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The roots of a divided eurozone: rigid labour markets or asymmetric technology-macroeconomic regimes?

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Abstract

In this paper, we analyse secular stagnation in the eurozone. We adopt a core-periphery perspective and analyse whether the 2007-2008 financial crisis triggered off diverging dynamics in the growth potential of core and peripheral eurozone countries. We find that secular stagnation affects the whole eurozone but is a much more serious concern in the periphery. Among the components of potential GDP, the NAIRU in particular has diverged since 2008. We find that the increase in the NAIRU is strongly related to demand-side factors such as investment demand and fiscal consolidation, as well as to the technological level of the economy. Labour market institutions seem to play a relatively minor role, which may also change depending on the level of technological development of an economy. In line with these findings, we argue that reforms in the eurozone should focus on levelling out the core-periphery technological gap via industrial policy, and on the creation of homogenous financial and macroeconomic conditions among member countries, rather than on the generalised deregulation of labour markets.

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NAIRU, secular stagnation, eurozone, core-periphery divergence, labor market, technology, demand regimes, government spending, austerity

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1. Introduction

The outbreak of the 2007-2008 financial crisis and its transformation into a sovereign debt crisis in the eurozone, dramatically twisted the assessment of the euro experiment. In November 2007, Tumpel-Gugerell, a previous member of the ECB executive board, claimed that the introduction of the euro had brought "monetary stability, with low inflation and convergence of long-term interest rates towards the low levels", these facts being "the best support for sustainable economic growth and employment". In 2008, an EU Commission report celebrating the 10-year anniversary of the introduction of the euro praised the single currency as a "resounding success". Just two years later, the eruption of financial turbulences surrounding public debt in the "periphery" of the eurozone, and the risk of a disintegration of the eurozone itself, radically changed the mind of policy makers and economists. According to several experts (Eichengreen, 2014; De Grauwe and Ji, 2015), the euro passed from being a "resounding success" to a cause of economic distress.

The above events triggered two interconnected evolutions in the economic literature. First, since 2008, the economic discipline has rediscovered the concept of "secular stagnation" (Summers, 2014a, 2015; Eggertsson and Mehrotra, 2014; Gordon, 2014, 2015) originally coined by Alvin Hansen (1934, 1939). Second, even though the concept of secular stagnation has been applied to most post-crisis developed economies worldwide, the idea of a secular decline has been frequently associated with the very meagre economic performance of the euro area in the last 10 years (De Grauwe, 2016).

In this paper, we tackle the issue of *secular stagnation* in the eurozone. We do so by adopting a *core-periphery perspective*. This is a novel contribution of our work with respect to previous papers on the same topic. Indeed, several papers have already documented the existence of considerable heterogeneity in the development process of eurozone countries. Estrada *et al.* (2013) and Barkbu *et al*. (2016) stress the lack (or slowdown) of *real* economic convergence among eurozone countries even before the outbreak of the 2007-2008 crisis. Landesmann (2015) and Celi *et al.* (2018) note that when pre-crisis convergence in per-capita GDP occurred (in Greece and Spain, for instance), such processes were accompanied by *structural* (external) imbalances making core-periphery catching-up unsustainable and likely to fail in the long run. Consistent with structuralist core-periphery theory, Simonazzi *et al.* (2013), Celi *et al.* (2018), and Grabner *et al.* (2019, 2020) provide evidence about differences in the technological capabilities of European countries. In their views, persisting or even increasing intra-European technological gaps significantly contributed to the unsustainability of macro convergence among euro countries, to the asymmetric response to 2008 shock, and eventually to the generation of the eurozone crisis itself, in the periphery of the euro area in particular. Despite this evidence, previous work about secular stagnation and/or unemployment in the eurozone ignored the possibility that the above two phenomena might be somehow related to an unfolding process of uneven development between the core and the periphery of the euro area. Our work aims at filling this gap by documenting how structural technological differences among core and peripheral eurozone economies, and the way they may interact with macro policies, may have ignited (or reinforced) *long-run diverging developments* in the aftermath of the common 2007-2008 financial shock.

In this paper, we first empirically analyse whether the 2007-2008 financial shock has triggered secular stagnation in the core and the periphery of the euro area. Following Jimeno *et al.* (2014), Gordon (2015), Storm (2017) and Crafts (2017), we take the dynamics of *potential* GDP as the main indicator of secular stagnation. Second, we focus on the components of potential GDP that have changed the most in the wake of the crisis and that may represent relevant sources of deepening core-periphery divergence. The key component that arises from this analysis if the NAIRU, which is

the focus for the rest of the paper[1]. Our analysis of the determinants of the NAIRU however departs from narrow mainstream approaches that focus on supply-side factors, in particular labour market institutions, first and foremost. We rather follow Storm and Naastepad (2015a) and Storm (2017) by offering a mixed structuralist/post-Keynesian analysis of the variables at stake with the following two extra groups of determinants of the NAIRU. Firstly, we analyse the influence of different technological capabilities in core and peripheral eurozone countries on the NAIRU. This follows Storm and Naastepad (2015a) who argue that the real problem of peripheral eurozone countries, in particular the Southern ones, lies in the lack of *non-price* competitiveness as "they are locked in to lower and middle levels of technology" (Storm and Naastepad, 2015, p. 969). Secondly, we investigate the role of demand-side forces in shaping the relative development trajectory of core and peripheral eurozone countries, and the way such demand-side factors may have interacted with the above-mentioned technological capabilities. Consistent with Stockhammer and Klär (2011) and Hemberger *at al.* (2017), we emphasize the importance of investment demand as a relevant determinant of potential GDP growth and of the NAIRU. Differently from them, we extend our analysis to the role played by fiscal austerity. To the best of our knowledge, this is the first paper to explore both fiscal austerity and technological capabilities together in an empirical analysis of the NAIRU.

Four different findings of our work are worth mentioning. First, whilst post-crisis secular stagnation seems to appear as a concrete reality in the whole eurozone, it is much more acute in the periphery. Since 2008, pre-crisis (timid) core-periphery convergence has turned into deep structural divergence. Capital accumulation and the level of the NAIRU are the components of potential GDP that have been most affected by the recessionary forces triggered by the worldwide financial crisis, and which diverged the most afterwards. Since 2008, the NAIRU in the periphery of the eurozone has increased substantially, whilst it has slightly decreased or remained constant in the core.

