive system is still affected by a lack of diversification, this fact being strikingly evident when capital goods sectors are considered.² Larger peripheral countries such as Italy and Spain are characterised by more variegated productive and export structures compared to small economies. Yet, in the case of Italy in particular, traditional low-tech and poorly innovative sectors still represent a relevant part of their productive systems. Central eurozone countries present a different picture. In the case of Germany, in particular, a well-diversified productive and export structure is deeply integrated inside the domestic economy, and shows relative comparative advantages in medium/high-tech sectors with supposedly strong potential for innovation and growth. Given these structural features, finance-led growth accelerations have led peripheral countries to run considerable external imbalances, hence their mounting external debts, vis-à-vis more developed central economies, by violating rather tight balance-of-payments constraints (Hein *et al.*,

² See also Best (2013) for a critical assessment of FDI-centred industrial policies followed by the Irish government as to their effects on the Irish productive system's dynamism and capability to undertake indigenous R&D and innovation.

2011).³ Soon after the outbreak of the worldwide financial crisis, such asymmetries, coupled with opposite financial positions on capital markets, capital flights away from the periphery and diverging *post*-crisis macroeconomic environments (interest rate hikes, credit crunch and tough austerity programs mainly concentrated in the periphery) all (inter-)acted to transform a common symmetric shock (i.e. the 2007-2008 financial meltdown) into asymmetric scenarios: a quick export-led recovery in the centre versus deepening and protracted recession in the periphery.⁴

In some previous contributions, we have shown that expansionary fiscal policies implemented by a monetarily sovereign eurozone central government, possibly funded by issuing Eurobonds, would likely represent the definitive way out of the crisis (Botta, 2013; 2014). Indeed, expansionary fiscal policies implemented by a federal euro government may favour economic recovery in the periphery, and avoid financial instability from spreading into the entire monetary union. In these contributions, we mainly focused on the short-run anti-cyclical nature of expansionary measures. Here we move to consider how short-run and long-run goals (i.e. reductions in centre-periphery structural asymmetries) could be jointly pursued through industrial policies that support productive investment, hence effective demand

³ According to data from UNCTAD, Greece, Italy, Spain and Portugal recorded remarkable and increasing trade account deficits vis-à-vis Germany since the end of the 1990s and until 2008. Before the outbreak of the present crisis, trade deficits versus Germany were as high as 2.13 and 2.22 percent of GDP in the case of Portugal and Spain, respectively (around 1 percent in the case of Italy and Greece). In the case of Ireland, relevant trade account surpluses registered in the second half of the 1990s were driven close to zero just before the outbreak of the worldwide financial meltdown. More generally, in the case of Ireland relevant trade surpluses have not been enough to compensate for a worsening and overall (pre-crisis) negative current account position due to large profit repatriation by foreign multinationals. According to Capelli and Vaggi (2013), profit repatriations made Irish GNP lower than Irish GDP by more than 20 percentage points in 2013.

⁴ In light of these facts, the hypothesis of the endogenous nature of the eurozone as an optimal currency area is no longer credible (see Frankel and Rose, 1998 on the idea of endogenous monetary areas; see also De Grauwe and Mongelli, 2005 for an application of this concept to the eurozone).

and economic recovery, and stimulate the long-run growth potential of peripheral countries.

In this paper, we take into account a wide range of policies, from more ‘traditional’ industrial measures influencing industrial and productive dynamics, to public involvement in research and development (R&D) activities. Nevertheless, they all depend on three main strategic actions. First, a euro-funded industrial policy should considerably increase expenditures devoted to basic research carried out through high-level education institutions. Indeed, according to Dosi *et al.* (2006), while these efforts are fundamental to expand the scientific knowledge with which applied innovations can be carried out, they also create a ‘business-friendly’ environment and are most welcomed by private corporations. Second, alongside basic research, public-private research centres should strengthen R&D networks in national innovation systems and focus on applied applications of the above knowledge. Last, but not least, the emergence of innovative firms should be stimulated through public support, let us say subsidies, fiscal incentives and/or the direct public procurement and financing of innovations. In this regard, sectoral policies should be reconsidered by European institutions. Provided that innovative sectors face dynamic demands from international markets, sectoral policies may help the eurozone’s periphery to improve its external balance position, and possibly achieve high and sustainable growth rates.

This paper is organised as follows. Section 2 provides a picture of structural asymmetries among eurozone countries. We assess them by computing a synthetic Productive Structure Similarity Index (PSSI) through which peripheral countries’ productive structures are compared with the German one. Furthermore, we assess central-periphery dichotomies as to the degree of (sector) diversification of their productive and export patterns. Section 3 analyses the implications of the above asymmetries in terms of diverging centre-periphery development paths. Here, attention is on the cumulative nature of production development as a technology and innovation process, hence the possible lock-in of peripheral euro countries in a low-growth low-tech trap. Section 4 discusses how euro-level R&D/industrial policy could address such

dichotomies and provide a way out of the crisis by favouring the upgrading of peripheral countries' production patterns. Section 5 concludes.

2. Centre-periphery structural asymmetries in the eurozone

When finance-led economic booms take place in developing countries, asymmetric productive structures with respect to more developed economies likely give rise to increasing external imbalances. Obviously, capital inflows can easily fill the gap in times of financial euphoria, when financial markets do not care about macroeconomic fundamentals and long-run trends (Krugman, 2009). However, abrupt shocks like the 2007-2008 worldwide financial meltdown very often induce sudden changes in the sentiments of foreign investors, huge capital flights and painful economic corrections in the host economies.

The most recent economic facts in peripheral eurozone countries broadly follow the above sequence of events, and the tough policy measures they are currently implementing basically aim to deal with the accumulated external debt position. On the one hand, austerity packages may work to reduce imports by cutting expenditures, depressing economic activity and (indirectly) bring about a real exchange rate devaluation.⁵ On the other hand, since the exchange rate policy is out of the control of national monetary authorities, internal devaluation carried out through sharp wage cuts attempts to spur exports, and possibly, recovery. While these measures desperately try to counteract diverging inflation and unit cost trends between peripheral and central economies⁶ and restore the price competitiveness of peripheral goods, productive structure asymmetries (in the form of the specific types of goods produced and sold) may easily frustrate such efforts. Ultimately, contrary

⁵ See Gibson and van Seunter (2000) for an illustration of the mechanisms through which reductions in public expenditure induce a real exchange rate devaluation in a simplified open-economy neoclassical model.

⁶ See Dullien and Fritsche (2009) and Bibow (2012) on diverging unit cost dynamics among eurozone countries.

to what is supposed by most international organisations, whereas the export response to internal devaluation may be mild, huge wage cuts may throw the economy into a deep recession and further impinge fiscal solidity.⁷

What is the extent of the productive asymmetries among eurozone countries, in particular between central and peripheral economies? Simonazzi *et al.* (2013) have recently provided some evidence on structural differences between Germany and peripheral countries such as Spain, Greece and Portugal. They do so by analysing cross-country differences in manufactured goods' exports, as synthesised by the Spearman rank correlation coefficient calculated on the revealed comparative advantage (RCA) Balassa Index (BI). A more general perspective on all 28 European Union member states is provided by the European Commission (2013) by assessing and confronting the degree of sectoral productive specialisation characterising EU countries. In this paper we follow a similar logic and we first focus on differences in the industry composition of the domestic manufacturing sector. In more detail, we present a Productive Structure Similarity Index (PSSI), which is computed according to the following formula:

$$\text{Industry-level PSS index:} \quad PSSI_{jt}^i = \frac{|M_{jt}^i - M_{Gt}^i|}{(M_{jt}^i + M_{Gt}^i)}$$

⁷ Following the one-sector open economy model proposed by Taylor (1991), chapter 7, we know that: $du/dw = -(\partial\Delta/\partial w)/(\partial\Delta/\partial u)$, with Δ being the usual open-economy equilibrium condition, $u = (X/K)$ current capacity utilisation and w the monetary wage rate. Once $(\partial\Delta/\partial u)$ is assumed to be negative according to standard stability conditions, the above differential has a negative sign (i.e. wage cuts stimulate economic activity) if $(\partial\Delta/\partial w)$ is negative. A necessary condition for this event to occur is: $\eta/a - 1 - \pi(1 - s_w)X/E > 0$ (with η being exports elasticity to the real exchange rate, a domestic dependence on imported intermediate goods, π the profit share, s_w saving propensity out of wages, X and E domestic production and exports, respectively). It is very likely that some peripheral eurozone countries like Greece and Portugal will not meet the above conditions, due to their relatively low propensity to export and heavy reliance on domestic demand injections. As to the consequences of austerity policies on fiscal solidity, note that public debt-to-GDP ratios have continuously increased in peripheral countries. In 2012, a partial default has been arranged in Greece.

Aggregated manufacturing sector PSS index:

$$PSSI_{jt} = \sum_{i=1}^{i=n} \left[\frac{(M_{jt}^i + M_{Gt}^i)}{\sum(M_{jt}^i + M_{Gt}^i)} PSSI_{jt}^i \right]$$

where M_{jt}^i is the share of sector i of total manufacturing value added in country j at time t , and M_{Gt}^i represents the same figure in the case of Germany.⁸ The PSS index ranges from 0 (identical productive structures) to 1 (absolute divergence in the sectoral composition of the economy). We computed the PSSI for thirteen manufacturing sub-sectors and for the manufacturing sector as a whole, from 1999 to 2011. We take into account all the peripheral eurozone countries (the so-called PIIGS). We include in our analysis the Czech Republic and Poland as well. At the present time, these countries do not participate in the monetary union. Yet, according to Simonazzi *et al.* (2013), their productive structures have been significantly influenced by increasing productive connections with Germany. It might thus be interesting to compare the evolution of their productive structures with those that characterise peripheral eurozone countries in order to check for the emergence of two different (and diverging) production poles inside Europe. In the case of Spain, Ireland and Greece we also computed a PSSI index for the construction sector, in order to emphasise the housing bubble (and the consequences for productive structures) affecting those countries before the 2007-2008 crisis, as well as the abrupt collapse (at least compared to other economies) of this same sector in the post-crisis period. Results for the overall manufacturing sector are reported in table 1 below.

