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Structural Asymmetries at the Roots of the Eurozone Crisis.

What's New for Industrial Policy in the EU?

Alberto Botta*

Abstract: In this paper, we analyze and try to measure productive and technological asymmetries between peripheral and central economies in the eurozone. We assess the effects such asymmetries will likely bring about on center-periphery divergence/convergence patterns, and derive some implications as to the design of future industrial policy at European level. We stress that future EU industrial policy should be regionally-focused and specifically target structural changes in the periphery as the main way to favor center-periphery convergence and avoid re-appearance of past external imbalances. To this end, a wide battery of industrial policy tools should be considered, ranging from subsidies and fiscal incentives to innovative firms, public financing of R&D efforts, sectoral policies and public procurements for home-produced goods. All in all, future EU industrial policy should be much more interventionist than it currently is, and dispose of much larger funds with respect to the present setting in order to effectively pursue both short-run stabilizing and long-run development goals.

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1. Introduction

Several economists describe the eurozone crisis according to three main facts. First, before the 2007-2008 financial crash, the process of monetary and financial integration has allowed most peripheral eurozone countries to benefit of considerable capital inflows (Perez-Caldentey and Vernengo, 2012). Accordingly, their economies expanded pretty fast, often faster than central economies, giving rise to some sort of center-periphery convergence (see Figure A.1 in the Appendix to the paper). Housing booms took place in Ireland, Spain, and (on a lesser extent) Greece in the first half of the 2000s, and increasing external imbalances emerged much in the same way it historically happened in several developing countries after financial liberalization (Stockhammer, 2012)¹. Second, the worldwide financial dislocation induced by the sub-prime crisis has thrown all the eurozone in a deep recession, and forced national governments to come in to bail out close-to-bankruptcy private financial institutions, and provide relief against recession. A prevalently private sector problem has become 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 about sovereign debt default, and opened space for speculative attacks and capital flights away from externally indebted peripheral countries.

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¹ See Figure A.3 in the Appendix to the paper on this point.

Part of the above problems have a structural nature linked to long-lasting productive asymmetries between peripheral and central economies. According to the findings of this paper, Greece and Portugal are characterized by poorly diversified productive and export structures. Perhaps more relevantly, their economies are mostly concentrated in resource-intensive and labor-intensive low-tech sectors that provide scarce opportunities for introducing product and process innovation. In the case of Ireland, the development of a restrict bunch of high-tech dynamic industries has fed past growth and export performances. However, the Irish productive system is still affected by lack of diversification, this fact being strikingly evident when capital good sectors are considered². Larger peripheral countries such as Italy and Spain are characterized by more variegated productive and export structures than above small economies are. Yet, in the case of Italy in particular, traditional low-tech and poorly innovative sectors still dominate their productive systems. Given these structural features, finance-led growth accelerations have led peripheral countries to run considerable external imbalances, hence mounting external debts, vis-à-vis more developed central economies, by violating rather tight Balance-of-Payments constraints due to overdependence on imported goods, and difficulties to penetrate foreign markets with high valuable innovative exports (Hein, Truger and van Treeck, 2011)³. In this sense, austerity measures (read wage cuts) in the periphery try to address such external disequilibria by fostering price competitiveness of peripheral countries' products through internal devaluation. Since 2007, current account deficits in peripheral euro countries have been effectively reduced, yet not eliminated or reversed in Greece, Portugal, Italy and Spain. This has happened at the cost of deep recessions. Moreover, there is the concrete risk that austerity measures could fail to restore financial soundness by setting-in a vicious spiral between fiscal restrictions, further economic contractions, and deeper fiscal imbalances⁴.

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, 2013a, 2013b). Indeed, expansionary fiscal policies implemented by a federal euro government may favor economic recovery in the periphery, and avoid financial instability to spread in 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 center-periphery structural asymmetries) could be jointly pursued through industrial policies that support productive investment, hence effective demand and economic recovery, and stimulate the long-run growth potential of peripheral countries.

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

³ According to data from UNCTAD, Greece, Italy, Spain and Portugal scored remarkable and increasing trade account deficits vis-à-vis Germany since the end of the 90s 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 90s were driven close to zero just before the burst of the worldwide financial meltdown.

⁴ Note that, despite the implementation of fiscal austerity programs, public debt-to-GDP ratios have continuously increased in peripheral countries. In 2012, a partial default has been arranged in Greece.

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 rely 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, Llerena and Sylos Labini (2006), whilst these efforts are fundamental to expand the scientific knowledge on which applied innovations can be carried out, they create a “business-friendly” environment, and are most welcomed by private corporations. Second, alongside basic research, public-private research centers should strengthen R&D networks in national innovation systems and care about applied applications of the above knowledge. Last, but not least, the emergence of innovative firms should be stimulated through public support, let say subsidies or fiscal incentives. In this regard, sectoral policies should be rediscovered by European institutions. Provided that innovative sectors face highly dynamic demands on international markets, sectoral policies may help eurozone’s periphery to significantly improve its external balance position, and possibly achieve fast and sustainable growth rates. All in all, what we think strikingly clear is that future eurozone industrial policy should look like very different from the current exclusive emphasis on non-distortionary supply-side horizontal policies and market-driven comparative advantages.

The paper is organized as follows. Section 2 provides a picture of structural asymmetries among eurozone countries. We propose a synthetic Productive Structure Similarity Index (PSSI) through which peripheral countries’ productive structures are compared with that prevailing in Germany. Further, we try to 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 center-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-technology-intensive trap. Section 4 discusses how euro-level R&D/industrial policy could address such dichotomies, and provide a way out from the crisis by favoring the upgrading of peripheral countries’ production patterns. Section 5 concludes.

2. Center-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 devaluation⁵. On the other hand, since the exchange rate policy is out of control of national monetary authorities, internal devaluation carried out through sharp wage cuts attempts to spur exports, and possibly recovery. Whilst 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 to what supposed by most international organizations, whereas export response to internal devaluation may be mild, huge wage cuts may throw the economy in a deep recession and further impinge fiscal solidity⁷.

What is the extent of productive asymmetries among eurozone countries, in particular between central and peripheral economies? Simonazzi, Ginzburg, and Nocella (2013) have recently provided some first evidence on structural differences between Germany and peripheral countries such as Spain, Greece and Portugal. They do so by analyzing cross-country differences in manufactured goods' exports, as synthesized by the Spearman rank correlation coefficient calculated on the revealed comparative advantage (RCA) Balassa index (BI). In this paper, we follow the same logic, but we first focus on differences in the industry composition of the overall domestic manufacturing sector rather than on trade statistics. More in details, we present a Productive Structure Similarity Index (PSSI), which is computed according to the following formula:

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

$$PSSI_{jt} = \sum_{i=1}^{i=n} \left[\frac{(M_{jt}^i + M_{Gt}^i)}{\sum (M_{jt}^i + M_{Gt}^i)} PSSI_{jt}^i \right] \quad (\text{aggregated manufacturing sector PSS Index})$$

⁵ See Gibson and Van Severter (2000) for an enlightening illustration of the mechanisms through which reductions in public expenditures likely 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.

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 utilization, and w the monetary wage rate. Once assumed $(\partial\Delta/\partial u)$ 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 reads: $\eta/a - (1 - \pi)(1 - s_w)X/E > 0$ (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). Very likely, some peripheral eurozone countries like Greece and Portugal won't meet the above conditions, due to their relatively low propensity to export, and heavy reliance on domestic demand injections.