Second, with the exception of active labour market policies, institutional factors affecting the functioning of the labour market (i.e., the provision of unemployment benefits, employment protection, and trade union density) do not play a consistent, clear or relevant role throughout eurozone core and peripheral countries. In general, they seem to be relatively minor determinants of potential GDP, and of the NAIRU in particular, with respect to structuralist-type technology and demand-side factors.

Third, the technology capability and, hence, the non-price competitiveness of eurozone economies, play an extremely important role in explaining the level of the NAIRU and the ensuing dynamics of potential GDP. This is particularly so in the periphery of the eurozone. The structural technological weaknesses characterizing these economies significantly contribute to raise their level of structural unemployment (making it much higher than that recorded in the core of the eurozone).

Fourth, structural unemployment and potential GDP are considerably affected by demand-side factors. Our analysis first confirms what has already been pointed out by Stockhammer (2004) and Stockhammer and Klär (2011): investment demand tends to negatively affect and squeeze the NAIRU. More than this, we present two novel findings. Firstly, in the eurozone, tough fiscal consolidation has significantly drained aggregate demand and increased the NAIRU. We find a significant positive correlation between the NAIRU and fiscal cuts in the public budget. Secondly, fiscal policy *interacts* with the structural (technological) features of peripheral countries themselves. We argue that National governments, in the periphery of the eurozone in particular, may have used expansionary fiscal policy to respond to and to compensate for the perverse effects that the technological weaknesses of the local economy may induce on structural unemployment. The

[1] We use the expressions NAIRU and structural unemployment as synonymous throughout the paper.

straight jacket imposed on fiscal spending since 2010 may explain why, in the absence of expansionary fiscal stances and given the long-lasting nature of intra-European technological gaps, the NAIRU increased so massively in peripheral eurozone countries.

The paper is organised as follows. Section 2 reviews the concept of secular stagnation and how it might be theoretically connected to and empirically analysed by looking at the dynamics of potential GDP and of its components. Section 3 illustrates the rationale for the core-periphery perspective adopted in this paper by providing evidence of technological gaps among eurozone countries. It also addresses the structural effects of the 2007-2008 crisis in the core and the periphery of the eurozone. Section 4 points out the respective roles of "mainstream-like" labour market institutions, structuralist-type technological factors and, finally, demand-side factors in the determination of the NAIRU. Section 5 concludes and drives some policy implications that stem from the above findings.

2. Secular stagnation and the dynamics of potential GDP

The concept of secular stagnation has neither a well-established definition nor a clear method of how to measure it. Similarly, a consensus does not exist about its causes and solutions. In 1938, the US economist Alvin Hansen defined the "essence of secular stagnation [as] sick recoveries which die in their infancy and depressions which feed on themselves and leave a hard and seemingly *immovable core of unemployment* [italics is ours]" (Hansen, 1939, p.4). He had first introduced this concept five years earlier however, saying that "the secular stagnation of business [is] incident to the accumulation of a surplus of funds unable to find an adequate outlet in profitable investment" (Hansen, 1934, p.19).

Hansen's reference to saving-investment matching as the possible missing economic adjustment leading to secular stagnation may have misdirected most of the recent mainstream contributions on secular stagnation from its original meaning, causes and solutions. On the one hand, these works take the Wicksellian theory of interest rate-driven adjustments to full employment as the proper theoretical framework in order to address the problem of secular stagnation (see Eichengreen, 2015; Blanchard *et al.*, 2014; Claeys, 2016; Eggertsson *et al.*, 2017). On the other hand, mainstream empirical analyses concentrate their attention on estimating the existence of a *negative* natural interest rate as proof of secular stagnation (see Hamilton *et al.*, 2016; Belke and Klose, 2017). A critique of these approaches is out of the scope of this paper.[2] What it is relevant for our purposes is that Hansen himself considered interest rate-led adjustments and the Wicksellian theory to be largely irrelevant in order to explain secular stagnation (Hansen, 1939, p.5). According to Hansen, the roots of secular stagnation lie in a structural lack of profitable investment opportunities and, hence, of an adequate investment *demand* as caused by structural forces such as the slowdown in population growth, a narrowing scope for innovation, the closing of the Western US frontier and a lower exploitation of natural resources.

The concept of potential GDP did not yet exist when Hansen first talked about secular stagnation (Gordon, 2014). Nonetheless, the long-run structural perspective characterising Hansen's view makes the association between the idea of secular stagnation and the evolution of potential GDP quite straightforward.[3] According to Teulings and Baldwin (2014), three different (but rather close) approaches have recently emerged after Larry Summers rediscovered secular stagnation in his 2013

[2] See Taylor (2017) for a critical analysis of the application of the loanable fund theory to secular stagnation.

[3] An alternative "structural" interpretation of stagnation has been elaborated by some heterodox and Marxian economists, who foresaw a permanent decline in the rate of capital accumulation of developed countries due to the intrinsic dynamics and contradictions of capitalist economies, i.e., the increase in oligopolistic concentration, a rise in the profit margins and an increase in excess capacity.

IMF address in honour of Stanley Fischer. The first one, consistent with Gordon (2014), links secular stagnation to the decline in the *growth rate* of potential GDP. The second one focuses on a one-off reduction in the *level* of potential GDP regardless of a possible slowdown in its trend growth. In both views, a slowdown in potential GDP is mainly explained by supply-side forces such as a negative exogenous shift in the dynamics of productivity or excessive labour market rigidities (causing persistent post-crisis increases in the NAIRU). A third Summers-like approach "measures" secular stagnation according to the *gap* between actual and potential GDP.