Results reported in table 1 show that small peripheral eurozone countries such as Greece, Portugal and Ireland present largely different productive structures with respect to the German one. Furthermore, productive asymmetries versus Germany seem to have widened and increased in the aftermath of the financial meltdown and throughout the ongoing eurozone crisis.

⁸ We built the PSS index in the same way as the well-known intra-industry trade Grubel-Lloyd index. Of course, arguments in the PSS index are industry shares of total manufacturing value added in the economy under consideration and in the benchmark economy (i.e. Germany), instead of export and import flows among trading partners.

More disaggregated data⁹ tell us that most of these asymmetries come from the relative (and increasing) state of backwardness among the above peripheral countries in the production of capital goods, which, on the contrary, stands out as the core of German productive specialisation. This evidence may be a sign that productive development is not fully complete in the aforementioned peripheral economies, since the emergence of a considerable capital goods sector has traditionally been seen as the most advanced stage in the development process of an economy (Akamatsu, 1962; Ricottilli, 1993; Kojima, 2000). Furthermore, provided that a productive structure featuring a relatively developed capital goods sector is an important factor conducive to innovation and growth (Ricottilli, 1993), perverse structural changes linked to the ongoing crisis may have a long-lasting negative impact on the growth potential of small peripheral economies.

Productive asymmetries with respect to Germany are much less evident in the case of larger economies such as Italy and Spain. However, centre-(big) peripheral countries' asymmetries are slightly increasing across time, this evidence being different from the conclusions reached by Simonazzi *et al.* (2013) in the case of Italy. In 2010 and 2011 in particular, the persistent recession affecting peripheral economies seems to have impeded the recovery of the investment goods sector, while Germany recorded a significant upturn in its most typical industries.¹⁰ Once again, should demand side-supply side interactions in the capital goods sector be relevant sources of technological spillovers for the whole economic system, such a temporary shock may impinge long-run performances also in the case of larger peripheral countries.

As expected, Austria and the Czech Republic show a productive structure closely similar to that of Germany. In the case of the Czech Republic, according to Simonazzi *et al.* (2013), this may be the result of

⁹ More disaggregated data are available from the authors on request.

¹⁰ According to data from Eurostat, in 2012 gross fixed capital formation (read investment demand) in Germany was higher than its 2005 pre-crisis level. By contrast, in Greece and Ireland investment demand was broadly half than that recorded in 2005. From 2005 to 2012, it decreased by one-third in Portugal. In the case of Italy and Spain, drops in investment demand amounted to 20 and 28 percentage points, respectively.

Table 1 – *Productive Structure Similarity Index (PSSI) between selected European countries and Germany*

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Austria													
PSSI	0.18	0.17	0.18	0.18	0.18	0.17	0.17	0.16	0.16	0.15	0.14	0.18	0.17
Czech Republic													
PSSI	0.18	0.17	0.18	0.19	0.19	0.18	0.16	0.16	0.15	0.17	0.17	0.16	0.16
France													
PSSI	0.14	0.14	0.17	0.18	0.18	0.18	0.17	0.18	0.19	0.18	0.17	0.20	0.20
Greece													
PSSI (M)	0.40	0.40	0.38	0.37	0.39	0.38	0.38	0.37	0.39	0.39	0.41	0.44	0.45
PSSI (C)	0.13	0.15	0.21	0.14	0.19	0.22	0.26	0.37	0.31	0.24	0.07	0.13	0.30
Ireland													
PSSI (M)	0.49	0.44	0.48	0.49	0.46	0.46	0.44	0.45	0.46	0.47	0.48	0.52	0.53
PSSI (C)	0.10	0.16	0.22	0.22	0.27	0.36	0.43	0.46	0.40	0.26	0.21	0.41	0.46
Italy													
PSSI	0.19	0.19	0.20	0.21	0.22	0.21	0.21	0.21	0.22	0.22	0.19	0.22	0.22
Poland													
PSSI	0.29	0.29	0.30	0.29	0.28	0.28	0.28	0.26	0.29	0.29	0.24	0.29	n.a.
Portugal													
PSSI	0.31	0.30	0.31	0.33	0.34	0.34	0.35	0.35	0.35	0.35	0.33	0.35	n.a.
Spain													
PSSI (M)	n.a.	0.20	0.20	0.21	0.22	0.23	0.24	0.24	0.25	0.25	0.22	0.24	0.24
PSSI (C)	n.a.	0.32	0.38	0.42	0.46	0.50	0.54	0.55	0.54	0.53	0.50	0.42	0.37

Note: letters (M) and (C) in parentheses stand for ‘manufacturing sector’ and ‘construction sector’ respectively.

Source: author’s calculation on the basis of data from Eurostat.

the reorganisation of German industries through partial delocalisation in Eastern European countries. In the same vein, Poland presents a productive structure more similar to the German one than Portugal and Greece do, even though in 2008 the level of economic development in Poland (as expressed by GDP per-capita) was less than one-half of that in Greece, and barely 60 percent of Portuguese GDP per-capita.¹¹

Finally, note the astonishing housing-boom-led expansion of the construction sector in Greece, Ireland and Spain. In all these economies, the PSSI index indicated remarkably increases in the economic relevance of the construction industry in the years preceding the outbreak of the worldwide financial crisis, this fact being a clear sign of the abnormal dimension (at least with respect to Germany) assumed by such a productive sector in the peripheral countries under observation. The huge drop in this same index since 2007 onwards, and its subsequent increase in Ireland and Greece, now stand for construction sectors further contracting and now downsized with respect to what is observed in Germany, and, more in general, in other European Countries.

In table 2, we extend our analysis and compute the above *aggregated* similarity index by now taking into account the sectoral composition of country exports. Sector definition follows the ‘technological classification’ provided by UNCTAD, according to which export flows are subdivided into four different groups on the basis of their input and technological intensity: resource-based and labour-intensive sectors; low-skill and low technology-intensive sectors; medium-skill and technology-intensive production; high-skill and technology-intensive industries. Arguments in the now-redefined Export Structure Similarity Index (ESS) are sectors’ export shares on total country exports.

Computation of the ESS index confirms that productive structure asymmetries between Germany and small peripheral countries such as Greece, Portugal and Ireland are mirrored in relatively deep export structure differences. ESS index values associated to the above

¹¹ According to traditional trade theory, trade and productive structures might be expected to become more similar the closer the development level of the economies under observation is. The above results may thus be considered partially surprising.

economies are the highest among those reported in table 2. By contrast, export structure differences are much lower or rapidly decreasing in the case of Austria, the Czech Republic and Poland. Once again, high or quickly increasing export similarity between Germany, the Czech Republic and Poland is likely due to German companies' outsourcing to the above-East-European countries, and of the ensuing increase in intra-industry trade. Table 2 confirms the existence and further development of a well-connected cross-border productive block in the core centre of Europe among Germany and Eastern European countries.

Data reported in table 2 also show that export structure differences between Germany and peripheral economies seem to be much lower when larger countries such as Italy and, in particular, Spain are considered. On the one hand, this result might be expected and could be due to the fact that larger peripheral countries likely produce and export a wider range of products than small economies do. On the other hand, this also depends on the high level of aggregation of trade records from which ESS indexes are calculated. Indeed, a closer look and a more disaggregated analysis of available trade statistics restores a sense of remarkable centre-periphery asymmetries, even when large peripheral economies are taken into account.

Table 3 reports data on RCA Balassa indexes associated with the above-defined sectors. As expected, Germany shows a persistent comparative advantage in medium-tech sectors including most capital goods industries. From 1999 to 2012, German exports seem to concentrate even further in the medium/high-tech segment of manufacturing goods, while a process of increasing *de*-specialisation is taking place in labour and resource-intensive or low-tech sectors. Quite interestingly, the same processes can be detected in countries such as Poland and the Czech Republic.

Italy and Spain are somehow midway on a hypothetical technology ladder from the eurozone periphery to Germany. In the case of Italy, its strong and persistent export specialisation in labour-intensive and low-tech sectors is evident. Italy also maintains a relatively weak specialisation in mechanical industry (a traditional pillar of Italian

Table 2 – *Export Structure Similarity Index (ESSI) between selected Eurozone countries and Germany*

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	0.19	0.18	0.19	0.18	0.19	0.16	0.16	0.15	0.15	0.16	0.16	0.16	0.16	0.17
Czech Republic	0.18	0.17	0.17	0.14	0.16	0.15	0.15	0.16	0.15	0.16	0.17	0.16	0.16	0.17
France	0.09	0.10	0.10	0.10	0.11	0.10	0.11	0.11	0.11	0.12	0.13	0.15	0.16	0.17
Greece	0.43	0.40	0.39	0.36	0.37	0.34	0.35	0.31	0.29	0.31	0.30	0.31	0.32	0.33
Ireland	0.65	0.65	0.65	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.64	0.65	0.66	0.65
Italy	0.23	0.24	0.24	0.23	0.22	0.22	0.21	0.21	0.20	0.19	0.19	0.19	0.19	0.21
Poland	0.37	0.31	0.33	0.31	0.29	0.26	0.23	0.21	0.20	0.19	0.18	0.18	0.20	0.20
Portugal	0.38	0.36	0.37	0.36	0.35	0.34	0.32	0.30	0.31	0.30	0.31	0.30	0.30	0.30
Spain	0.09	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.09	0.10	0.10	0.10	0.11	0.11

Source: author's calculation on the basis of data from UNCTAD.

exports). However, (revealed) comparative *disadvantages* are deep in the high-tech sector. As far as Spain is concerned, relative specialisation in the low-skill intensive sector is accompanied by comparative advantages in medium-skill technology-intensive industries. This last fact is obviously a common aspect with respect to the German experience, and consistent with low ESSI index values shown in table 2. Nevertheless, whilst Spain's relative specialisation in medium-skill sectors is mostly due to strong export concentration in a restricted bunch of industries, motor vehicles and railway vehicles mainly (sector codes 781, 782, 784 and 791 in the three-digit SITC rev. 3 classification), German specialisation is the outcome of a much more diversified export structure, and comparative advantages were recorded in almost all capital goods sectors included in the medium-tech category (more on this point in the following section). Indeed, when a covariance index is computed to evaluate the similarity of Spain vs. Germany in the sectoral distribution of comparative advantages in 2012, a negative value equal to -0.06 is obtained.¹² With the exception of a few sectors, Germany presents comparative advantages in those industries where Spain does not.