M_{jt}^i is the share of sector i on total manufacturing value added in country j at time t , and M_{Gt}^i represents the same figure in the case of Germany⁸. 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 Czech Republic and Poland also. Actually, these countries do not participate to the monetary union. Yet, according to Simonazzi, Ginzburg, and Nocella (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 characterizing peripheral euro 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 PSS index referred to the construction sector, in order to emphasize the housing bubble (and the consequences on productive structures) affecting those countries before the 2007-2008 crisis. Results for the overall manufacturing sector are reported in Table 1 below.

Table 1- Productive Structure Similarity Index (PSSI) between selected European countries and Germany.

| Country/Year | 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 | - |
| 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 | - |
| Spain | | | | | | | | | | | | | |
| PSSI (M) | - | 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) | - | 0,32 | 0,38 | 0,42 | 0,46 | 0,50 | 0,54 | 0,55 | 0,54 | 0,53 | 0,50 | 0,42 | 0,37 |

Source: Author's calculation on the base of data from Eurostat.

Note: Letters "M" and "C" in parentheses stand for "manufacturing sector" and "construction sector" respectively.

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

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 that prevailing in Germany. Further, productive asymmetries versus Germany seem to have widened and increased in the aftermath of the most recent financial meltdown and all along the ongoing eurozone crisis.

More disaggregated data⁹ tell us that most of these asymmetries come from the relative (and increasing) state of backwardness of the above peripheral countries in the production of capital goods, which, on the contrary, stands out as the core of German productive specialization. This evidence may be a sign that productive development is not fully completed in the peripheral economies mentioned before, since that the emergence of a considerable capital good sector has been traditionally seen as the most advanced stage in the development process of an economy (Akamatzu, 1962; Ricottilli, 1993; Kojima, 2000). Even more, provided that a productive structure featuring a relatively developed capital good 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, our results tell us that center-(big)peripheral countries' asymmetries are slightly increasing across time, this evidence being different from the conclusions reached by Simonazzi, Ginzburg and Nocella (2013) in the case of Italy. In 2010 and 2011, in particular, persistent recession affecting peripheral economies seems to have impeded the recovery of the investment good sector, whilst Germany has recorded a significant upturn in its most typical industries¹⁰. Once again, should demand side-supply side interactions in the capital good sector be relevant sources of technological spill-over for the whole economic system, such a perhaps temporary shock may impinge on long-run economic performances also in the case of larger peripheral countries.

As expected, Austria and Czech Republic show a productive structure closely similar to that of Germany. In the case of Czech Republic, according to Simonazzi, Ginzburg and Nocella (2013), this may be the result of the reorganization of Germany industries through partial delocalization 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 captured by GDP per-capita) was less than one-half of the Greek one, and barely 60 percent of Portuguese GDP per-capita¹¹.

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 has decreased by one-third in Portugal. In the case of Italy and Spain, drops in investment demand amount to 20 and 28 percentage points, respectively.

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

Finally, note the astonishing house-boom-led expansion of the construction sector in Greece, Ireland and Spain with respect to Germany.

Different productive structures often go hand-in-hand with differences in the product composition of exports. In Table 2, we compute the above 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 in four different groups on the base of their input and technological intensity: resource-based and labor-intensive sectors; low skill and low technology intensive sectors; medium skill and technology intensive productions; high skill and technology intensive industries. Arguments in the now-redefined Export Structure Similarity Index (ESSI) are sectors’ export shares on total country exports.

Despite pretty high levels of aggregation naturally tend to hide structural differences, center-periphery asymmetries appear clearly in the case of Greece, Portugal, and Ireland. By contrast, export structure differences are much lower or rapidly decreasing in the case of Austria, Czech Republic and Poland. Once again, high or fast increasing export similarity between Germany, Czech Republic and Poland is likely due to German companies’ outsourcing in the above East-European countries, and of the ensuing increase in intra-industry trade.

Table 2 – Export Structure Similarity Index (ESSI) between selected European countries and Germany.

| Country/Year | 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 calculations on data from UNCTAD

The high level of aggregation tends to downsize the value of the ESS index, and therefore of perceived export structure differences with respect to Germany, in the case of large peripheral economies such as Italy and, above all, Spain. Asymmetries, however, partially re-emerge if we move on our analysis and consider RCA Balassa indexes associated to the above defined sectors. Data are reported in Table 3.

Consistently with the structural features summarized in Table 1, Germany presents a persistent comparative advantage in medium-tech manufacturing sectors including most of capital good industries. From 1999 to 2012, German exports seem to concentrate even further in the medium/high-tech segment of manufacturing goods, whilst a process of increasing *de*-specialization is taking place in labor and resource intensive or low-tech sectors. Quite interestingly, the same processes can be detected in countries such as Poland and Czech Republic.

Table 3 – Revealed comparative advantages in manufacturing sub-groups in selected European Countries.

| Country/Year | 99 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
|--|------|------|------|------|------|------|------|------|------|
| Austria | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 |
| Ireland | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 | | | | | | | | | |
| Labor-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 calculations on data from UNCTAD

Small peripheral countries such as Greece, Ireland, and Portugal are characterized by a radically different picture. Peripheral countries' export de-specialization in the medium-tech capital good sector is evident and striking in the case of Ireland and Greece. In Greece and Portugal, comparative advantages are still significantly localized in labor and resource intensive and low-tech sectors. In

Greece and Ireland, finally, a 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 productions included in such a group. According to UNCTAD classification, most chemical industries are classified as high-tech productions. It is in these sectors that Greece and Ireland score an increasing export specialization¹². Germany, on the contrary, is acquiring an increasing specialization in the production of highly-technological transport equipment and scientific instruments (sector codes 791 and 87 in the SITC rev. 3 classification). Center-periphery differences that may appear somehow softened at an aggregated level of analysis thus clearly re-emerge when a more disaggregated perspective is adopted.

Italy and Spain are somehow midway on a hypothetical technology ladder from eurozone periphery to Germany. In the case of Italy, in particular, it is evident his persisting export specialization in labor-intensive and low-tech sectors. Italy also maintain a relatively weak specialization in the mechanical industry (a traditional pillar of Italian exports), whilst (revealed) comparative *disadvantages* are deep in the high-tech sector.

2.1 Specialization 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 on 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 scales originating from production and trade specialization (Rivera-Batiz and Romer, 1991; Bachus et al., 1992; Lee, 1995; Lane, 1996). Whilst this argument is generally referred to 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 performances depend on the specific sector you specialize in. Growth potential in the periphery may thus worsen (at least with respect to the center) should it perversely specialize 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 characterized by a process of productive ad export diversification, instead of concentration and specialization (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 accelerations and catching-up with more advanced countries (Herzer and Novak-Lehmann, 2006; Rodrik, 2007)¹³.

¹² Greece specialization is relevant in the production of fertilizers, perfumes, and plastic goods (sector codes 55, 56 and 57 in the SITC rev.3 classification). In the case of Ireland, specialization is strongly concentrated in the production of perfumes and pharmaceuticals goods (sector codes 541, 542 and 551 in the SITC rev. 3 classification at three-digit disaggregation level).