In this paper, we analyse post-2008 secular stagnation in the eurozone, and the possibility such a phenomenon might have taken different orders of magnitude in the core and the periphery, by looking at the *dynamics of potential output*. We do so for two reasons. First, using the output gap as a measure of secular stagnation is highly questionable. As Summers (2014b) himself admits, a squeeze in the output gap may actually come from a reduction in potential output itself rather than in a rebound in actual output towards its pre-crisis potential trend. Indeed, this is what has happened in Japan in the 1990s and, more recently, in the US and EU alike. As a consequence, the output gap may well disappear, even though the economy remains depressed with widespread unemployment. As we will highlight later on, a leading reason why potential output stagnated or even declined in the post-crisis eurozone periphery is precisely because of an increase in the NAIRU. Second, we follow Storm (2017) and we depart from the standard mainstream explanation of potential GDP as determined by supply side factors related to labour market institutions (or the regulation of the goods market). In this paper, we analyse the evolution of potential GDP, and of some of its components, by taking on board suggestions from structuralist and post-Keynesian theory. In line with structuralist theory, we investigate whether differences in the growth potential of eurozone countries may be influenced by differences in their levels of technological capability and productive complexity. From post-Keynesian theory, we admit for the possibility that some components of potential GDP may be influenced by demand factors. One example of how demand may influence potential GDP is through productivity dynamics, which may be positively stimulated by a buoyant aggregate demand via Kaldor-Verdoon effects (Storm, 2017).[4] This is also the case for an *endogenous* NAIRU that may change due to demand-related factors (Stockhammer, 2004; Ball, 2009; Stockhammer and Klär, 2011), and show path-dependency with respect to actual unemployment (Ball, 2009; Storm and Naastepad, 2015b)[5].

Potential GDP is a theoretical construct that cannot be directly observed from available economic data. The definition of potential output commonly adopted by international institutions and national economic bodies refers to the *maximum quantity of output that can be produced at stable inflation*. It is usually estimated by applying a standard production function (say a Cobb-Douglas production function) to filtered macro data on GDP, capital stock, labour force and Total Factor Productivity (TFP). This is explicitly pointed out in equation (1) below, where Y^* stands for potential output, TFP^* and N^* represent trends values for Total Factor Productivity and the available labour input[6] respectivelly, and K_t is the available capital input at time t. In equation (1), u^* stands for the NAIRU, i.e., the rate of unemployment of the labour force that ensures inflation to remain constant.

[4] This perspective seems to be consistent with Hansen's own view, in particular when he stressed, in the words of Backhouse and Boianovsky (2016), that sustained post-Second World War productivity dynamics "could have not happened without expansionary fiscal policy [and that] technological progress was probably stimulated by adequate aggregate demand, meaning that the actual and potential growth trends are not independent from one another" (Backhouse and Boianovsky, 2016, p.958).

[5] The fact that demand shocks may affect the long-run development trajectory of an economy (Dutt, 2006; Dosi *et al*., 2010; Dosi *et al.*, 2018), and the determination of an *endogenous* NAIRU (Stockhammer, 2008), are consolidated pillars of post-Keynesian and evolutionary economics now increasingly accepted by mainstream authors as well (Ball, 2014).

[6] Total available labour force is in turn computed as the product between working age population, the average participation to the labour force, and a trend value for average worked hours.

$$Y_t^* = [TFP_t^* N_t^* (1 - u^*)]^{\alpha} K_t^{(1-\alpha)} \quad (1)$$

There are several critiques to the above definition of potential output and to the way it is estimated. Palumbo (2015) and Fontanari *et al.* (2019) criticise the fact that the concept of potential output is theoretically biased, as it incorporates the mainstream theory of inflation and unemployment, i.e., the NAIRU, and its computation is based on filtered macro data fitted onto a mainstream production function. According to them, this approach may impede potential output, as generally intended and measured, to correctly gauge the real production potential of an economy and tend to systematically underestimate output losses during recessions. Heimberger *at al.*, (2017) note that the way the NAIRU is sometimes measured (i.e., by applying some smoothing filters to data about actual unemployment) may be inconsistent with the concept of structural unemployment (i.e., the level of unemployment caused by institutional factors such as labour market rigidities). These critiques are well grounded. Nevertheless, a critical appraisal of the definition and measurement of potential GDP and of its components is far beyond the scope of this paper. For the sake of comparability with previous mainstream studies of this topic, we maintain the same methodological approach. In a way, this is a critique "from inside the mainstream" by starting from the same data and estimation techniques used by mainstream analyses. However, the theoretical framework of our study is much broader as it embraces relevant insights coming from structuralist core-periphery theory and from post-Keynesian economics. This way, we show how economic mechanisms central to structuralist and post-Keynesian theory may provide more effective explanations for the economic phenomena and the connected data usually interpreted through the narrow lenses of mainstream economics.

3. The 2007-2008 financial shock, the dynamics of potential output and secular stagnation in the eurozone: A core-periphery perspective

The fact that the last financial crisis may induced a prolonged economic slowdown, if not stagnation, in the euro area is not new in the economic literature (Summers, 2014b). Nonetheless, only a few works have addressed this issue from an empirical point of view. Anderton *et al.*, (2014) perform a detailed empirical analysis of the main components of potential output for the eurozone as a whole and detect an unprecedented decline in the speed of capital accumulation and a symmetric increase in structural unemployment after 2008. Ollivaud and Turner (2014) conduct a similar analysis for OECD countries, eurozone Member States among them, reporting evidence of post 2008 changes in potential output for each economy.

The above contributions provide clear evidence of the possible long-lasting negative effects of the 2007-2008 shock on the economy of eurozone countries. However, by analysing the Eurozone as whole, they miss the considerable degree of heterogeneity within the monetary union. This is not a trivial shortcoming. Indeed, following Storm and Naastepad (2015a) and Celi *et al.* (2018), the fact that eurozone countries responded asymmetrically to a somehow symmetric shock is related to the way their different technological capabilities and productive structures *interacted* with the process of monetary integration itself. Since late 1990s until the outbreak of the crisis, quite abundant capital flows moved from the core of the eurozone to structurally weaker peripheral countries, attracted by (temporarily) higher yields and by the (apparent) disappearance of the exchange rate risk. Such capital flows gave rise to economic accelerations in the periphery, and signs of core-periphery macro convergence. However, they also fed deepening imbalances. The technological gap dividing the periphery of the eurozone from the core, and the lack of *non-price* competitiveness in the periphery, was mirrored by widening current account deficits in the former set of countries, and by persistent surpluses in the latter. The financial crisis brought this process to

an abrupt end (Merler and Pisani-Ferry, 2012). Sudden stops, capital reversals and the ensuing sovereign debt crisis, eventually led to structural adjustment in the periphery, much like those frequently observed in the periphery of the world economy since the 1980s.