Small peripheral countries such as Greece, Ireland and Portugal are characterised by a radically different picture. Their export despecialisation in the medium-tech capital goods sector is evident and striking in the case of Ireland and Greece. In Greece and Portugal, comparative advantages are still significantly localised in labour and resource-intensive and low-tech sectors. In Greece and Ireland, finally, an RCA Balassa index higher than 1 is recorded in the case of high-tech industries. This perhaps surprising result largely depends on the type of manufacturing production included in such a group. According to UNCTAD classification, most chemical industries are classified as high-tech production. It is in these sectors that Greece and Ireland score an

¹² Spanish-German covariance in sectoral specialisation is calculated according to the following index: $COVBI_{G/ES} = \left(\frac{1}{n}\right) \sum (BI_i^G - 1)(BI_i^{ES} - 1)$, with BI_i^G and BI_i^{ES} being German and Spanish Balassa indexes in sector i in 2012, respectively.

Table 3 – *RCA Balassa Index in selected European countries and in selected manufacturing sub-groups*

	1999	2005	2006	2007	2008	2009	2010	2011	2012
Austria									
Labour-intensive and resource-intensive	1.04	0.94	0.91	0.94	0.93	0.90	0.87	0.87	0.95
Low-skill and technology-intensive	1.66	1.51	1.45	1.48	1.49	1.67	1.61	1.62	1.64
Medium-skill and technology-intensive	1.07	1.17	1.17	1.16	1.17	1.17	1.16	1.15	1.11
High-skill and technology-intensive	0.56	0.59	0.62	0.63	0.61	0.66	0.68	0.67	0.68
Czech Republic									
Labour-intensive and resource-intensive	1.06	0.85	0.80	0.79	0.76	0.72	0.69	0.69	0.68
Low-skill and technology-intensive	1.78	1.51	1.41	1.35	1.32	1.35	1.29	1.33	1.35
Medium-skill and technology-intensive	1.13	1.36	1.39	1.40	1.43	1.55	1.54	1.52	1.49
High-skill and technology-intensive	0.50	0.43	0.42	0.42	0.42	0.42	0.42	0.41	0.42
France									
Labour-intensive and resource-intensive	0.70	0.65	0.65	0.67	0.66	0.63	0.61	0.64	0.67
Low-skill and technology-intensive	1.06	0.91	0.90	0.92	0.86	0.89	0.85	0.81	0.82
Medium-skill and technology-intensive	1.01	1.04	1.01	1.00	0.99	0.98	0.94	0.94	0.90
High-skill and technology-intensive	1.30	1.31	1.34	1.33	1.35	1.34	1.42	1.42	1.42
Germany									
Labour-intensive and resource-intensive	0.57	0.53	0.53	0.54	0.55	0.54	0.53	0.54	0.51
Low-skill and technology-intensive	1.01	0.92	0.91	0.90	0.86	0.93	0.90	0.86	0.88
Medium-skill and technology-intensive	1.23	1.32	1.29	1.29	1.31	1.33	1.35	1.35	1.32
High-skill and technology-intensive	1.09	1.01	1.03	1.02	1.02	1.01	0.99	0.97	1.01
Greece									
Labour-intensive and resource-intensive	2.57	1.80	1.70	1.62	1.56	1.46	1.46	1.35	1.53
Low-skill and technology-intensive	1.18	1.43	1.34	1.34	1.56	1.54	1.42	1.85	1.69
Medium-skill and technology-intensive	0.33	0.42	0.49	0.55	0.49	0.47	0.49	0.50	0.45
High-skill and technology-intensive	0.82	1.22	1.21	1.20	1.18	1.24	1.26	1.19	1.22

(continues)

(continued)

	Ireland									
Labour-intensive and resource-intensive	0.23	0.14	0.14	0.14	0.12	0.08	0.11	0.10	0.11	
Low-skill and technology-intensive	0.19	0.10	0.11	0.12	0.10	0.08	0.09	0.10	0.10	
Medium-skill and technology-intensive	0.27	0.16	0.18	0.18	0.17	0.14	0.14	0.15	0.15	
High-skill and technology-intensive	2.92	3.19	3.14	3.18	3.13	2.91	2.95	2.98	2.97	
	Italy									
Labour-intensive and resource-intensive	1.49	1.40	1.39	1.36	1.35	1.29	1.31	1.32	1.39	
Low-skill and technology-intensive	1.21	1.27	1.27	1.31	1.25	1.40	1.32	1.30	1.30	
Medium-skill and technology-intensive	0.92	0.99	1.01	1.03	1.07	1.11	1.07	1.06	1.01	
High-skill and technology-intensive	0.65	0.69	0.67	0.65	0.63	0.64	0.68	0.68	0.70	
	Poland									
Labour-intensive and resource-intensive	1.84	1.34	1.27	1.27	1.22	1.21	1.25	1.24	1.26	
Low-skill and technology-intensive	2.22	1.70	1.56	1.56	1.48	1.56	1.42	1.55	1.59	
Medium-skill and technology-intensive	0.73	1.11	1.15	1.15	1.19	1.29	1.23	1.17	1.12	
High-skill and technology-intensive	0.42	0.43	0.45	0.45	0.48	0.46	0.52	0.53	0.57	
	Portugal									
Labour-intensive and resource-intensive	2.42	2.22	2.17	2.25	2.21	2.18	2.18	2.19	2.12	
Low-skill and technology-intensive	0.67	0.88	0.95	0.98	0.95	1.04	0.97	0.95	1.10	
Medium-skill and technology-intensive	0.83	0.89	0.91	0.87	0.91	0.95	0.93	0.92	0.92	
High-skill and technology-intensive	0.36	0.48	0.48	0.51	0.51	0.46	0.52	0.54	0.54	
	Spain									
Labour-intensive and resource-intensive	0.92	0.88	0.91	0.92	0.96	0.95	0.94	0.94	0.99	
Low-skill and technology-intensive	1.22	1.26	1.26	1.15	1.11	1.20	1.21	1.20	1.19	
Medium-skill and technology-intensive	1.23	1.20	1.20	1.21	1.21	1.26	1.19	1.21	1.14	
High-skill and technology-intensive	0.69	0.80	0.78	0.81	0.80	0.79	0.86	0.82	0.87	

Source: author's calculation based on data from UNCTAD.

increasing export specialisation.¹³ Germany, on the contrary, is acquiring an increasing specialisation in the production of high-tech transport equipment and scientific instruments (sector codes 791 and 87 in the SITC rev. 3 classification). Also in this case, centre-periphery differences that may appear somehow softened at an aggregate level of analysis clearly re-emerge when a more disaggregated perspective is adopted.

2.1. Specialisation versus diversification in the eurozone

Some economists might reply to this analysis by arguing that productive and export differences among countries might not necessarily imply negative consequences for the long-run growth potential of an economy. According to them, trade and monetary integration might actually accelerate economic growth thanks to dynamic economies of scale originating from production and trade specialisation (Rivera-Batiz and Romer, 1991; Backus *et al.*, 1992; Lee, 1995; Lane, 1996). While this argument usually refers to economic integration among similar developed countries (Rivera-Batiz and Romer, 1991), two possible answers could be levied against such an objection. First, a traditional response would stress that growth performance depends on the specific sector you specialise in. Growth potential in the periphery may thus worsen (at least with respect to the centre) should it perversely specialise in passive sectors experiencing poor technological improvements. Second, according to some recent evidence, economic growth and a relevant part of the development process are significantly characterised by a process of productive and export diversification, instead of concentration and specialisation (Imbs and Wacziarg, 2003; Klinger and Lederman, 2004; Rodrik, 2007). It is the enlargement of the production (export) space of a given economy that allows for growth acceleration

¹³ Greece is specialised in the production of fertilisers, perfumes and plastic goods (sector codes 55, 56 and 57 in the SITC rev. 3 classification). In the case of Ireland, specialisation is strongly concentrated in the production of perfumes and pharmaceutical goods (sector codes 541, 542 and 551 in the SITC rev. 3 classification at three-digit disaggregation level).

and catching-up with more advanced countries (Herzer and Nowak-Lehmann, 2006; Rodrik, 2007).¹⁴

In light of this evidence, here we re-elaborate the analysis carried out in the previous section in order to stress differences between central and peripheral countries as to the diversification of their productive and export bases. Indeed, when we emphasise the need for a process of structural convergence between central and peripheral economies, we do not mean that all of them should adopt exactly the same productive structure and export the same types of goods. Yet, we stress that peripheral eurozone countries, in particular some small peripheral economies, should undertake a significant process of innovation-led diversification of their production sectors towards high-tech dynamic sectors in order to partially close the structural gap with respect to more advanced central economies.

There is an intrinsic contradiction between revealed comparative advantages, as measured by the Balassa index, and the degree of diversification in an economy's production and export base. The more heterogeneous the range of goods you produce and export on international markets, the lower the sectoral Balassa indexes will be.¹⁵ In order to deal with these technical aspects, in table 4 we present a series of indicators which, taken together, may perhaps provide a comprehensive perspective on the structural features of selected European countries. Data reported in table 4 rely on a detailed three-digit decomposition of European countries' exports. In column one we compute the number of industrial sectors showing values of Balassa index higher than 0.9 (i.e. those sectors that present or are close to presenting a comparative

¹⁴ The specialisation/diversification divide may be at least partially reconcile if you think that specialisation in the industrial sector away from natural-resource based industries (i.e. a main feature of the development process) generally entails the expansion of the range of home-made manufactured goods. In a way, product diversification may lie behind specialisation in manufacturing or traded-good sectors that characterise fast-growing economies in two-sector models by Krugman (1981) and Matsuyama (1992) among others.

¹⁵ Indeed, this is why average Balassa indexes are generally higher in relatively backward countries with export structures concentrated in a restrict bunch of sectors than in more diversified advanced economies.

advantage).¹⁶ Column two reports the median value of the sectoral Balassa indexes. We put emphasis on a median Balassa index instead of an average one because the former is more robust than the latter. In addition, average values of sectoral Balassa indexes are influenced by in-built asymmetries characterising the computation of such an indicator: an average sectoral Balassa index, taken alone, might provide a distorted image of a country's external competitiveness.¹⁷ Finally, in the third column of table 4, we report the inverse of sectoral Balassa indexes' variance. We label such an indicator as the concentration index, since it might provide information about the degree of homogeneity of a country's export structure. Values in parentheses in column three are average values of the sectoral Balassa indexes. Figure 1 graphically reproduces data reported in table 4. In figure 1, the dimensions of each bubble stand for the abovementioned concentration index. The larger (the lower) a bubble dimension is, the higher is a country sectors' comparative advantage concentration (dispersion) around its mean value.