¹³ The specialization/diversification divide may be at least partially reconcile if you think that specialization 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 specialization in manufacturing or traded-good sectors which characterizes fast-growing economies in two-sector models by Krugman (1981) and Matsuyama (1992) among others.

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 base. Indeed, when we emphasize the need for a process of structural convergence between central and peripheral economies, we do not mean that all 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 space 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 Balassa index, and the degree of diversification of an economy's production and export base. The more heterogeneous is the range of goods you produce and export on international markets, the lower will be sectoral Balassa indexes¹⁴. 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 manufacturing sectors showing values of Balassa index higher than 0,9 (i.e. those sectors that present or close to presenting a revealed comparative advantage)¹⁵. Column two reports the median value of sectoral Balassa indexes. We put emphasis on median Balassa index instead of average one because the former is more robust than the latter. On top of this, average values of sectoral Balassa indexes are influenced by in-built asymmetries characterizing the computation of such an indicator: average sectoral Balassa index, taken alone, might provide a distort image of a country external competitiveness.¹⁶ In the third column of Table 4 we finally report the inverse of sectoral Balassa indexes' variance. We label such indicator as concentration index, since that it might provide a synthetic information about the degree of homogeneity of a country export structure. Values in parentheses in column three are average values of sectoral Balassa indexes. Figure 1 graphically reproduces data reported in Table 4. In Figure 1, bubbles' dimensions stand for the abovementioned concentration index. The larger(the lower) the bubble, the higher is sectors' comparative advantage concentration(dispersion) around its mean value.

¹⁴ 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.

¹⁵ Statistics reported in column 1 in 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 on 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 country's exclusion from international markets.

¹⁶ By construction, Balassa index ranges between zero and, potentially, infinite. Accordingly, arithmetic average of sectoral Balassa indexes will naturally increase in case of highly concentrated productive structures. Median values of the above index, on the contrary, better reflect the degree of sectoral polarization of a country productive and export vector.

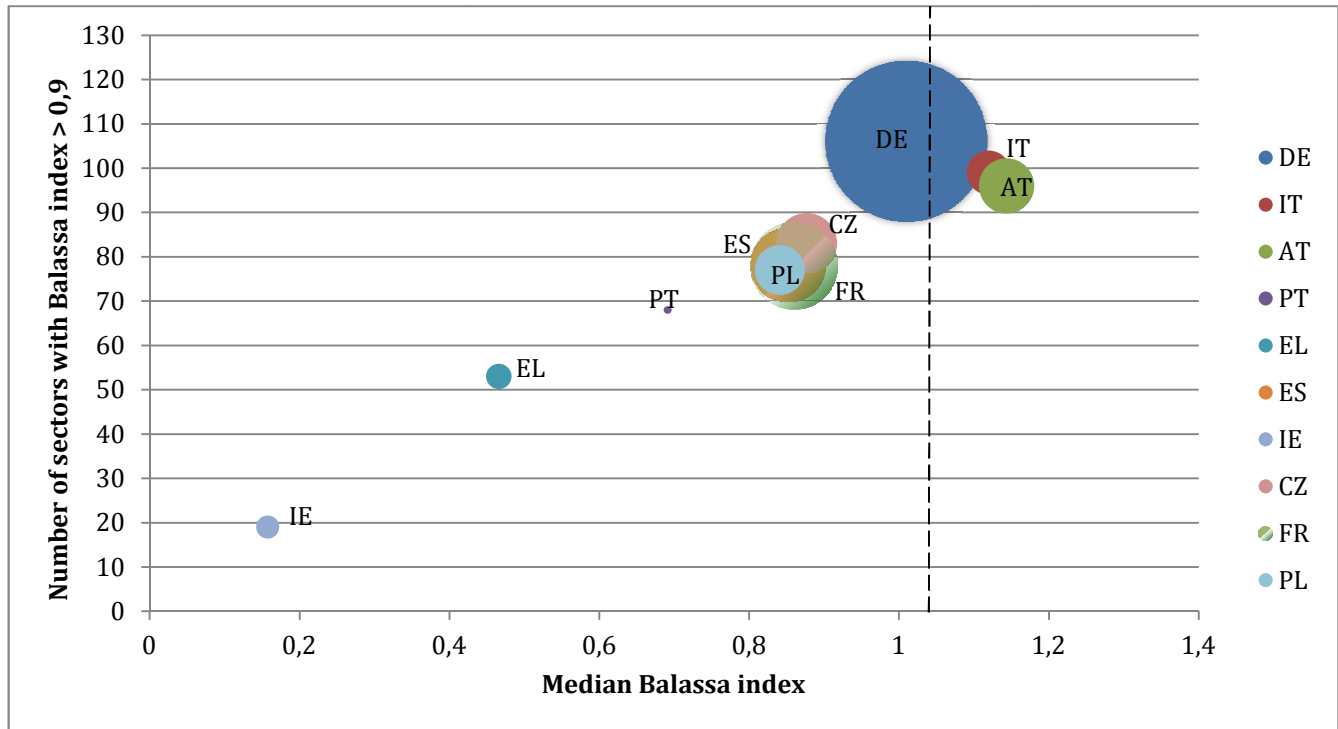
According to Table 4, in Germany 106 sectors out of 166 manufacturing industries included in the SITC rev.3 three-digit classification score Balassa indexes higher than 0,9. This figure is the highest registered amongst the European countries under observation, and far higher than the same statistics recorded in most peripheral countries with the partial exception of Italy. Consistently with the above results, median Balassa index in Germany is rather high and equal to 1,01. It is much higher than those characterizing 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 manufacturing 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 small bubbles associated to small peripheral economies in Figure 1). Median and average Balassa indexes are almost equal in Germany. Further, from Figure 1 it emerges astonishingly clear the deep level of concentration of German manufacturing sectors' Balassa indexes around the corresponding mean value (dashed vertical line in Figure 1). Needless to say, this is a sign that, on top of increasing price competitiveness, Germany's enthusiastic export performance significantly depends 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 (AT) | 96 | 1,14 | 0,65 (1,34) |
| Czech Republic (CZ) | 83 | 0,88 | 0,78 (1,22) |
| France (FR) | 78 | 0,86 | 1,61 (1,03) |
| Germany (DE) | 106 | 1,01 | 5,53 (1,06) |
| Greece (EL) | 53 | 0,47 | 0,14 (1,07) |
| Ireland (IE) | 19 | 0,16 | 0,11 (0,79) |
| Italy (IT) | 99 | 1,12 | 0,41 (1,32) |
| Poland (PL) | 77 | 0,84 | 0,53 (1,25) |
| Portugal (PT) | 68 | 0,69 | 0,01 (2,09) |
| Spain (ES) | 78 | 0,85 | 1,17 (1,07) |

Source: Author's calculation on data from UNCTAD.

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



Source: Author's elaboration on data from UNCTAD.

Note: Countries abbreviations are on based on Eurostat's system: Germany (DE); Italy (IT); Austria (AT); Portugal (PT); Greece (EL); Spain (ES); Ireland (IE); Czeck Republic (CZ); France (FR); Poland (PL).

Results presented in Table 4 and Figure 1 deserve three more comments. First, impressive GDP per-capita growth rates registered in Ireland in the second half of the 90s and before the outbreak of the worldwide financial crisis largely hinged on the expansion of a few dynamic sectors. The huge drop in Irish growth records and relative GDP per-capita (with respect to central economies) since 2007 now questions the sustainability of previous trends in the absence of a much wider process of structural change and productive structure diversification.