The relevance of the technological gap shaping the economic interaction between core and peripheral eurozone countries is well documented by the so-called "Cepalitec" index originally computed by ECLAC for Latin American countries (ECLAC, 2016). The index takes a simple average of two normalized indicators: one related to a country's export share of medium/high-tech engineering-related manufactured goods over total (country) exports (${ES_{HT}}_t^i$); the other to the number of granted patents per million inhabitants (PT_t^i).[7] Equation (2) below formally states Cepalitec, here re-labelled "technological capability" (TC) index for the sake of our argument:

$$TC_t^i = \frac{1}{2}\left[\frac{({ES_{HT}}_t^i - {ES_{HT}}_t^{min})}{({ES_{HT}}_t^{max} - {ES_{HT}}_t^{min})}\right] + \frac{1}{2}\left[\frac{(PT_t^i - PT_t^{min})}{(PT_t^{max} - PT_t^{min})}\right] \quad (2)$$

In equation (2), "*i*" stands for countries, whilst "*t*" indicates time. ${ES_{HT}}_t^{min}$ (${ES_{HT}}_t^{max}$) and PT_t^{min} (PT_t^{max}) stand for the lowest (highest) values of the export and patent sub-indexes registered in our sample of countries at time "*t*".

Figure 1 below portrays the evolution of the "TC" index from 1984 to 2018 in core and peripheral eurozone countries. Figure 2 offers an indicative measure of the core-periphery technological gap as captured by the ratio between *weighted* averages of "TC" indexes for core and peripheral countries[8].

[FIGURES 1 and 2 HERE]

The TC index provides a ranking of eurozone countries by technology capability. From Figure 1, it is easy to see how, with the partial exception of Ireland in some years, all core economies (black lines in Figure 1) are persistently positioned above peripheral countries (red lines in Figure 1) in the technological ladder. Greece has permanently remained at the bottom of this technological hierarchy, whilst Germany at the top. Figure 2 reveals that there were signs of core-periphery technological catching-up before mid-1990s. The technological gap, however, never closed and has even diverged since 1996. Consistent with Simonazzi *et al.* (2013), and Celi *et al.* (2018), such a newly established technological divergence between core and peripheral eurozone countries is linked to the enlargement of the European Union towards East European countries (the so-called "catching-up countries" in Grabner *et al*. (2019)). The relocation of some manufacturing productions towards East European countries has in fact partially displaced those in Southern European economies, thus pushing their technological capabilities downwards.

The empirical evidence portrayed by Figures 1 and 2 gives a clear idea of persisting structural differences between core and peripheral eurozone countries and explains the rationale for the adoption of a core-periphery approach for our analysis of secular stagnation in the eurozone. In this paper we adopt a rather "standard" classification of eurozone Member States. We define as peripheral economies those hit the most by the 2007-2008 financial shock and/or by the sovereign

[7] The inclusion in the TC index of data related to patents alongside to trade statistics is meant to provide a remedy to the misleading evaluation of the technological capability characterizing an economy that could possibly emerge by considering trade data only. With the spread of global value chains (GVC), a country may well end up exporting goods classified as a high-tech, which however represent the low-tech low-skill labour intensive components of much more complex products produced elsewhere. The integration of data about the outcome of innovation processes (i.e., patents) with trade statistics may offer a more realistic picture of the technology level of an economy.

[8] Weights are countries' GDP shares over sub-groups (i.e., core and peripheral) totals.

debt crisis, i.e., Portugal, Ireland, Italy, Greece and Spain. We include Austria, Belgium, Finland, France, Germany and the Netherlands in the core. Our classification is different from that one put forward by Grabner *et al*. (2019) because we restrict our analysis to the eurozone only, and not to the wider European Union. Moreover, we exclude from our sample very small economies such as Luxemburg, Malta and Cyprus, or Eastern economies that joined the eurozone during or after the outbreak of the 2007-2008 financial crisis. Furthermore, the inclusion of France among core economies is controversial. Celi *at al.* (2018) document the progressive process of "peripheralization" of the French economy since 1980 as due to its industrial decline (of the automotive sector, in particular), and the ensuing emergence of persistent external imbalances (read current account deficits). Grabel *et al.* (2019) define France as an intermediate case between core and peripheral countries, but eventually include it in the periphery as a consequence of widening technological gaps with respect to core economies. In this paper, we take a different approach, considering France as a core economy. We do this for three different reasons. First, albeit French de-industrialization is undeniable, France's technological capabilities seem to be closer to those of the core than the periphery (see Figure 1). This is likely due to the fact that the *TC* index we compute in this paper does not exclusively rely upon trade statistics as Grabel *et al.* (2019) do[9]. When data about the outcome of innovation processes are considered as well, France seems to be better placed in the technological hierarchy. This view is supported by data about investments in R&D and employment in scientific and high-tech sectors (Botta, 2014). Second, the post-2008 increase in unemployment and slowdown in potential GDP (i.e., the variables at the basis of this study) registered in France seem to be much weaker than those recorded in the periphery (Botta *et al.* 2018). They are more aligned to the data of Centre-North eurozone countries. Third, in the aftermath of the 2007-2008 shock, France has not been exposed to acute financial turbulences and/or did not have to rely on bail-out programs. The leeway for expansionary fiscal policy has been significantly larger than in the periphery.

Given such classification, we have collected data for potential GDP and its components from 1998 to 2017 for all the countries in the sample.[10] The statistical information comes from AMECO and Eurostat datasets. Consistent with the above-mentioned production function technique, we have then computed average annual growth rates for the following components of potential GDP: trend TFP growth; net capital formation and the growth rate of working age population. We have finally taken average levels of labour force participation and the NAIRU. After constructing the dataset, we have computed simple averages for the core and the periphery for the sub-periods from 1999 to 2008 and from 2009 to 2017. We have checked for the occurrence of any *structural break* from one period to the other, and between core and periphery economies, by performing a two sample t-test on computed averages for all the variables at stake. The results of this analysis are reported in Tables 1.a-1.f below.