According to table 4, in Germany 106 out of 166 industrial sectors included in the SITC rev. 3 classification (at three digit disaggregation level) score Balassa indexes higher than 0.9 in 2012. This figure is the highest registered amongst the European countries under observation, and far higher than the same statistics recorded in most peripheral countries with the partial exception of Italy. Consistent with the above results, the median Balassa index in Germany is rather high and equal to 1.01. It is

¹⁶ Statistics reported in column 1 of table 3 are computed according to a Balassa index threshold level lower than 1 (i.e. the traditional boundary between revealed comparative advantage and disadvantage), and equal to 0.9. We do so in light of the above consideration of the inverse relationship connecting revealed comparative advantages and the diversification of an economy export structure. The lower-than-usual threshold we adopt allows us to take into account in our statistics also those industries that register Balassa indexes slightly lower than 1 but that might wrongly be considered as uncompetitive. Their apparent lack of competitiveness may actually derive from a widening of the home economy export base rather than from a country's exclusion from international markets.

¹⁷ By construction, the Balassa index ranges between zero and, potentially, infinity. Accordingly, the arithmetic average of sectoral Balassa indexes will naturally increase in the case of highly concentrated productive structures. Median values of the above index, on the contrary, better reflect the degree of sectoral polarisation of a country's productive and export vector.

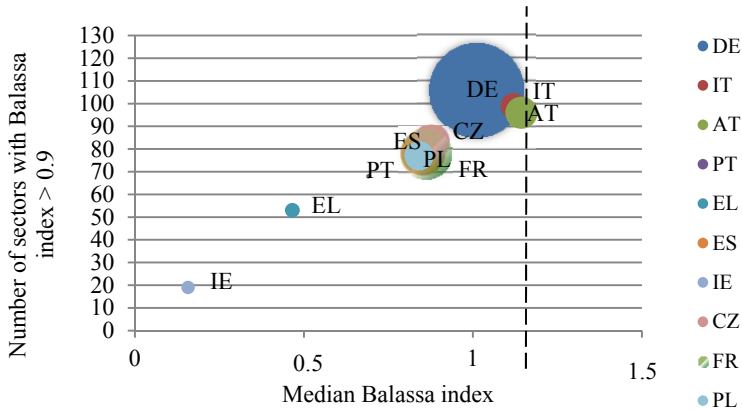
much higher than those characterising peripheral countries (with, again, the exception of Italy). In the case of Portugal, Greece and, in particular, Ireland, median Balassa indexes are considerably lower than 1. This means that these countries feature highly concentrated export structures: the vast majority of industrial sectors show revealed *disadvantages*, whilst comparative advantages emerge only in a few of them. Such a perspective is corroborated by both the considerable gap that divides median from average Balassa indexes in the above economies (the latter being considerably higher than the former), and by the high dispersion of sectoral comparative advantages (indexes) around corresponding mean values (see the smaller bubbles associated with small peripheral economies in figure 1). The median and average Balassa indexes are almost equal in Germany. Further, from figure 1 it becomes astonishingly clear that a high level of concentration of sectors' Balassa indexes are clustered around the corresponding mean value in Germany (dashed vertical line in figure 1). Needless to say, this is a sign that, on top of increasing price competitiveness, Germany's enthusiastic export performances significantly depend on structural causes, i.e. the diversification of Germany's productive structure and the capability to export a wide range of goods.

Table 4 – *Export (productive) structure differentiation in selected European countries 2012*

	Industrial Sectors with RCA > 0.9	Median	Concentration Index (Average Balassa Index)
Austria	96	1.14	0.65 (1.34)
Czech Republic	83	0.88	0.78 (1.22)
France	78	0.86	1.61 (1.03)
Germany	106	1.01	5.53 (1.06)
Greece	53	0.47	0.14 (1.07)
Ireland	19	0.16	0.11 (0.79)
Italy	99	1.12	0.41 (1.32)
Poland	77	0.84	0.53 (1.25)
Portugal	68	0.69	0.01 (2.09)
Spain	78	0.85	1.17 (1.07)

Source: author's calculations based on data from UNCTAD.

Figure 1 – *Export (productive) structure differentiation in selected European countries 2012*



Source: author's elaboration based on data from UNCTAD.

The empirical evidence presented so far, and the above economic implications, deserve three more comments.

First, Ireland seems to represent an exception to the prototype development process described in the previous sections, and a peculiar case with respect to other central and peripheral euro countries. Indeed, impressive GDP per-capita growth rates registered in Ireland in the second half of the 1990s and before the outbreak of the global financial crisis largely hinged on the expansion of a few dynamic high-tech sectors. Accordingly, Ireland's successful catching-up to more developed economies mostly relied upon increasing productive and export polarisation rather than diversification, suggesting that diversification might not be a necessary condition for growth acceleration and solid external balance-of-payments positions to emerge. Although we cannot neglect the positive outcomes of such an alternative development pattern, exclusive reliance on it should be undertaken with caution. First, specialisation-based growth may be viable and sustainable in the case of small economies (like Ireland), but perhaps less suitable in the case of

larger countries. Second, the Irish development experience has some shadowy areas beside the highlights. Indeed, Irish high-tech exports are mostly due to foreign multinationals delocalising a small (and decreasing) part of much wider (and internationally fragmented) production processes in Ireland. According to recent analyses by the European Commission on global value chains (2013), the effective domestic content of Irish manufacturing exports is lower than 50 percent, this figure being significantly lower than those observed in other eurozone and Eastern European countries. Furthermore, domestic services, in particular knowledge-intensive business services, account for a marginal part of Irish manufactured exports' value added.¹⁸ All in all, the Irish export sector seems to be a sort of enclave with poor backward and forward linkages with the rest of the economic system.¹⁹ These facts cast doubts on the concrete capability of the Irish export sector to feed fast export-led recovery and, above all, job creation.²⁰ Macroeconomic data reported in the appendix to this paper demonstrates that during the 2000s and before the outbreak of the world crisis, persistent Irish trade balance surpluses had become insufficient to compensate for huge profit repatriation out of Ireland, and insufficient to avoid an overall negative current account position from emerging. It is reasonable to believe that safe current account surplus positions might be obtained in the future only by

¹⁸ Some recent empirical analyses stress the positive effects knowledge-intensive business (KIB) service inputs can induce on manufacturing innovativeness (Ciriaci *et al.*, 2013). In light of this evidence, scarce production linkages between export sectors and domestic KIB services in Ireland could represent a shortcoming of the Irish development pattern raising constraints to its innovation capabilities and perhaps to its long-run sustainability.

¹⁹ According to Foster *et al.* (2013), possible negative effects of poor backward and forward linkages on domestic development might be compensated for by efficiency gains and higher external competitiveness of home-made production as accruing from participating at internationally fragmented value chains.

²⁰ See Kinsella (2012; 2014) on the pros and cons of the peculiar Irish development model, and on the effectiveness of austerity packages when applied to the specific Irish context. Note, in particular, Kinsella's concern about unemployment rates higher than those expected according to EU/IMF forecasts, and recent unemployment reductions mostly due to emigration (Kinsella, 2014). Note, also, that a brief inspection of the IMF's most recent projections on Irish growth would reveal significant downsizing with respect to past post-bailout forecasts in the order of 1 percentage point (see IMF World Economic Outlook, April 2014).

increasing the degree of integration of the Irish export sector with the rest of the economy, and by widening the set of exported goods. This might be the main goal of future industrial policies targeted on the specific needs of eurozone peripheral countries, Ireland among others (more on this in section 4 of the paper).

Second, large peripheral economies such as Spain and Italy appear much closer to Germany in terms of productive and export diversification than small peripheral countries do. In Italy, in particular, the majority of manufacturing sectors present Balassa indexes higher than 0.9 (99 sectors out of 166). This is likely due to the long-lasting Italian tradition in the production of some manufactured goods. This fact notwithstanding, the Italian economy seems to be stuck in a sort of structural hysteresis. In line with data contained in table 3, Italian manufacturing strength remains concentrated in labour and low-skill intensive sectors, while more technologically advanced sectors are largely absent from the Italian production landscape. This fact is reflected in the high level of polarisation (i.e. a low concentration index) of comparative advantages that characterises the Italian economy.

Productive and export diversification have been relatively intensive in the Czech Republic and Poland. These countries are now better ranked than small peripheral eurozone countries in terms of the widening of their production space. Such structural changes may have favoured the partial convergence in GDP per-capita that has recently emerged between these countries and peripheral eurozone economies like Portugal and Greece (see figure A.1). However, their long lasting effects on Poland and the Czech Republic's growth potential are still to be verified. These effects will largely depend on the deepness of the aforementioned structural changes. Indeed, the Czech Republic experience seems to present similarities with the Irish development pattern, since the emergence of new sectors seems to reflect delocalisation in the home economy of relatively small segments of much more complex production processes. Accordingly, these sectors are weakly embedded in the host economy, and give rise to a scarce demand for manufacturing and service-sector inputs. This same evidence is much less strong in the case of Poland, where domestic production connections appear more solid (see European

Commission, 2013). Once again, it could be expected that pro-growth effects of ongoing structural change will differ from one economy to another according to the capability of new industries to demand domestic intermediate inputs, and give rise to a ‘fat’ input-output matrix.

3. Productive asymmetries and innovation dynamics in the eurozone

A considerable body of literature has traditionally placed great emphasis on the problems arising from economic (and monetary) integration between asymmetric economies. Balance of payments constrained models, for instance, have clearly shown that productivity backwardness in the periphery can induce peripheral countries to persistently fall behind more developed economies (see McCombie and Thirlwall, 1994; Thirlwall, 2011). The economic scenario now prevailing in the periphery of the eurozone is no exception, and there exists mounting concern about hysteretic effects of the ongoing crisis on long-run growth and employment dynamics in peripheral countries (Fitoussi and Saraceno, 2013).