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 a heritage of 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 remain concentrated in labor and low-skill intensive sectors, whilst more technologically advanced sectors are largely absent from the Italian production panorama. This fact is reflected in the pretty high level of polarization (i.e. a low concentration index) of revealed comparative advantages that characterizes the Italian economy.

Productive and export diversification has been relatively intensive in Czech Republic and Poland. These countries are now better ranked than small peripheral eurozone countries as to the widening of their production space. Such structural changes may have favored converge 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's and Czech Republic's growth potential are still to be verified. These effects will largely depend on the deepness of before mentioned structural changes. Questions to be answered are of this kind: do structural changes in East European countries only reflect the delocalization in the home economy of low-skill labor intensive stages of more complex processes carried out by western corporations? Alternatively, do they entail some vertical integration of domestic productions? A well-calibrated answer to these questions should take into account a detailed analysis of the contribution of new and export-oriented sectors to manufacture's aggregate value added. For the time being, this topic is out of the scope of the present paper, but it certainly deserves to be taken on board in upcoming research efforts.

3. Productive Asymmetries and Technology Dynamics in the Eurozone

A considerable body of literature has traditionally devoted great emphasis to the problems arising from economic (and monetary) integrations between asymmetric economies. Balance-of-Payments-constrained models, for instance, have clearly shown that productive backwardness in the periphery can induce peripheral countries to persistently fall behind more developed economies if the trade account equilibrium is binding (see McCombie and Thirlwall, 1994). Even admitting the possibility of running current account deficits and accumulating external debts, these imbalances must be short-lived. Very often, they have been conducive to exchange rate and/or financial crises that may ultimately have long-lasting negative effects on growth performances of an economy. The economic scenario now prevailing in the periphery of the eurozone makes no exception, and there exists mounting concern about hysteretic effects of the ongoing crisis on long-run growth and employment dynamics in the periphery of the eurozone (Fitoussi and Saraceno, 2013).

In the past, the strategic answer of most backward countries to recurrent (external) imbalances and economic downswings was the intervention of the public sector in the economic sphere so as to support domestic industrialization and eliminate structural asymmetries with respect to more developed economies. Since the beginning of the 80s, 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 liberalization 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. Further, sectoral allocation of productive inputs should have been driven by unfettered market mechanisms, whilst industrial policy should have had care of increasing the availability of productive inputs only (i.e. stimulating people participation to the labor market by flexibilizing it; favoring capital accumulation by attracting foreign direct investment; neutrally supporting R&D activities). Indeed, in the neoliberal perspective long-run economic growth is a pure supply-side phenomenon.

The current institution design of the eurozone is totally inspired by such a philosophy. European institutions' exclusive focus on market integration, market competition, and market-driven adjustments is nothing but the complementary part of macroeconomic rules that define price stability and balanced public budgets as the only ways to achieve fast growth. However, protracted crisis in the periphery of the eurozone and persistent center-periphery asymmetries cast doubts on the effectiveness of such an institutional building (Pianta and Lucchese, 2012). Pressures to rediscover and reconsider sectoral, and perhaps market-distorting, industrial policies are increasing (Aghion, Boulanger, and Cohen, 2011).

There are at least two well-grounded reasons to support such an instance. One comes from economic theory on structural change and innovation. The other one is based on the observation of some stylized facts in the eurozone.

From a theoretical point of view, the process of structural change and production upgrading implies innovation. New sectors must emerge, and new goods be produced into a more general Smithian process of increasing division of labor (Ricottilli, 1993). New and more efficient technologies must be adopted. Innovation, in turn, requires the acquisition and development of scientific knowledge, of technological and managerial capabilities. All these perhaps intangible productive inputs share the common aspect of being partially sticky and spatially localized (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). Further, technological competencies involved in complex productions are crystallized in the interaction between interconnected firms and industries. In a way, technological and productive skills of intertwined firms and sectors could be thought as pieces of a more complex puzzle, so that they are strictly complementary each other. Accordingly, the profitability of any single production process highly depends on the (perhaps close) availability of other connected activities, so that coordination problems may impede new production initiatives to be viable in relatively backward economies. Market failures arising from lack of coordination among interdependent productive initiatives emerge as leading sources of cumulative diverging processes between developed and (relatively) underdeveloped economies (Ros, 2000; Lorentz and Llerena, 2004). These kinds of development traps still provide strong arguments for calling public intervention in the economic sphere back so as to stimulate structural change and economic development.

After five years since the outbreak of the worldwide financial crisis, empirical evidence tells us that economic convergence between central and peripheral euro countries looks like a pale memory and a temporary perhaps unsustainable phenomenon. Indeed, converging trends concerned some macro-aggregated real and financial variables (see De Grauwe and Mongilli, 2005). Behind the surface, however, structural and technological differences largely persisted¹⁷. These

¹⁷ The European Commission evaluates European countries' innovation performances by computing a eight-dimension index covering several aspects of the innovation process (i.e. public and private support to R&D activities, availability of high-skilled labor, firms interaction into production networks etc...etc). Results of such analysis are published in the Innovation Union Scoreboard (IUS). According to the 2013 Innovation Union Scoreboard, peripheral countries are still

asymmetries, together with opposite financial positions on capital markets, capital flights away from the periphery, and diverging 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 pretty quick export-led recovery in the center versus deepening and protracted recession in the periphery. In light of these facts, the hypothesis of the endogenous nature of the eurozone as an optimal currency area does not get much credit any longer¹⁸.

This picture gets even more dismal if we consider that some recent empirical evidence suggest center-periphery structural differences and technological gap might even widen in the foreseeable future. According to Filippetti and Archibugi (2010), “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, 2010, pag. 10)”. The European Commission clearly states in the 2013 Innovation Union Scoreboard that, from 2008 to 2012, “the overall process of [innovation performance] convergence witnessed in previous IUS editions have come to an halt [...] and has been reversed into divergence in 2012 (EU, 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 the twenty eight member States of the European Union in evaluating converging and diverging patterns inside Europe. Nonetheless, a narrower focus on central and peripheral euro countries seems to confirm 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 that 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 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: pre-crisis years from 2004 to 2008, and years from 2008 to 2012.

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 “innovator follower”. Ireland is the only exception among peripheral countries, since that it belongs to the “innovation follower” group.

¹⁸ Frankel and Rose (1998) first proposed the idea that monetary integration among different countries may eventually lead them to develop those properties characterizing an optimal currency area. De Grauwe and Mongilli (2005) tried to assess whether these mechanisms were at work in Europe after the introduction of the common euro currency. Their findings were cautiously on the positive.

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 (percentage of total) | 0,012 (34%) | 0,011 (33,3%) | 0,007 (25,5%) | 0,009 (28,9%) | 0,007 (26,6%) | 0,010 (34,7%) | 0,009 (30,9%) |
| “Between-group” difference (percentage of total) | 0,022 (66%) | 0,022 (66,7%) | 0,021 (74,5%) | 0,021 (71,1%) | 0,019 (73,4%) | 0,019 (65,3%) | 0,022 (69,1%) |
| | 2004-2008 | | | 2008-2012 | | | |
| Beta convergence | -0,54 | | | 0,33 | | | |
| Beta convergence (excl. Greece) | | | | -0,004 | | | |

Source: Author’s calculations on data from Innovation Union Scoreboards 2008, 2010, 2013.