From Table 1.a, pre-crisis potential growth in the periphery was slightly higher, although not statistically different, with respect to what was recorded in the core. The outbreak of the crisis gave rise to a considerable and statistically significant drop in potential growth in both sets of countries. If we take a reduction in potential GDP growth as a sign of secular stagnation, both the core and periphery of the eurozone exhibit signs of secular decline post-2007/2008. The reduction in the periphery, however, has been much more pronounced (indeed around 2.5 times deeper) than the decline registered in the core of the euro area. Whilst potential growth in the core is still positive

[9] Grabel *et al.* (2019) try to assess the technological trajectory of European countries by combining changes in countries' exports of different types of goods with the corresponding product complexity index as computed by Hildalgo and Hausmann (2009). The product complexity index itself hinges upon the concept of revealed comparative advantages computed on the basis of trade statistics about relative export shares.

[10] Data for Ireland run from 1999 to 2014 only due to a change in statistical methodology thereafter.

(albeit 1.1 percentage points lower than pre-crisis average), potential output dynamics has turned negative in the periphery. As a consequence, from 2009 to 2017, there is solid empirical evidence for core-periphery divergence in the evolution of potential output.

When it comes to the components of potential output, our results show that capital accumulation (see Table 1.b) and TFP growth (see Table 1.c) have been significantly (and negatively) affected by the financial crisis in both peripheral and core economies. Once again, reductions in the periphery have been as large as or deeper than what was observed in the core. Capital accumulation was significantly faster in the periphery than in the core from 1999 to 2008 - a positive sign of intra-eurozone convergence. In the wake of the financial crisis, however, things have reversed, with core countries now investing much more than what economic actors do in the periphery. As to TFP growth, the dynamics of productivity has been persistently higher in the core than in the periphery both before and after the financial shock. This may be taken as additional evidence of the "structural" core-periphery divide that peripheral economies have never managed to reduce, and that is at least in part due to their persisting productive specialization in relatively low-tech industries with reduced scope for innovation and productivity growth, compared to the medium-high tech sectors at the centre of core economies' productive systems (Storm and Naastepad, 2015b and 2016; Celi *et al.*, 2018). What is however different, and certainly worrisome, with respect to pre-crisis dynamics is that post-2009 TFP average growth in the periphery of the eurozone has turned negative.

Table 1.d shows another interesting part of the story of euro area core-periphery divergence. Before the 2007-2008 financial shock, core and peripheral countries recorded similar rates of working age population growth. Indeed, this variable was slightly higher in the periphery but not statistically different with respect to what was observed in the core. On the contrary, post crisis trends are statistically different and show different signs between the core and the periphery. Whilst working age population has kept on growing in core economies (albeit at a lower rate), it has declined in the periphery. This outcome should not come as a surprise. Indeed, it is consistent with the increasing evidence of intra-euro area migration, with part of the labour force in the periphery moving towards core economies in search for better employment opportunities (Fries-Tersch *et al.*, 2016). Whilst, on the one hand, this fact may partially alleviate the problem of mass unemployment in certain peripheral countries (see Greece and Spain in particular), it stands out as an additional factor of divergence when periphery-to-core migration, especially high-skill workers' migration, gives rise to a brain drain from the former in favour of the latter.

[TABLES 1.A – 1.F HERE]

Last but not least, Table 1.f portrays the results of our two-sample t-test analysis related to structural unemployment. As Table 1.f clearly shows, structural unemployment rates have been persistently higher in the periphery than in the core regardless of whether we are looking at the period before or after the crisis. Before the outbreak of the 2007-2008 financial crisis, NAIRU rates were, on average, 3 percentage points higher in peripheral eurozone countries than in core economies, this difference being statistically significant. This fact notwithstanding, it is worth noting that such a gap has significantly widened in the post-crisis period. On the one hand, average NAIRU rates have slightly decreased in core economies, with no sign of a structural break being recorded. On the other hand, structural unemployment has remarkably increased in peripheral countries by around 3 percentage points. The statistically relevant dimension of this change suggests that a perverse structural break in the level of structural unemployment has indeed occurred in the periphery following the financial and sovereign debt crisis.

Once accepted that changes in the NAIRU may play a significant role in determining the level, if not the growth rate, of potential output (see Anderton *et al.*, 2014), it is important to determine which factors lie behind structural unemployment itself. This is even the more so in the context of our analysis, since opposite post-crisis variations in structural unemployment have increasingly divided the eurozone periphery from core economies. Such analysis is also relevant from the point of view of EU policy-making and institutional reforms. Most European institutions have so far interpreted the long-lasting rise in structural unemployment and decline in potential output as consequences of market rigidity, perhaps interacting with the real-side economic effects of the financial shock (ECB Task force, 2012; Masuch *et al.*, 2018). Accordingly, they have increasingly pushed for the introduction of structural reforms, i.e. deregulation of domestic labour markets, in the periphery with the hope of restoring international competitiveness (via internal devaluation) and reducing structural unemployment (ECB, 2015). However, several contributions have recognised demand-related factors as relevant determinants of the NAIRU (Ball, 2009; Stockhammer and Klär, 2011; Jump and Stockhammer, 2019). In the next section we will address this point by testing which factors have contributed most to the recent dynamics of structural unemployment in the core and in the periphery of the eurozone. More than that, we will test for the role played by persisting differences in euro countries' technological capabilities in the determination of diverging core-periphery economic trajectories.

4. Secular stagnation and the NAIRU in core and peripheral eurozone countries

There are contesting theories about the determinants of the NAIRU. In this section, we test the contribution of these alternative theories in the core and the periphery of the eurozone. Our econometric analysis extends the previous empirical contributions by Stockhammer and Klär (2011), and Heimberger *et al.*, (2017). We estimate a model with four sets of explanatory variables. First, we consider institutional labour market-related variables. According to mainstream theory, these factors might have an effect on structural unemployment by increasing the rigidity of the labour market. Second, we consider a range of "macro shock" variables (Blanchard and Wolfers, 2000; Stockhammer and Klär, 2011) such as the long-run real interest rate, changes in terms of trade, and the TFP growth rate. The first macro shock variable may contribute to structural unemployment via demand-side mechanisms by affecting capital accumulation and as the variable captured the uneven effects of ECB monetary policy. Terms of trade and TFP shocks are usually interpreted as supply shocks that may have an effect on the NAIRU via wage bargaining and/or price setting rules. In the specific context of the eurozone, the terms of trade variable may also control for the relative importance of price-competitiveness in influencing economic performance, and hence structural unemployment, in core and peripheral economies. Third, the "Keynesian" demand side components of our analysis are represented by investment demand, as measured by the gross rate of capital formation, and the fiscal policy stance, here gauged by the cyclically adjusted primary balance. Whilst the inclusion of the former is standard practice in the analyses about structural unemployment, the consideration of a fiscal policy variable is a novel contribution. After 2010, the implementation of fiscal austerity has been a distinguishing feature of policy making in the eurozone. By incorporating a fiscal policy variable in our econometric analysis, we test whether fiscal retrenchments, together with the decline in capital accumulation, may have led to increased structural unemployment, depressed potential output and, eventually, secular stagnation. Last but not least, we further extend the set of variables explaining structural unemployment by considering country-specific technological capabilities. The technological level of an economy obviously influences its supply side but through a different mechanism to the labour market factors pinpointed by mainstream theory. Rather, it effects the accumulation of knowledge and the