In the past, the strategic answer of most less developed countries to recurrent (external) imbalances and economic downswings was the intervention of the public sector in the economic sphere so as to support domestic industrialisation and eliminate structural asymmetries with respect to more developed economies. Since the beginning of the 1980s, however, the ruling policy regime has changed conformingly to the newly set neoliberal agenda. Sectoral industrial policies have been abandoned, and protectionist measures removed. Market liberalisation has been implemented in order to increase competitive pressures. Industrial policy has mostly taken the form of *horizontal* measures. According to this view, innovation should have emerged from market-driven business initiatives rather than public sector-targeted actions. Sectoral allocation of productive inputs should have been driven by unfettered market mechanisms, while industrial policy should have attended to increasing the availability of productive inputs only. From the neoliberal

perspective, long-run economic growth is purely a supply-side phenomenon.

The current institutional design of the eurozone is largely inspired by such a philosophy. So far, European industrial policy has largely amounted to a considerable body of rules aiming to eliminate market barriers, limit national governments' actions that may distort market mechanisms and enforce a business-driven approach to innovation. According to Pelkmans (2006), the European "economic union [mostly] consists of the internal market and a *very modest* set of cohesion [read regional] policies" (Pelkmans, 2006, p. 5). Protracted crisis in the periphery of the eurozone and persistent centre-periphery asymmetries now cast doubts on the effectiveness of such an institutional structure (Pianta and Lucchese, 2012). Pressures to rediscover and reconsider sectoral, and perhaps market-distorting, industrial policies are increasing (Aghion *et al.*, 2011). Indeed, some of these observations have gained some attention from EU institutions as witnessed by the most recent European Commission communications (European Commission, 2012; 2014) on the state of European industry. Yet, there are at least two well-grounded reasons to believe that such changes, although relevant, are not enough to effectively confront the deep and widening centre-periphery industrial-technology gaps. One argument comes from the economic theory on structural change and innovation. The other one is based on the observation of some stylised facts within the eurozone.

From a theoretical point of view, the process of structural change and production upgrading implies innovation. Indeed, structural change basically means that new sectors must emerge and new goods be produced through a more general Smithian process of increasing division of labour (Ricottilli, 1993). New and more efficient technologies must be adopted. The abundant evolutionary literature on innovation, in turn, underlines at least three main features of innovation processes. First, innovation requires the acquisition and development of scientific knowledge and of technological and managerial capabilities. The evolution of these competencies heavily relies on interactions between technologically intertwined firms and industries. In a way, firm and sectoral technological and productive dynamics can be thought of as

pieces of a more complex puzzle, in which they are strictly complementary to each other. In this context, the profitability of any single firm or industry is influenced by the (perhaps close) availability of other connected activities. Accordingly, market failures arising from a lack of coordination among interdependent productive initiatives can impede new production initiatives from being viable in relatively backward economies, and lead to cumulative divergence between developed and (relatively) underdeveloped economies (Ros, 2000; Lorentz and Llerena, 2004). Second, and consistently with the previous point, scientific and technological capabilities stand out as perhaps intangible inputs that are at least partially sticky and spatially localised (Cimoli *et al.*, 2009). Indeed, innovation and technological knowledge have a *cumulative* and *path-dependent* nature in that their evolution hinges on past innovation and knowledge (Cimoli *et al.*, 2009; Castellacci, 2007). Accordingly, it is pretty hard to believe that innovation capabilities and technological competencies could naturally flow from global technological frontiers to relatively backward economies only through market mechanisms. Last but not least, innovation processes involve a great deal of Knightian uncertainty, so that their positive outcome cannot be (probabilistically) assessed due to the lack of any reliable probability distribution function. It is even more so in the case of path-breaking innovations. This is why historical facts clearly show that most radical innovations (and the subsequent wave of creative destruction) are mostly due to public authorities' efforts in envisioning new technological paradigms, and to strong public support and procurement of targeted innovations. Several private sector innovations have been triggered by technological breaches previously opened or pursued by 'entrepreneurial states' (see Mazzucato, 2011 on this point).

All the above properties of innovation processes provide strong arguments for calling public intervention in the economic sphere back so as to stimulate structural change and economic development. Even more, paraphrasing Mazzucato (2011), state intervention may be expected not only to deal with market failures and to fix markets but also to actively create them. When related to the specific eurozone context, these observations imply that structural and technological convergence between

central and peripheral economies cannot be thought an automatic outcome of economic and monetary integration, and of unfettered market forces. More reasonably, it might take place in the future only by adopting some ad-hoc preferential measures targeted on peripheral regions' development needs (more on this in section 4).

Besides the above theoretical arguments, available empirical evidence on innovation performances in the EU undoubtedly confirms the persistence of profound technological and innovation gaps among member States.²¹ Even worse, centre-periphery structural differences may even widen in the foreseeable future as long-run outcomes of the present crisis. The European Commission clearly states in the 2013 Innovation Union Scoreboard (IUS) that from 2008 to 2012, "the overall process of [innovation performance] convergence witnessed in previous IUS editions has come to a halt [...] and has been reversed into divergence in 2012" (European Commission, 2013, pp. 11-12). In the case of Greece, in particular, innovation performance has dramatically weakened since 2008 on, scoring the worst negative percentage variation (-1.66% yearly) among European countries. The Innovation Union Scoreboard takes into account all 28 EU member states in evaluating converging and diverging patterns inside Europe. Nonetheless, a narrower focus on central and peripheral euro countries confirms the above findings. In table 5 below we first assess changes in the degree of dispersion of euro countries' innovation performances through the well-known Theil index. We do so since decomposition techniques applied to the Theil index allow us to measure how much of converging/diverging trends in euro countries' innovation performances might be imputed to 'within-group' and/or 'between-group' differences. In table 5, we also check for the emergence

²¹ The European Commission evaluates European countries' innovation performance by computing an eight-dimension index covering several aspects of the innovation process (i.e. public and private support to R&D activities, availability of high-skilled labour, firms interaction into production networks etc.). Results of this analysis are published as the Innovation Union Scoreboard (IUS). According to the 2013 Innovation Union Scoreboard, peripheral countries are still classified as 'moderate innovators'. On the contrary, Germany is classified as one of the most innovative worldwide economic systems together with Finland, Denmark and Sweden. Most of the other central developed economies are defined as 'innovation followers'. Ireland is the only exception among peripheral countries, since it belongs to the 'innovation followers' group.

of beta convergence as reflected by the degree of correlation between countries' innovation records at the beginning of a period and subsequent growth rates in innovation/technological deepening. Data on average annual growth rates are taken from Innovation Union Scoreboards 2008 and 2013, and distinguished between two different periods: the pre-crisis years from 2004 to 2008, and from 2008 to 2012.

According to table 5, mild signs of decreasing heterogeneity between central and peripheral euro countries were registered between 2006 and 2008. Most of this trend, however, was due to higher 'within-group' homogeneity, rather than lower technological differences between central and peripheral countries. Indeed, 'between-group' differences remain sustained and broadly unchanged all along the time span covered by our analysis. They still account, on average, for more than two-thirds of the observed dispersion.

Data contained in the 2008 Innovation Union Scoreboard seem to show some sort of beta convergence between central and peripheral countries. This data, however, should be viewed with caution since subsequent revisions of European countries' innovation performances generally tended to describe a wider central-periphery technological gap. Furthermore, the above tendency seems to be reversed since 2008 on, so that a deepening innovative gap now divides peripheral from central economies. This last result is highly influenced by the worrisome negative innovative performance characterising Greece during the last five years. Nonetheless, even when dropping Greece from our sample, centre-periphery technological convergence has stopped and substantially vanished since the outbreak of the present crisis. This picture could get even worse if we consider that some of the latest pieces of information contained in the most recent multi-dimensional innovation performance indexes refer to 2010. It is very likely that they do not reflect to a full extent the perverse effects of a protracted recession on the innovation parabola of peripheral economies.

Table 5 – *Converging/diverging trends in innovation performances, central and peripheral eurozone countries*

	2006	2007	2008	2009	2010	2011	2012
Dispersion in innovation performances (Theil index)	0.034	0.033	0.028	0.030	0.026	0.029	0.031
Within-group difference	0.012	0.011	0.007	0.009	0.007	0.010	0.009
(percentage of total)	(34)	(33.3)	(25.5)	(28.9)	(26.6)	(34.7)	(30.9)
Between-group difference	0.022	0.022	0.021	0.021	0.019	0.019	0.022
(percentage of total)	(66)	(66.7)	(74.5)	(71.1)	(73.4)	(65.3)	(69.1)
	2004-2008			2008-2012			
Beta convergence	-0.54			0.33			
Beta convergence (excl. Greece)				-0.004			

Source: author's calculation on the basis of data from the *Innovation Union Scoreboard*, years 2008, 2010, 2012 and 2013.

Note: 'central economies': Austria, Germany, the Netherlands and Finland. 'Peripheral economies': Greece, Ireland, Italy, Portugal and Spain. Theil index values are computed on the base of data provided by *Innovation Union Scoreboard* 2010 and 2013. Beta convergence calculations rely on data from 2008 *Innovation Union Scoreboard* for the period from 2004 and 2008. Data contained in the 2013 *Innovation Union Scoreboard* are used for assessing beta convergence since 2008 on.