Note: Central economies are Austria, Germany, Netherlands, Finland. Peripheral economies are Greece, Ireland, Italy, Portugal, Spain. Theil index’s values are computed on the base of data provided by Innovation Union Scoreboards 2010 and 2013. Beta convergence calculations for the 2004-2008 time span rely on data provided by 2008 Innovation Union Scoreboard. Data contained in the 2013 Innovation Union Scoreboard are used for assessing beta convergence since 2008.

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, to more than two-third of observed dispersion.

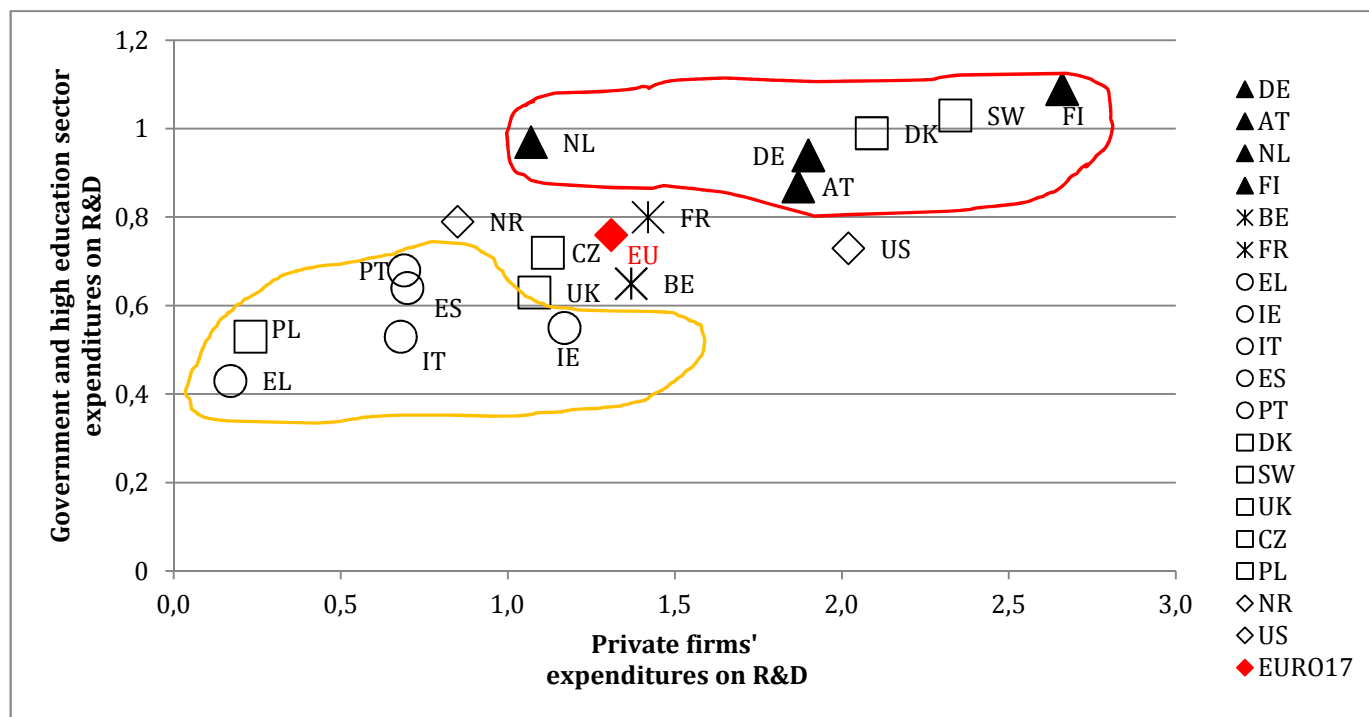
Data contained in the 2008 Innovation Union Scoreboard seems to witness some sort of beta convergence between central and peripheral countries. This data, however, should be kept with caution since that subsequent revisions of European countries’ innovation performances generally updated upward evidence about central-periphery technological gap. Beyond this, 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 characterizing Greece during the last five years. Nonetheless, even dropping Greece from our sample, center-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 several information contained in the multi-dimensional innovation performance index are updated until 2010. Very likely, they do not reflect in a full extent the perverse effects of protracted recession on the innovation parabola of peripheral economies.

A closer look to the single components of the aggregated innovation performance index computed by the European Commission reveals that center-peripheral gaps are particularly relevant in three fields. First, peripheral economies (with the exception of Ireland) lag far behind central economies as to the accumulation of human resources as measured by the percentage of new doctorate graduates per thousands inhabitants (aged 24-64), and by the percentage of people completing upper secondary and tertiary education levels. 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.

Such empirical evidence is not surprising. According to the cumulative nature of innovation processes outlined above, productive structure asymmetries are naturally reflected in cross-country different intensities with which private agents undertake innovative activities (Bilbao-Osorio and Rodriguez-Pose, 2004; Filippetti and Archibugi, 2010). In light of this, public authorities in the periphery should try to (more than) compensate private sector backwardness and overcome technology lock-in phenomena by devoting privileged attention to innovation (both directly and indirectly by properly incentivizing private sector-led innovation). However, data on R&D expenditures (as a percentage of GDP) by the government and high education sector seem to describe a different reality (see Figure 2).

Figure 2 – Government plus high education sector and private expenditures on R&D activities in percentage of GDP, selected countries, 2011.



Source: Author's calculations on data from Eurostat.

Note: Data on Greece (EL) refer to 2007. Data on United States (US) refer to 2009. Country sample in Figure 2 also includes Belgium (BE), Denmark (DK), Nederland (NL), Norway (NR), Sweden (SW), United Kingdom (UK), and United States (US).

Indeed, peripheral countries are clustered in the south-west part of Figure 2 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 even exacerbated by insufficient efforts by national governments and high education systems.

4. What's new for European Industrial Policy?

Structural and technological convergence are not automatic outcomes of economic and monetary integration. Well on the contrary, according to Cimoli et al. (2009), specific institutional settings and public policies are required to deal with structural asymmetries between countries. The central-peripheral technological divide in the eurozone does not seem to make exception.

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. These measures are likely inappropriate and insufficient to confront with persisting (or widening) center-periphery technological and economic gaps in the eurozone. This is even more so if we think that current "economic union consists of the internal market and a *very modest* [italics is ours] set of cohesion [read regional] policies (Pelkmans, 2006, p.5)". Given above evidence, two general principles should guide the reform of European industrial policy and the implementation of a new industrial strategy in the upcoming years.

First, future European industrial policy should have a strong *regional* character. With this term, we 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 favor regional cohesion and center-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. Indeed, more balanced productive and trade links would likely rise inside the eurozone should center and peripheral countries present more technologically homogeneous productive structures, and compete on more equitable bases. A strong emphasis on regional productive development may likely turn out as the main way for "europeanizing" the European productive system and removing the existing center-periphery dichotomy.

Second, market coordination failures due to productive assets complementarities (see complementarities between a high-skilled labor force, and R&D and physical investment, for instance) shape structural changes in the center and in the periphery of the eurozone. As a consequence, European industrial policy should take on board *demand-side factors* alongside supply-side ones as relevant forces determining productive structures' evolution and productivity dynamics inside Europe. Productive structures in the periphery may credibly upgrade only if efforts to improve labor force skills would be coupled with rising regional demand for high-skill workers due to increasing productive investment and newly established high-tech productions.