evolution of the productive structure of an economy and therefore the non-price competitiveness of country. According to structuralist-evolutionary theories, these are the most relevant factors behind economic success or decline. The large gap in the technological capabilities of core and peripheral eurozone economies we document above makes the analysis of the role of technology in the determination of eurozone core-periphery divergency of paramount importance.

4.1 Data and estimation methodology

The data for institutional factors is based on the OECD dataset about labour market variables. In order to keep data source homogeneity as high as possible, we also use the OECD estimations for the NAIRU and TOTS shocks. Data for the long-term real interest rate, capital accumulation and TFP growth are in turn collected from AMECO. None of the abovementioned datasets provide data for cyclically adjusted primary balances (CAPB) over a sufficiently long time period. Hence, we calculate CAPB in the eurozone as structural government budget balance minus net interest payments, as a ratio to potential GDP, using data provided by the IMF.

In this paper, we extend the period of analysis in Heimberger *et al.*, (2017), which covered the period from 1985 to 2012. Our baseline regression model uses data for the period of 1985-2014. 2014 is the last year for which comprehensive information about labour market institutions are available. Due to the lack of data for CAPBs for the full sample, estimations including CAPB is based on an unbalanced dataset.

Before proceeding with the estimation of the model, we first checked for the presence of unit roots. Results from the Fisher test[11] (see Table A.1 in the Appendix) reject the null hypothesis for the presence of unit roots at 1 percent confidence level for all the variables but Employment Labour Protection measures (EmP). In the case of EmP, the null hypothesis is rejected at 5 percent confidence level. Panel data may also be characterised by cross-sectional heteroskedasticity and autocorrelation. In order to check for these features, we run the Woolridge, Pearson and LR Maximum likelihood tests (see Table A.2). They all confirm the presence of heteroskedasticity and autocorrelation. As a consequence, we follow Orlandi (2012) and Heimberger et al. (2017) and adopt an Ordinary Least Square Panel Data Corrected Standard Error (OLS-PCSE) estimation method. According to Beck and Katz (1995), this methodology is well suited when dealing with panel data where the time dimension is not much larger than the cross-section size. It ensures that our estimations and significance analysis are appropriately corrected for the presence of autocorrelation. In the same vein, for the sake of comparability, we also maintain a similar structure of the regression model with respect to the above-mentioned works, as well as to Blanchard and Wolfers (2000), and Stockhammer and Klär (2011).

Equation (3) below shows the full model we estimate to analyse the determinants of structural unemployment in the core and peripheral eurozone countries:

$$NAIRU_{it} = \alpha LMI_{it} + \beta MS_{it} + \lambda TC_{it} + \gamma ACCU_{it} + \delta_1 CAPB_{it} + \delta_2 CAPB_{it} * d_{cris} + \delta_3 CAPB_{it} * d_{per} + \theta_1 FE_i + \theta_2 FE_t + e_{it} \quad (3)$$

LMI_{it} is a vector of labour market institutions for country *i* in time *t* including employment protection legislation (EmP), active labour market policies (ALMP), trade union density (UnD), and the

[11] As our panel is unbalanced and we have a relatively large *T* to *N*, the Fisher unit root test is the most appropriate (see Maddala and Wu, 2002). We include a drift term as the mean for each variable for any country is non-zero. We also include a demean term to remove cross sectional means. The null hypothesis is that all panels' series are non-stationary. This follows the same strategy adopted by Orlandi (2012) and Heimberger et al. (2017) in the previous empirical literature on the NAIRU.

unemployment benefit replacement rate (UBR)[12]. Table A.3 in the Appendix provides a detailed description of the variables and data sources. MS_{it} is the vector of macro shock variables (i.e., the level of the real long-term interest rate (LTI), the growth rate of total factor productivity (TFP), and the growth rate of terms of trade (TOTS)). TC_{it} is the technology capability index[13]. Finally, $ACCU_{it}$ and $CAPB_{it}$ represent the demand-side factors: capital accumulation and fiscal policy stance, respectively. The fiscal policy variable is also interacted with the dummy variable d_{cris}, which is equal to 1 during 2008-2010, and zero otherwise. At the peak of the financial crisis, eurozone governments implemented costly bail-out plans of financial institutions. These measures led to deep public deficits and significantly worsened *CAPB* without preventing a rise in unemployment (they might have tamed its increase with respect to the "hypothetical" counterfactual scenario with no bail-out) [14]. A "spurious" negative correlation between a lower *CAPB* and a higher NAIRU is likely to emerge in the midst of the financial crisis. The interaction dummy checks for the significance of this possible bias and helps to remove it from the causal relation between fiscal policy and the NAIRU that would emerge in "normal" times. Following Stockhammer and Klär (2011), Orlandi (2012) and Heimberger *et al.* (2017), we also include period-fixed effects (FE_t) and country-fixed effects (FE_i).