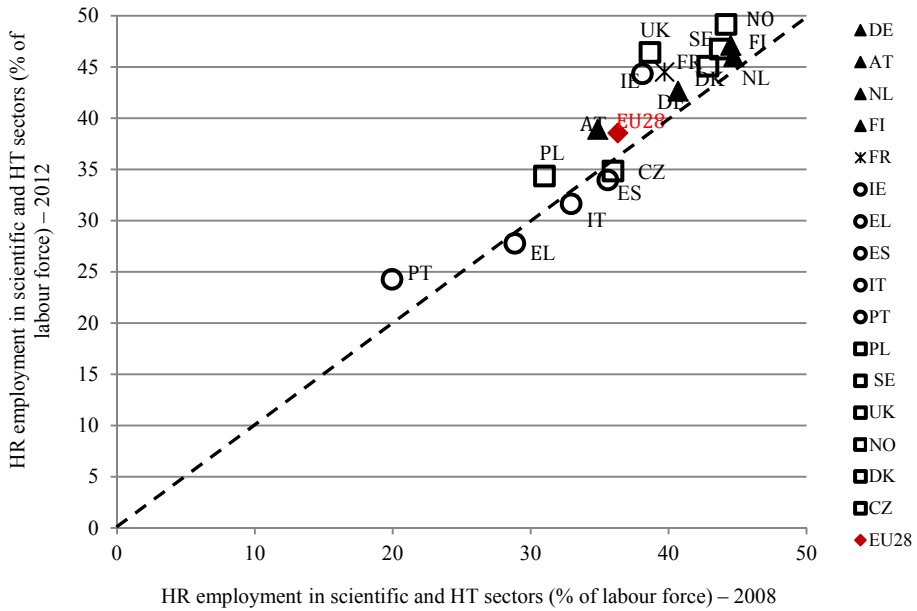
A closer look at the single components of the aggregated innovation performance index computed by the European Commission reveals that centre-peripheral gaps are particularly relevant in three fields. First, peripheral economies (with the exception of Ireland) lag far behind central economies concerning the accumulation of human resources as measured by the percentage of new doctoral graduates per thousand inhabitants (aged 24-64), and by the percentage of people completing upper secondary and tertiary education. Second, private and public financing of research activities and innovation, and firms involvement in R&D expenditures are particularly disappointing in peripheral countries with respect to data registered in central economies. Finally, peripheral countries seem to be persistently afflicted by a low capability to create shared innovations through (productive) linkages inside their own national innovation systems. This final point is particularly worrisome if

we think that, according to Filippetti and Archibugi (2011), “countries endowed with stronger national innovation systems [read central economies] are less affected and are better able to respond, at least in relative terms, to the present recession” (Filippetti and Archibugi, 2011, p. 10). Figures 2 and 3 below provide further evidence on such peripheral countries’ (negative) gaps. Figure 2 portrays data on human resource employment in scientific and high-tech sectors as a percentage of total labour force in 2008 and 2012 in selected European countries. In our view, these data may be intended as giving insights on technology absorption and generation capabilities in the above economies as related to employment opportunities in high-tech activities. Figure 2 clearly shows that peripheral euro countries lag far behind central economies, and that the centre-periphery gap is widening since 2008 on. Upward trends in the scientific and high-tech sectors’ employment have been uniformly registered in central economies (above-bisectrix points in figure 2). On the contrary, these same figures (slightly) decline in most peripheral eurozone countries (below-bisectrix points in figure 2), all but Portugal and Ireland in the post-crisis period. In this regard, data on Portugal and Ireland must be handled with care. Actually, (relative) employment dynamics in Portugal and Ireland also reflect rather unique reductions in the available labour force that have not been registered elsewhere. Effective improvements in high-tech sector employment in Portugal and Ireland are indeed smaller than those emerging, at first sight, from figure 2.

Figure 3 matches each other data on R&D expenditures by private firms and by public agents (governments and high-education institutions). According to figure 3, peripheral countries are clustered in the South-West part of figure 3 with respect to the North-East position of central economies. In the periphery, a low propensity to invest in innovative activities by the private sector is further exacerbated by relatively low efforts by national governments and higher education systems.

The empirical evidence portrayed through figures 2 and 3 is not surprising as far as the private sector’s innovative character is concerned. Indeed, a considerable body of literature clearly stresses that productive

Figure 2 – Human resource (HR) employment in scientific and high-tech (HT) sectors, selected European countries, years 2008-2012

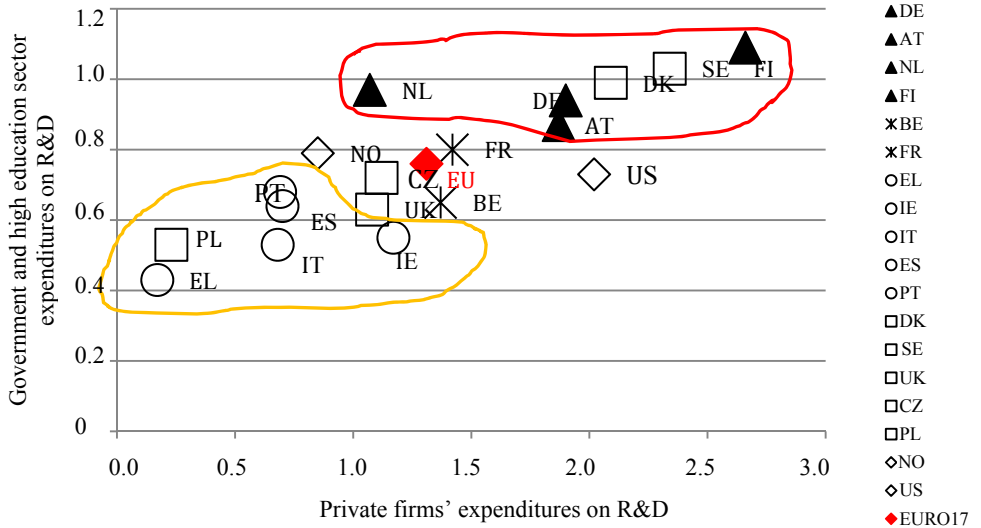


Note: last data available on United Kingdom refer to 2011. Country sample in figure 2 also includes Denmark (DK), the Netherlands (NL), Norway (NO), Sweden (SE) and the United Kingdom (UK).

Source: author’s calculation based on data from Eurostat.

structure asymmetries are naturally reflected in differing cross-country intensities with which private agents perform innovative activities, devote resources to R&D and eventually create employment opportunities in the high tech sector (Bilbao-Osorio and Rodriguez-Pose, 2004; Filippetti and Archibugi, 2011). In light of this, public authorities in the periphery should devote special attention to innovation (both directly and indirectly by properly incentivising private sector-led innovation) in order to overcome technology lock-in phenomena. In the short run, public authorities may be expected to compensate private sector backwardness in innovation activities. In the long run and according to a dynamic

Figure 3 – Public (Government plus high education sector) and private expenditures on R&D activities in percentage of GDP, selected countries, years 2011



Note: data on Greece (EL) refer to 2007. Data on the United States (US) refer to 2009. Country sample in figure 3 also includes Belgium (BE), Denmark (DK), the Netherlands (NL), Norway (NO), Sweden (SE), United Kingdom (UK) and United States (US).

Source: author's calculations based on data from Eurostat.

perspective, public institutions should try to trigger off virtuous self-reinforcing feedbacks between public-private innovation efforts. In this sense, Mazzucato (2011) is very clear when she notes that the emergence of innovative firms and new sectors very often represent long-run outcomes of an entrepreneurial state directly demanding and searching for technology leapfrogs. Data reported in figure 3 thus witness the co-existence of virtuous/vicious public-private feedbacks in innovation activities at the centre and at the periphery of the eurozone, respectively. There is a concrete risk that innovation capabilities in the periphery of the eurozone will further fall behind those of central economies and those of 'technology frontier' countries.

4. Regional policies for regional development: what's new for European industrial policy?

Theoretical reasons and empirical facts both suggest that existing centre-periphery structural asymmetries and diverging growth potentials will likely and naturally persist in the future in the absence of any specific economic strategy to tackle them. A deeply revised EU industrial policy is the first candidate to come in and deal with such a centre-periphery technology divide. Let's see some principles that may inspire future EU industrial policy.

According to the above evidence, future European industrial policy should have a strong *regional* character. With this term, we first mean that peripheral countries' productive development should become the main goal of industrial measures undertaken by European institutions, and that industrial policy should emerge as the strongest action to favour regional cohesion and centre-periphery convergence. Cohesion funds, structural funds and financial resources devoted to R&D and innovation should become parts of a unique integrated policy focused on peripheral countries' productive development.

The regional 'orientation' of EU industrial policies also means that they should be calibrated to specific regional development problems. The periphery of the Eurozone does not represent a homogeneous body. Rather, it is composed of heterogeneous systems with different needs. Ireland, we noted, is relatively well placed as to productive specialisation in dynamic and fast-growing sectors on international markets (see a positive correlation value in table 6 below).²² Yet, its export sector is

²² In table 6, we assess the degree of correlation between peripheral countries' sectoral revealed comparative advantages (RCA) and fast-growing manufacturing sectors (FGS) in international markets. Fast-growing sectors are defined as industries whose worldwide exports have growth, on average, faster than overall manufactured exports from 1995 to 2012. Correlation indexes reported in table 6 are computed according to the following formula: $\frac{RCA}{FGS} CI = \left(\frac{1}{n}\right) \sum_{i=1}^n (BI_i^j - 1) \left(\frac{g_i}{g_w} - 1\right)$. In the computation of a country $\frac{RCA}{FGS} CI$ index, BI_i^j stands for country j 's Balassa index (BI) in sector i in 2012; g_i is the average worldwide export growth rate in sector i from 1995 to 2012 and g_w is the average worldwide growth rate of overall manufactured goods from 1995 to 2012. Positive values

weakly linked with the rest of the economy. Industrial policy in Ireland should thus primarily focus on preserving existing Irish comparative advantages, whilst strengthening domestic productive networks, the export sector's demand for domestic manufactured and service inputs and domestic participation in global value chains.

Table 6 – *Peripheral euro countries' specialisation in demand dynamic sectors, correlation index 2012*

	RCA-(average) sectoral demand growth rate correlation
Greece	-0.12
Ireland	0.14
Italy	-0.28
Portugal	-0.76
Spain	-0.05

Source: author's calculation based on data from UNCTAD.

Italy and Spain are much more diversified economies, but Italy in particular still presents strong comparative advantages in stagnant and mature industries. Here, industrial policies should target the creation of new high-tech firms and sectors in order to strategically modify existing comparative advantages towards high-tech sectors and away from more traditional low-tech industries. Last but not least, industrial policies should likely adopt a multi-task perspective in small countries such as Greece and Portugal, in which strong productive and export concentration (i.e. poor diversification) combines with the low-tech nature of prevailing industries.