Which are the concrete implications of the above principles as to EU budget for industrial policy, sectors expected to be most relevantly affected by EU intervention, and the specific measures to adopt? Let us discuss some points.

The sovereign debt crisis and the ensuing constraints (self-imposed by EU institutions or set by financial markets) to member States' budgets largely prevent national governments from

implementing vigorous industrial measures. Thus, European institutions should take a much more interventionist stance, and considerably expand financial resources devoted to an integrated cohesion-industrial-technology policy. Obviously, this would entail to provide EU institutions with more conspicuous own financial resources than now is. Eurobond issuances in a future European or at least in a eurozone federal entity might be the financial vehicle pursuing this task. Unfortunately, following Fiorentini and Montani (2013), the European Council seems to have recently preferred taking a different way, downsizing the EU budget instead of expanding it¹⁹.

The 2013 European Innovation Scoreboard clearly stresses peripheral eurozone countries' deep lags with respect to both central economies and international foreign competitors as to the accumulation of human resources, here intended as high education level and professional skills attained by domestic labor force. This fact notwithstanding, from 2008 to 2012, the ongoing crisis has forced most peripheral economies to cut high 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 to high education has increased in Germany and Austria (European University Association, 2012). EU industrial/cohesion funds to peripheral countries might primarily aim to fill such a widening discrepancy. Two actions are at stake. First, EU funds to the periphery should support domestic expenditures on high education systems so as to perhaps indirectly favor a larger domestic availability of high-skilled workers. EU financing of fellowship programs, and of modern and technologically advanced education infrastructures are examples of possible measures in this vein. Second, and accordingly with the previous point, EU emphasis on high education systems should also imply encouraging research activities carried out by universities and governmental-public centers in peripheral economies. In this sense, EU support should aim at strengthening physical infrastructures (say labs) devoted to host research activities; enlarging the domestic research community; financing international research programs held in peripheral countries. Positive spill-overs of this kind of initiatives on the economic performances of peripheral countries may be expected to be considerable, even though not immediate. Indeed, according to Filippetti and Archibugi (2010), the more skilled and well-prepared is labor force a country can dispose of, the more resilient it is to economic downswings. Further, according to Dosi, Llerena and Sylos Labini (2006), increasing efforts on basic research by high education and governmental institutes are functional to create more business-friendly environments.

Institutions involved in the national innovation system are often not well integrated in peripheral countries. A further goal of EU industrial policy may thus focus on tightening and widening innovation linkages inside local productive systems. We think about the creation of EU-funded research centers in the periphery that should involve high education institutions and private enterprises in joint innovation processes. On the one hand, these centers should focus on

¹⁹ On 8th February 2013, the European Council has decided to cut EU budget to 1% of EU GDP. Further, a eight percentage points cut in cohesion and regional funds has been prospected in the framework of the 2014-2020 multi-period financial planning. 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 modest (to be fair) measures could effectively address inside-Europe discrepancies noted in the paper.

applied innovations, perhaps based on new basic scientific knowledge. In this sense, it would be fundamental to develop their links with the university system, and support researchers' mobility among research centers (from basic research to applied one, for instance) in order to facilitate knowledge dissemination. On the other hand, research centers' linkages with the private business sector would be intended to ease commercially valuable applications of technological innovations. Indeed, EU-funded research centers may pursue three distinct but connected tasks. First, they may act as catalysts of production investment aiming to exploit joint public-private innovations. Second, they may act as *autonomous embedded* public institutions recollecting and sharing information on firms' needs and innovation opportunities that are so important to properly implement industrial and innovation policies (Rodrik, 2008). Third, they may track the effectiveness of R&D efforts in terms of innovations applicable to commercial uses.

Coordination failures very often prevent radical structural changes to take place in relatively poor productive structures. In this sense, the above initiatives may well turn out to be useless insofar as a better trained labor force, more qualified workers, and a higher stock of scientific knowledge do not find adequate employment opportunities in the domestic productive system. Such employment opportunities lacking, periphery-to-center brain drain would likely emerge or intensify, eventually reinforcing center-periphery technological asymmetries (Brussels Think Tank Dialogue, 2013).

According to the intrinsic properties of technological knowledge, innovative firms would not naturally localize in backward economies. EU future industrial policy should take this into account, and question if unfettered market competition between asymmetric productive structures constitutes a sort of *unfair* competition between differently equipped competitors. Paradoxically, competitive pressures may intensify in the long run once public institutions *temporary* defend *initial* losers.

In terms of our analysis, the above consideration might suggest that a European industrial development authority should be created interacting with economic agents and coordinating investment initiatives 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 European institutions entitled of implementing EU industrial policy. EU industrial policy should then envisage some perhaps market-distorting measures incentivizing innovative firms' localization in peripheral countries. Public support to innovative activities may take the form of easy credit or public financing of productive investment, as well as of tax incentives and subsidies linked to R&D efforts.

As to the financing of innovative entrepreneurial initiatives, regionally-oriented easy credit policy might likely be fundamental to restore growth in the periphery should the ongoing credit crunch persist and credit accessibility remain extremely difficult in those economies. More in details, such kind of intervention may be implemented through the action of the European Investment Bank (EIB). From the very onset, EIB has been conceived as a public development bank providing funds for infrastructural projects mainly (Griffith-Jones and Tyson, 2013). More recently,

it has started to care about the development of technologically advanced small and medium size firms also. In the near future, EIB's commitment to industrial development goals should be reinforced. Indeed, EIB's concern about infrastructure financing, although appreciable, cannot fully remove economic bottlenecks and coordination failures that prevent productive upgrading to take place in the periphery of the eurozone. EIB's financial support to productive development should thus become a main pillar of EIB's action. EIB's intervention should first go far beyond the provision of public guarantees to private agents' financing of innovation efforts. It may be asked to adopt a perhaps riskier direct financial stance. Second, EIB's credit policy should be anti-cyclical in nature. Actually, co-financing philosophy that informs EIB's operation intrinsically has a pro-cyclical character whenever austerity programs cut national funds for public investment and depress private agents' propensity to risk (let say animal spirits). EIB's financial load of supported projects should thus increase in time of financial and economic distress. Last but not least, EIB should start to consider program financing as a policy tool for supporting coordinated innovation initiatives. Such a far-sighted wide financial perspective may likely improve EU institutions' capability to effectively address coordination failures in backward productive systems.

As to the adoption of tax and subsidy incentives, such measures should be graduated according to the degree of embeddedness of new production activities in the local productive system. For instance, public subsidies or tax exemptions granted to productive investment might augment in case of shared innovation activities among multiple actors that increase the density of peripheral national innovation systems. Further, such regionally-based incentives should be temporary and submitted to conditionality requirements. According to a well-known carrot-and-stick argument, public support must be conceded and (temporary) maintained provided that supported firms perform well in terms of easily checkable targets such as export shares on foreign markets and/or patented innovations.