4.2 Estimation results

We estimate four different specifications. The first set of estimations (I.A – I.C) includes labour market institutions only. Specification (I.A) refers to the full sample of eurozone countries. Specification (I.B), in turn, focuses on core economies, whilst Specification (I.C) looks at peripheral eurozone countries. Results from this first set of regressions are reported in Table 2. A second set of Specifications (II.A – II.C in Table 3) adds our structuralist-type technological capability index to the set of mainstream labour market factors. In regressions (II.A – II.C) we thus test for the relative importance of different types of supply-side factors. Once again, we run this regression for the full sample of countries (II.A), as well as for the core (II.B) and the periphery (II.C) separately. Specification (III) further expands the set of explanatory factors by considering macro-shock variables and capital accumulation (see Table 4). Finally, Specification (IV) introduces the fiscal policy variable. Due to the reduced availability of observations, we run this regression for the full sample only. However, we include in the regression an additional dummy variable (d_{per}) which, once interacted with *CAPB*, may capture periphery-specific effects of fiscal austerity (see Table 5). [15]

The results in Table 2 suggest that labour market institutions play some role in explaining the evolution of structural unemployment. In some cases, however, our findings contradict the expectations of mainstream theory. Employment protection policies, for instance, have a statistically significant negative effect on the NAIRU for the full sample (I.A), i.e. the tougher the

[12] Previous empirical works also include the tax wedge in this set of institutional variables. Tax wedge data from the OECD only goes back to the year 2000. One option would be to compute a longer series by splicing this data with an older tax wedge series found in the Bassanini and Duval (2006) dataset, along the lines of Orlandi (2012). However, the Bassanini and Duval (2006) dataset does not have historical tax wedge data for Greece, a key peripheral country, and so we have left this institutional variable out of the analysis.

[13] In our regression model, we use a modified version of the technological index as defined in equation (1). Each sub-component of the technological index is scaled down by its sample average and not standardized. This way, whilst the technology-based ranking of countries does not change, we can appropriately consider both the cross-section and time variability of the technological variable.

[14] The public bailout of private financial institutions certainly helped not to precipitate the financial crisis in an even deeper recession. Yet, those measures were not meant, by themselves, to stimulate aggregate demand and, therefore, to reduce unemployment.

[15] We only run regressions (IV.A – IV.C) on the full sample, as we do not have enough observations in order to run them on the core and periphery separately. Due to a lack of CAPB observations in the periphery, we would only have 89 observations.

measures protecting employment are (i.e., the more rigid the labour market is), the lower the structural unemployment is. When the specification is estimated separately for the core and peripheral economies, the coefficient is still negative albeit statistically insignificant.

[TABLE 2 HERE]

The effects of the other institutional variables are more in line with the standard mainstream theory. Active labour market policies have a significant negative impact on structural unemployment in all three specifications in Table 2. Trade union density and the level of unemployment benefits appear to increase structural unemployment. However, trade union density is statistically significant only in the full sample regression (I.A). Unemployment benefits are statistically significant in the full sample and in the "core economies" (I.B) only, but is insignificant in the periphery.

Table 3 reports the results we obtain when the baseline "mainstream" analysis is extended to include the technological index and hence the more "heterodox" supply-side factor. Our results tell us that technological capabilities display the expected *negative* effect on the NAIRU. An increase in the technological capability and, hence, in non-price competitiveness of an economy tends to reduce structural unemployment. This effect seems to be statistically significant for the regression over the full sample, and for the periphery in particular. It is not significant, albeit with the correct sign, for core countries only. This fact could be related to a sort of threshold effect in the accumulation of technology: its virtuous effects over structural unemployment may tend to weaken once a certain level of technological capability is achieved.

[TABLE 3 HERE]

The inclusion of the technological capability index in our regression also brings some changes in the effects carried out by some labour market institutions. In the periphery, the coefficients for trade union density (UD) and for the unemployment benefits (UnB) become negative and statistically significant. A possible explanation for this is that in technologically weaker and less competitive economies, labour market institutions that help to increase wages, union density and unemployment benefits among them, stand out as relevant contributors to *domestic sources* of aggregate demand and to the generation of employment (i.e., a negative effect of (UD) and (UnB) over the NAIRU). At the same time, low technology levels may be associated with lower levels of union density and unemployment benefits. The inclusion of the technological capability index in our regression analysis may help to capture the interplay of these conflicting forces[16].

In Table 4, we report the results from the expanded regressions (III.A – III.F) where, following Stockhammer and Klär (2011) and Heimberger *et al.* (2017), macro shocks variables and capital accumulation are added to labour market institutions. In the last three columns of Table 4, regressions (III.D – III.F) also consider the technological capability index.

[TABLE 4 HERE]

[16] This finding is consistent with Storm and Naastepad (2015a) when they stress the crucial role played by domestic aggregate demand for the economic performance of technologically weaker eurozone countries. It is also in line with Hartmann *et al.* (2017), who find that higher levels of economic complexity reduce inequality by feeding stronger workers' unions and the development of labour market institutions conducive to higher wage standards. Finally, our results may identify additional "structural" factors influencing the determination of unemployment benefits, this time related to the technological level of a country, with respect to those pinpointed by Di Tella and MacCulloch (2002).

Consistent with Stockhammer and Klär (2011) and Heimberger *et al.* (2017), capital accumulation always displays a negative and statistically significant effect on the NAIRU through all the regressions. This confirms that demand-side factors captured by capital accumulation is a key determinant of structural unemployment.

The coefficient associated to the long-term real interest rate (LTI) is positive and statistically significant in full sample regressions (III.A and III.D). This outcome is consistent with economic theory: an increase in the long-term real interest rate may discourage capital accumulation and hence, increase structural unemployment. When we split the sample into core and periphery, results are more nuanced. LTI's coefficients remain positive and significant in the periphery (regressions III.C and III.F). LTI's effects become insignificant (and with a negative sign) in the core. We interpret these results as evidence of diverging financial and monetary conditions in periphery and core eurozone countries since 2008. In core economies, net capital inflows partially related to the repatriation of capital previously invested in the periphery led to reduced, even negative, long-term interest rates, while the periphery suffered from financial turmoil and the sovereign debt crisis. Implicitly, our results seem thus to suggest that the ECB's monetary policy was initially ineffective in avoiding the fragmentation of eurozone financial markets and in levelling the "financial" playing field among core and peripheral eurozone countries. Such core-periphery financial asymmetry likely contributed to deepen economic stagnation in the periphery.

The terms of trade variable TOTS is always insignificant (and with mixed signs) throughout all the regressions. Contrary to what claimed by Sinn (2014) and consistent with Storm and Naastepad (2015a), this could be taken as sign of the irrelevance of price-competition in explaining economic decline in the periphery. Technological capabilities and, hence, factors influencing non-price competitiveness seem to be of paramount importance in the periphery instead. The coefficient associated to the TC index remains strongly negative and significant in regression (III.F), whilst it is insignificant for the full sample (with the expected negative sign) and in the core (with a wrong positive sign).