The regional focus of future EU industrial policies naturally raises questions as to the institutions that should finance and implement them. As to the financial side of the story, the sovereign debt crisis and the ensuing constraints (self-imposed by EU institutions or set by financial

indicate relative specialization in fast-growing sectors. Negative values witness a country's RCA advantages registered in a relatively stagnant industry.

markets) to member states' budgets impose strait jackets on national governments' capabilities to finance vigorous industrial and innovation policies. Thus, European institutions should take a much more interventionist stance, and considerably expand financial resources devoted to an integrated cohesion-industrial-technology policy. This is even more the case if we think about EU institutions acting in the (hopefully not too distant) future as the 'entrepreneurial state' described by Mazzucato (2011). Obviously, this would entail providing EU institutions with more conspicuous financial resources than are currently made available. Eurobond issuances in a future European or at least in a eurozone federal entity might be the financial vehicle needed to pursue this task.²³ Besides this, vital financial support to peripheral countries' productive development may be provided by the European Investment Bank (EIB). From the very outset, the EIB was conceived as a public development bank providing funds mainly for infrastructural projects (Griffith-Jones and Tyson, 2013). More recently, it has started to focus on the development of technologically advanced small and medium sized firms, as well. This is good news. Indeed, the EIB's traditional remit concerning infrastructure financing, although appreciable, cannot fully remove economic bottlenecks and coordination failures that prevent productive upgrading from taking place at the periphery of the eurozone. The EIB's financial support of productive development should thus become a main pillar of its action. Furthermore, it should go beyond the provision of public guarantees to private agents' financing of innovation efforts, and perhaps take a riskier direct financial stance with an anti-cyclical character. The EIB's financial load of supported projects should increase in times of financial and economic distress. Such a new

²³ Unfortunately, following Fiorentini and Montani (2013), the European Council seems to have recently preferred taking a different path, downsizing the EU budget instead of expanding it. On 8th February 2013, the European Council decided to cut the EU budget to 1% of EU GDP. Furthermore, an eight percentage point cut in cohesion and regional funds has been proposed in the framework of the 2014-2020 multi-period budget. Ultimately, Horizon 2020, i.e. the European Commission 2014-2020 R&D program, establishes that European funds for R&D and innovation activities will amount to €80 billion from 2014 to 2020, i.e. 0.08 percent of 2012 EU GDP yearly. It is very hard to see how these (to be fair) modest measures could effectively address inside-Europe discrepancies noted in the paper.

orientation would constitute a deep discontinuity with respect to the EIB's current behaviour. Indeed, the co-financing philosophy that currently informs its operation intrinsically makes it pro-cyclical whenever austerity programs cut national funds for public investment and depress private agents' propensity to take on risk.

As to the institutional framework in which EU industrial policy should be implemented, national and sub-national authorities will likely play a decisive role in order to make its implementation efficient and effective. Designing EU industrial policies according to regional development needs requires recollecting information on local development bottlenecks and opportunities, calibrating policy measures in order to maximise local systems' responsiveness, as well as screening and evaluating policy outcomes. National and regional authorities may likely perform these functions better than a centralised authority due to their proximity and supposedly better knowledge of regional socio-economic contexts. These facts notwithstanding, we argue that national and sub-national authorities should be integrated into and cooperate with a wider EU-centred institutional body. We think about, let's say, a European Industrial Development Authority interacting with economic agents and local institutions, and coordinating investment in order to foster innovation in the European Union as a whole, and in peripheral countries in particular. Historical experience of the Japanese Ministry for Trade and Industry (MITI) might somehow inspire the design of the European Industrial Development Authority. Quests for such an industrial policy integration and coordination at central European level emerge from the need for avoiding and possibly eradicating regional differences and disparities in the efficient implementation of designed policies. Indeed, there is evidence of a lack of administrative capabilities at national and sub-national level that, historically, have prevented supported regions to fully exploit financing opportunities, channel available funds towards the most remunerative investment projects and/or, more radically, to design any effective industrial measure (Ederveen *et al.*, 2006; Milio, 2007). Should these inabilities persist, any strong EU financial support to region-centric industrial policies would likely prove useless. The integration/coordination of regional institutions

with a central EU industrial policy authority may at least partially fix past implementation problems (see also Barca, 2009 for an articulated proposal of a strong multi-level governance scheme for EU cohesion policy).

4.1 Some industrial policy targets and measures

The 2013 Innovation Union Scoreboard recognises the deep gap dividing peripheral economies, with the partial exception of Ireland, from central economies (and from international foreign competitors) as to the accumulation of human resources, identified here as a high educational level and professional skills attained by the domestic labour force. Even worse, from 2008 to 2012, the ongoing crisis has forced most peripheral economies to cut higher education funding. Cuts amount to far more than 10 percent of pre-crisis resources in Greece, Italy, Portugal, Spain and Ireland. By contrast, public support of higher education has increased in Germany and Austria (European University Association, 2012). It goes without saying that the above gap could be expected to widen even further with associated consequences in terms of growth and recovery potential. Indeed, following Filippetti and Archibugi (2011), the more skilled and well prepared a country's labour force is, the more resilient it is to economic downswings.

The European Commission is well aware of these trends and has recently called for an "immediate action to invest more in education and training" (European Commission, 2014, p. 16). Consistent with the European Commission's proposal, we suggest EU industrial/cohesion funds for peripheral countries with the primary aim of correcting the above discrepancy. EU funds to the periphery should support expenditures on higher education, scientific and technological education above all, so as to favour the larger domestic availability of high-skilled workers. In this vein, EU funds should also help to enlarge the domestic scientific research community, to strengthen physical infrastructures (say labs) devoted to hosting research activities, to finance international technology research programs held in peripheral countries, and more generally to encourage and stimulate scientific and high-tech research

activities carried out by universities and governmental-public centres in peripheral economies. Such initiatives might have positive side effects on the economic performances of peripheral countries insofar as they would increase peripheral countries' high-tech absorption and creation capabilities, and stimulate the emergence of a high-tech industry by creating more business-friendly environments (see Dosi *et al.*, 2006).

EU policies that increase the periphery's endowment of high-skilled human resources and make peripheral economies *in principle* more capable to absorb technological knowledge and create innovation are obviously appreciable. Nevertheless, they will hardly be effective by themselves. Indeed, their pro-growth impact vitally depends on local productive systems' responsiveness to supply-side stimuli. The cumulative and localised nature of technology and innovation processes indicates such a response might be mild since innovative firms will not automatically move to backward economies even in the presence of such supply-side incentives. The above EU efforts may be frustrated if better scientific, technological and innovation *potential* capabilities (as incorporated in a high-skilled labour force and an increased availability of, let's say, engineers or physicians) do not find adequate employment opportunities in the domestic productive system.²⁴ Should such employment opportunities be lacking, the above measures may eventually give rise to a more intensive periphery-to-centre brain drain, reinforcing instead of counteracting centre-periphery technological asymmetries (Brussels Think Tank Dialogue, 2013).

EU industrial policies may avoid such disappointing outcomes by specifically dealing with demand-side/supply-side mismatches and coordination failures that very often prevent structural changes from taking place in relatively backward productive structures. Besides the

²⁴ See, for instance, Huggins and Johnston (2009) for some evidence on university-business sector demand-side/supply-side complementarities in the generation of innovation and growth opportunities at a regional level in the UK. In particular, the authors first note that backward regions heavily *depend* on local universities as sources of knowledge and innovation. Possible beneficial side effects for the local economy, however, turn out to be under-exploited (with respect to what has been observed in more developed regions) due to the *lack of demand* for innovation and new technological knowledge in the local productive system.

supply-side measures considered so far, EU policies should also care about tightening productive and innovation linkages inside the periphery's productive and innovation system. There is a wide battery of measures that could be deployed to this end.

First, a considerable body of literature stresses that connections between universities, research centres and firms constitute a strong positive factor feeding knowledge transfer, industrial clustering and cumulative development processes (Cook, 2001; Charles, 2003). D'Este *et al.* (2013) note that the importance of spatial proximity between the above institutions becomes even greater in the case of relatively backward economies, due to the scarce density in these contexts of alternative business sector innovation-production networks. In backward regions, firms perceive university-industry interactions as relevant (and unique) sources of knowledge accumulation that could not be easily found elsewhere in the domestic productive system. In light of these facts, EU industrial policies should support the creation of EU-funded research centres in the periphery involving universities and private enterprises in joint innovation processes. On the one hand, these centres may be vehicles of technological knowledge creation and dissemination due to researchers' mobility among research institutions. On the other hand, following D'Este *et al.* (2013), they may act as catalysts of production investment aiming to exploit joint public-private applied innovations. Besides this, such kinds of centres may perform two additional functions. First, they could emerge as *autonomous embedded* public institutions collecting and sharing information on firms' needs and innovation opportunities that are so important to properly implement industrial and innovation policies (Rodrik, 2008). Second, they may track the effectiveness of R&D efforts in terms of innovations' applicability to commercial uses.

Second, high-tech firms' clustering in peripheral countries could be favoured by recognising region-specific preferential treatments to new and fast-growing innovative businesses. We are thinking here about tax and subsidy incentives, but also easy credit (perhaps conveyed through the EIB's operations), which is all the more important should the current credit crunch persist. Consistent with the previous point, such measures

should aim at increasing the density of peripheral productive and innovation systems. Therefore, they might be graduated proportionally to the degree of embeddedness in the local productive system of new production and innovative activities. Region-specific incentives of this kind obviously create distortions in the European common market. This fact notwithstanding, their introduction may be justified by acknowledging existing productive and technological asymmetries between central and peripheral economies. Moreover, they could be temporary and subject to conditionality requirements. According to a well-known carrot-and-stick argument, public support must be conceded and (temporarily) maintained provided that supported firms perform well in terms of easily verified targets such as export share in foreign markets and/or patented innovations.

The industrial/technology policy measures discussed so far should be conceived of in a more general framework together with other policy measures that go beyond the previous focus on peripheral regions' development. Technological and productive upgrading in the Eurozone as a whole, and in peripheral countries in particular, may be pursued by rediscovering *sectoral* policies that specifically target the development of those industries in which innovation may be deemed to concentrate most in the near future (and generate most relevant improvements in social welfare). Some recent documents on industrial development by the European Commission portray EU institutions moving in this direction. Indeed, the European Commission assigns priority to productive and innovation efforts concentrated in a set of, at least, six sectors: advanced manufacturing, key enabling technologies, bio-based products, clean vehicles, sustainable construction and raw materials, the smart grid and digital infrastructure. Most of these sectors produce environmentally friendly and energy-saving technologies. This appears a far-sighted perspective: rising worldwide concern about environmental protection seems to suggest that sectors generating such kind of innovations may expand rapidly in the near future.