Some final notes concern EU industrial policy if considered in a wider perspective than the previous focus on its usefulness as regional development policy tool. First, even though sectoral industrial policies have been largely disregarded by EU institutions in the last decades, they are now implicitly advocated back in the Horizon 2020 program, insofar as EU Commission identifies some specific fields research and productive efforts should concentrate in. This is the case of all sectors producing environmental-friendly technologies. Indeed, rising worldwide concern about environment protection seems to suggest that sectors generating such kind of innovations might expand pretty fast in the near future. Accordingly, industrial policy spurring development in those fields may turn out to be decisive to lead Europe acquiring competitive advantages in the production of, let say, energy-saving goods. In line with the above observations, such policies should have a look at both the supply-side and the demand-side of the market. As to the supply side, production incentives may stimulate the emergence of highly competitive European production networks in targeted sectors. On the demand side, incentives to the adoption of eco-friendly technologies could create a large enough domestic market domestic producers may profitably supply. Past empirical experience, for instance, shows that stricter environmental

regulation, by expanding domestic demand for renewable energy and energy-saving goods and processes, may eventually lead to improving export performances in those same industries (Costantini and Crespi, 2008).

Second, differently from what supposed by most supply-side growth models, demand-side and supply-side factors feedback each other to determine productivity dynamics and countries' external competitiveness. Demand stimuli in the form of EU-level public procurement of Europe-made new technologies and investment goods may thus contribute to set in virtuous circles between enhanced European competitiveness and expanding European firms' market shares on new dynamic productive sectors. Remarkable increases in EU-level public investment demand may be desirable to both favor recovery out of the present crisis and trace European long-run development path.

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 contrasting the ongoing crisis. More importantly, productive investment could help reducing 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 to 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 kind of measures should take inspiration from Keynes' lesson on the intrinsic unstable nature of market economies. First, a EU plan for productive investment in the periphery of the eurozone should try to apply Keynes's ideas of a "somehow comprehensive socialization of investment...[as] the only means of securing an approximation to full employment (Keynes, 1972a, pag. 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":

The 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, pag. 291)

Further:

I believe that some *coordinated* [italics is of the authors] 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 organization 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, pag. 292)

Market failures are pervasive in the field of basic research and on financial markets. This is even more so in time 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 stoutly address them in the near future.

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Appendix. Macroeconomic convergence-divergence trends among selected European countries

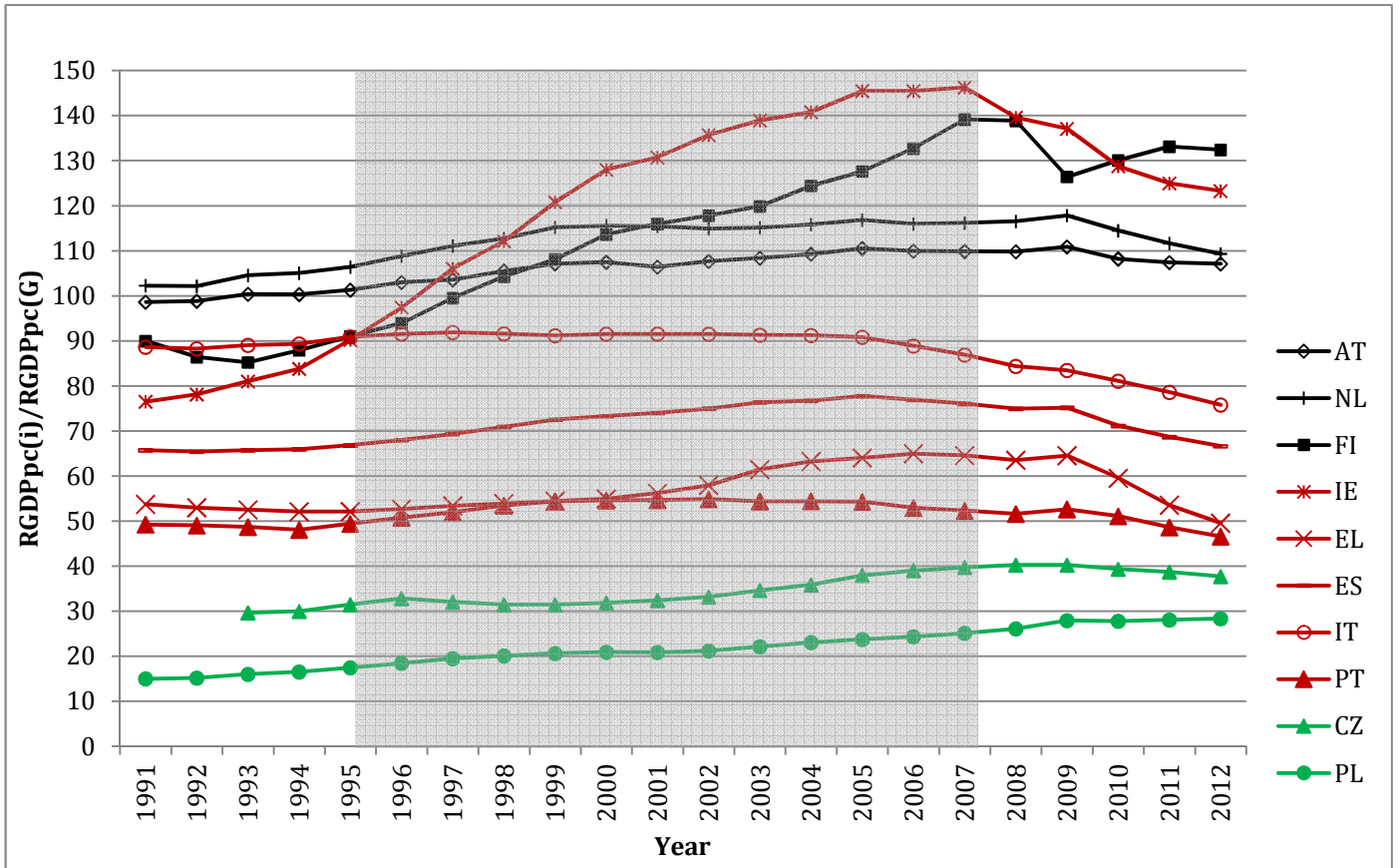
Figures A.1, A.2 and A.3 below provide evidence about comparative macroeconomic trends, as well as likely connected external imbalances, among eurozone countries in the last two decades.

Figure A.1 portrays eurozone center-periphery real GDP per-capita convergence-divergence patterns from 1991 to 2012. According to the analysis carried out in the main text, in Figure A.1 we take into account the dynamics of real GDP per-capita in Czech Republic and Poland also. Germany's real GDP per-capita is taken as benchmark. From 1995 until the outbreak of the most recent worldwide financial crisis (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 bonds' yields (see Figure A.2), fed peripheral countries' catching-up on Germany. Irish macro-aggregated performance and take-over on 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 East European countries.

The effects of the ongoing crisis appear clearly since 2007 on. The disappointing Irish performance with respect to Germany is impressive. Perhaps even more worrisome, newly established divergence increasingly divide relatively poor peripheral countries (Greece, Portugal, Spain and Italy) from Germany and the other central economies. At the end of 2012, Greek GDP per-capital is less than 50 percent of the German one (i.e. it is now lower than it was in 2001 at the beginning of the common currency experiment). Finally, 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 do.

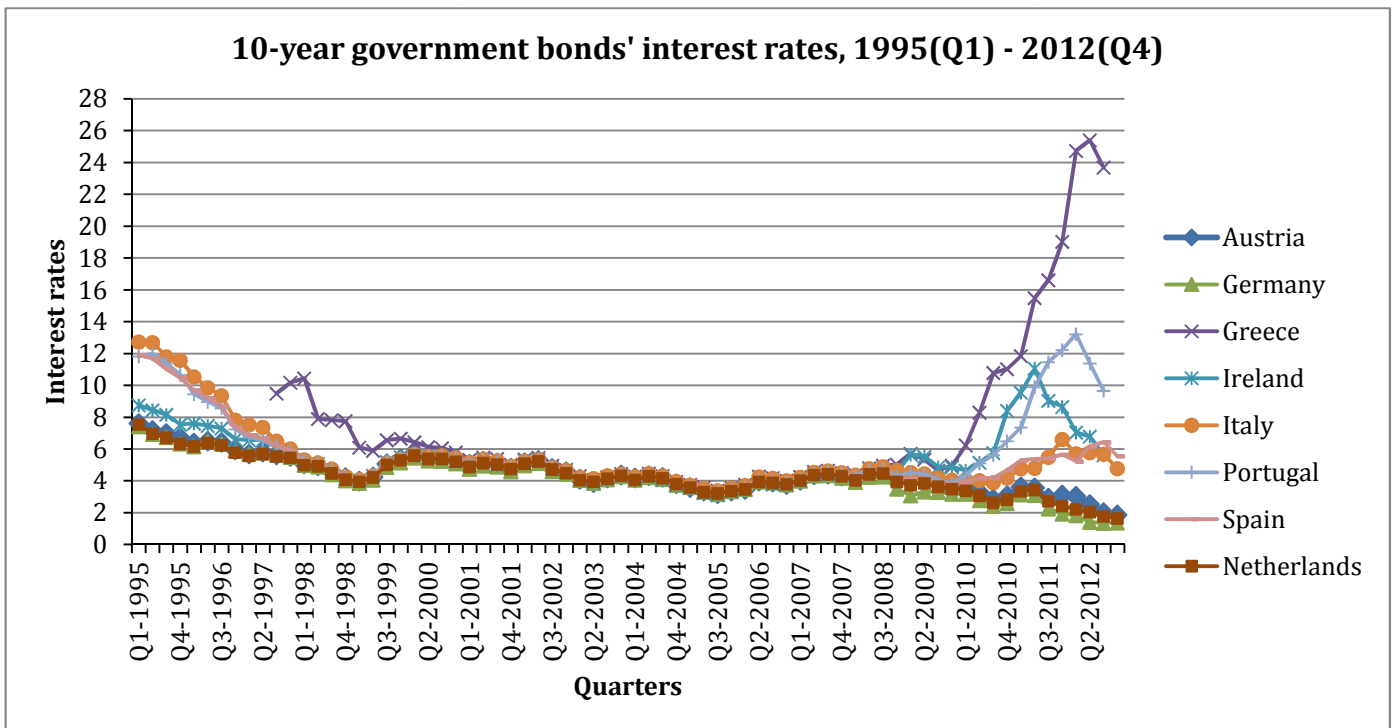
According to the arguments presented in the main text, initial finance-led center-periphery convergence, when associated to persistent center-periphery asymmetries, has been reflected in widening external imbalances (see Figure A.3). Relevant current account deficits started to emerge in the Balance of Payments of most peripheral countries (Ireland is the exception) in the second half of the 90s (light grey in Figure A.3). They further increased in the years immediately before the 2007-2008 financial meltdown (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 European countries (Germany = 100).



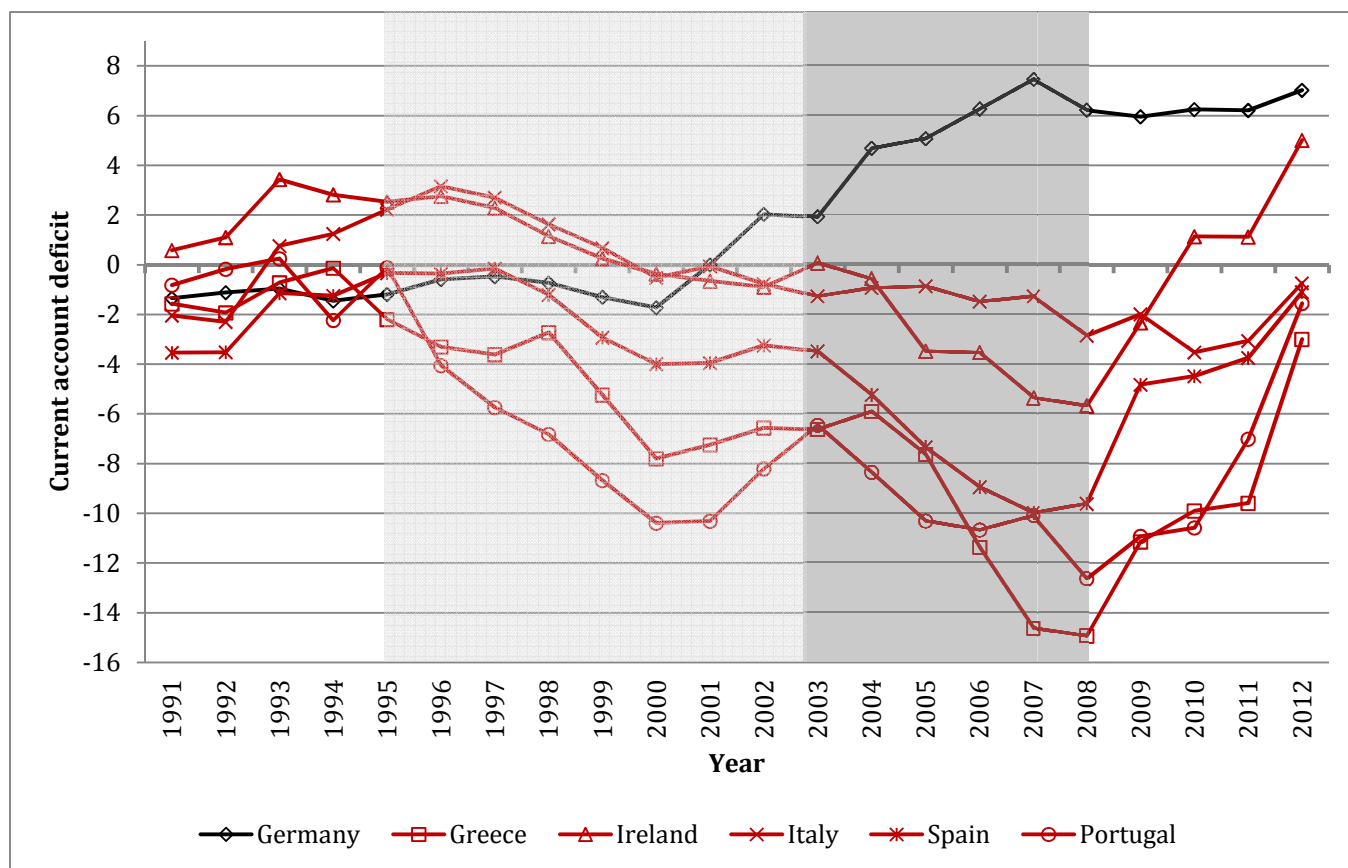
Source: Author's elaboration on data from UNCTAD.

Figure A.2 – Financial integration among eurozone countries and interest rate dynamics.



Source: Author's representation on data from OECD.

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



Source: Author's representation on data from UNCTAD.