EU institutions will firstly pursue advances and European leadership in the above areas by devoting particular attention to the accumulation of technological knowledge and productive competencies specific to the

targeted sectors. Alongside supply-side measures, a couple of demand-side policies are worth considering. On the one hand, following Mazzucato (2011), direct EU involvement in the generation and procurement of eco-friendly innovations may turn out to be decisive to guarantee a European lead in the production of such new technologies. On the other hand, EU institutions may artificially create a large and attractive market for eco-friendly technologies by imposing stricter environmental regulations, raising demand for renewable energy, energy-saving goods and clean production processes.²⁵ These lines of intervention also seem to have recently entered the industrial policy toolkit of EU institutions. Now the point is to deploy them with enough strength, as has been the case in other foreign countries.

5. Final Keynesian remarks

Peripheral euro countries urgently need investment. Increased demand injections in the form of higher investment expenditures could first act as counter-cyclical forces counteracting the ongoing crisis. More importantly, productive investment could help reduce structural and technological gaps that still divide peripheral from central economies. Actually, should the above structural asymmetries persist, external balance constraints would likely impose protracted stagnation on peripheral countries. Growth spurts would probably be unsustainable and conducive to well-known macroeconomic imbalances and financial havoc.

Peripheral countries' investment needs call for EU intervention insofar as budget restrictions make national governments' anti-cyclical policies inactive. EU intervention should take the form of regionally focused industrial policy. Such measures should take inspiration from Keynes's lesson on the intrinsic instability of market economies. First, an EU plan for productive investment in the periphery of the eurozone

²⁵ Costantini and Crespi (2008) provide empirical evidence at a worldwide level on the effectiveness of stringent environmental rules in improving a country's competitiveness and export performance in those same industries.

should try to apply Keynes's ideas of a "somehow comprehensive socialisation of investment [as] the only means of securing an approximation to full employment" (Keynes, 1972a, p. 378). Second, EU industrial measures may try to accomplish with Keynes's perspective on what public intervention aim should be. Indeed, Keynes clearly states in *The end of the laissez-faire*:

"[t]he most important agenda of the State relates not to those activities which private individuals are already fulfilling, but to those functions which fall outside the sphere of the individual, to those decisions which are made by no one if the State does not make them. The important thing for government is not to do things which individuals are doing already, and to do them a little better or a little worse; but to do those things which at present are not done at all" (Keynes, 1972b, p. 291).

Further:

"I believe that some *coordinated* act of intelligent judgment is required as to the scale on which it is desirable that the community as a whole should save, the scale on which these savings should go abroad in the form of foreign investments, and whether the present organisation of the investment market distributes savings along the most nationally productive channels. I do not think that these matters should be left entirely to the chances of private judgment and private profits, as they are at present" (Keynes, 1972b, p. 292, italics added).

Market failures are pervasive in the field of basic research and on the financial markets, more so in times of economic contraction and widespread uncertainty. Lack of coordination among possibly intertwined innovation initiatives severely discourages technological improvements and production upgrading in peripheral countries. These constitute structural problems that currently dampen development in the periphery of the eurozone, and put eurozone survival at risk. EU industrial policy should boldly address them in the near future.

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Appendix A. Macroeconomic converge-divergence trends among selected European countries

Figures A.1, A.2 and A.3 below provide evidence about comparative macroeconomic trends, as well as likely connected external imbalances among eurozone countries in the last two decades.

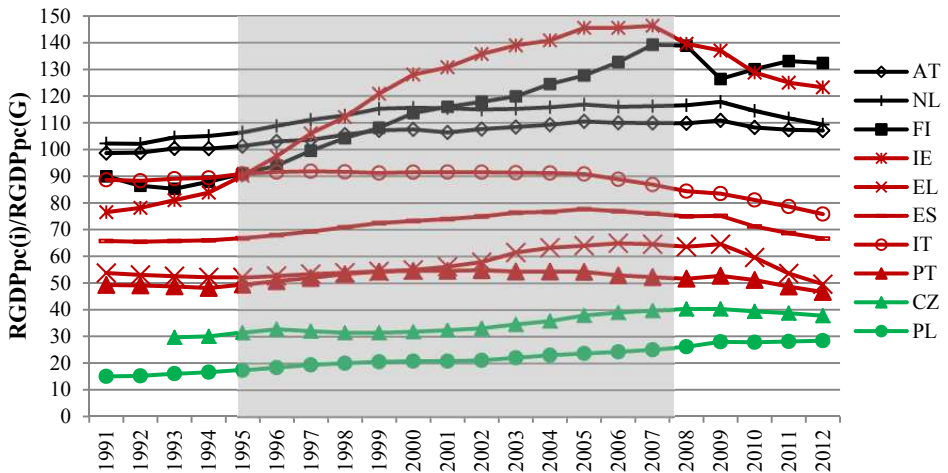
Figure A.1 portrays eurozone centre-periphery real GDP per capita convergence-divergence patterns from 1991 to 2012. In figure A.1 we take into account the dynamics of real GDP per capita in the Czech Republic and Poland. Germany's real GDP per capita is taken as benchmark. From 1995 until the outbreak of the worldwide financial crisis (shown as a grey zone in figure A.1), increasing economic and financial integration between European countries, here witnessed by converging (and, since 2001, broadly equal) 10-year government bond yields (see figure A.2), fed peripheral countries' catching-up with Germany. Irish performance and overtaking of central European countries is astonishing. Convergence is far more modest but still significant in the case of Spain (since 1995) and Greece (since 2000), as well as in the case of the abovementioned Eastern European countries.

The effects of the ongoing crisis appear clearly from 2007 onwards. The disappointing Irish performance with respect to Germany is remarkable. Perhaps even more worrisome, newly established divergence increasingly divides relatively poor peripheral countries (Greece, Portugal, Spain and Italy) from Germany and the other central economies. At the end of 2012, Greek GDP per capita is less than 50 percent of the German level (i.e. it is now lower than it was in 2001 at the beginning of the common currency experiment). Finally, the Czech Republic and, in particular, Poland seem to have been less vulnerable to the worldwide financial crisis and to the ensuing sovereign debt crisis than peripheral eurozone countries.

Initial finance-led centre-periphery convergence, when associated to persistent centre-periphery asymmetries, has been reflected in widening external imbalances (see figure A.3). Relevant current account deficits started to emerge in the balance of payments of most peripheral countries in the second half of the 1990s (and since the beginning of the 2000s in

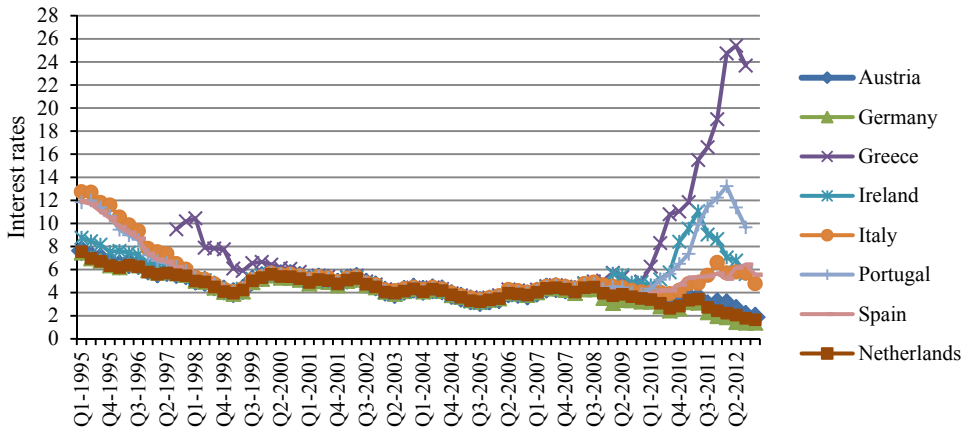
Ireland). They further increased in the years immediately before the 2007-2008 financial meltdown (shown as dark grey in figure A.3). The worldwide financial crisis has eventually brought to an end irrational euphoria on financial markets. Since 2008, painful macroeconomic adjustments have been improving peripheral countries' external imbalances at the cost of collapsing domestic markets.

Figure A.1 – Converge-divergence pattern in real GDP per-capita among selected eurozone countries (Germany = 100)



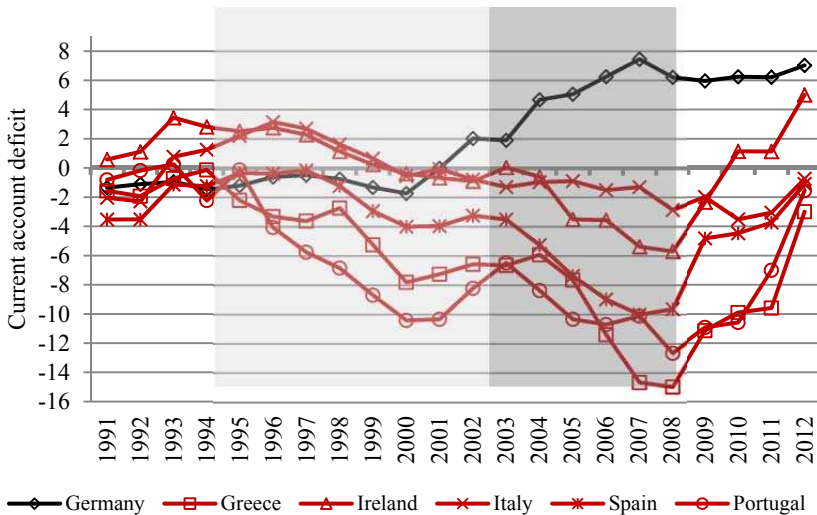
Source: author's elaboration of data from UNCTAD.

Figure A.2 – Financial integration among eurozone countries and interest rate dynamics, 10-year bond interest rates, 1995(Q1)-2012(Q4)



Source: author’s representation on the basis of data from OECD.

Figure A.3 – Current account deficits/surplus (% of GDP) in peripheral euro countries and in Germany



Source: author’s representation based on data from UNCTAD.