Finally, the effects of some labour market institutions are not robust and often at odds with what mainstream theory would expect. Active labour market policies (AlmP) is the only one consistently displaying the expected negative effect over the NAIRU. Employment protection policies (EmP), instead, are insignificant in most of the regressions. More interestingly, the inclusion of technological capabilities in our regressions seems to reveal a deep asymmetry in the way Trade union density (UD) and unemployment benefits (UnB) influence structural unemployment in the core and in the periphery. Whilst higher values for (UD) and (UnB) tend to increase the NAIRU in the core, the opposite happens in the periphery. The rationale for this result could be connected again to Storm and Naastepad (2015a). In technologically weaker economies, domestic sources of demand play a leading role in the generation of employment opportunities. As a consequence, stronger union density and more generous unemployment benefits, by perhaps increasing the wage share, could stimulate economic recovery and reduce the NAIRU. Instead, policies aiming at internal devaluation may actually exacerbate economic stagnation and unemployment. In the end, our results suggest that the role played by labour market institutions in influencing structural unemployment cannot be taken in isolation from other fundamental (supply-side) factors such as the level of technological and productive development characterizing an economy.

Table 5 presents the results obtained when the full list of explanatory factors is considered, and *CAPB* is included alongside to capital accumulation as additional fiscal policy-related demand side variable.

[TABLE 5 HERE]

In regressions (IV.A) and (IV.B), the coefficient associated to the fiscal policy variable display the expected positive sign. Discretionary fiscal contractions, i.e., increases in the cyclically adjusted fiscal primary balance, tend to raise the NAIRU. Once again, demand side factors matter in the determination of structural unemployment. It is even the more so in the periphery of the eurozone. The Wald test confirms that the *overall* contractionary effects of fiscal austerity in the periphery (i.e., δ_1 + δ_3 = (0.155; 0.152)) is statistically different from zero. This result can be taken as complementary to the findings of De Long and Summers (2012), and Fatas and Summers (2018) about the permanent effects of fiscal consolidations on actual and potential GDP. It also provides direct support to Jump and Stockhammer (2019) when they claim that demand shocks likely affect structural unemployment.

In Table 5, the interacted dummy variable $CAPB*d_{crisis}$ for the peak years of the financial crisis is statistically significant with the expected negative sign. This means that the financial shock may give rise to a spurious relation between *CAPB* and structural unemployment in those years. The crisis jointly led to the deterioration of the cyclically adjusted primary balance through bail-outs to the financial sector, and to the increase of unemployment.

The introduction of the fiscal policy variable in regressions (IV.A) and (IV.B) significantly reduces the coefficient associated to capital accumulation (see regressions (III.A) and (III.C)). It remains negative and statistically significant, but with a much lower absolute value. This may be due to the fact that discretionary fiscal contractions may directly curtail public investment and, hence, cause a rise in the NAIRU. Furthermore, in a recession, fiscal stimuli may tame the reduction in economic activity and encourage entrepreneurs. Fiscal retrenchments may instead exacerbate the recession and spread "pessimistic" expectations, leading business to downsize investment further and cause an escalation in structural unemployment.

When the technological capability index TC is included in our final regressions together with CAPB, its coefficient becomes significantly smaller in absolute value and statistically irrelevant (albeit with the "correct" negative sign). To investigate further this result, we introduce in regression (IV.C) an interaction between *TC* and *CAPB*. Our hypothesis is simple: less technologically complex countries may tend to compensate structurally lower employment opportunities offered by a relatively underdeveloped productive system with more expansionary discretional fiscal policies (say, more public employment)[17]. Our findings tend to confirm this hypothesis. In the periphery, the overall direct effect of austerity measures (δ_1 + δ_3 = – 0.128 + 0.219 = 0.091) remains positive. The Wald test suggests this effect might be weakly insignificant with a borderline p-value equal to 0.12 very close to 0.1. Given the considerable variability of macro data over the time span taken into account, this could be taken as a roughly solid confirmation that fiscal policy is important for the determination of structural unemployment.

Last but not least, the interacted term between *CAPB* and *TC* is positive and significant.[18] A lower value for *TC* may induce eurozone countries to run discretional fiscal expansions. The need for a compensatory stance by fiscal policy for the structural weaknesses of the economy is obviously lower in more technology advanced core countries. They can take much more neutral fiscal stances. We take the possible interaction between the structural technological conditions of an economy

[17] More formally, in regression (IV.C) we test for the following relation: $NAIRU = \alpha * CAPB(TC) + \beta * TC$, with $\alpha > 0$; $\beta < 0$ and $(\partial CAPB/\partial TC) > 0$. In this context, the "direct" negative effect that lower technological capabilities might have on structural unemployment could be at least partially compensated by the "indirect" compensation carried out via fiscal policy.

[18] There is a clear correlation between CAPB and TC in the data. A simple pooled regression of CAPB and TC has positive and significant coefficient at the 1% significant level. In the sake of space, we did not include this evidence in the paper. Please contact authors for details.

and the implementation of expansionary/restrictive (fiscal) macro policy as an interesting new topic that deserves further investigation in future research.

4.3 Interaction between economic shocks and labour market institutions

Mainstream theory considers the *interaction* between economic shocks and rigid labour market institutions as a possible relevant source of increases in structural unemployment (Blanchard and Wolfers, 2000; Blanchard *et al.*, 2006). When a negative economic shock takes place, actual unemployment increases. In presence of rigid labour market institutions, such an increase may last long eventually raising structural unemployment.

In order to test this effect, we conduct an empirical analysis similar, in spirit, to that performed by Blanchard and Wolfers (2000). We take 5-year average values of *actual* unemployment rates[19] for a sample of eurozone countries[20] before and after the financial shock. We then run a simple correlation analysis between the degree of rigidity in labour market institutions at the beginning of the crisis (i.e. 2008), and the absolute change between pre- and post-crisis unemployment.[21] According to Blanchard and Wolfers (2000), we would expect a stronger increase in (average) unemployment rates in those countries characterized by more rigid labour market institutions when the shock struk the real economy. Pre-crisis unemployment averages are computed over the period 2003-2007, whilst post-crisis averages run from 2010 to 2014. The results are portrayed in Figures 3 to 6 below.

[FIGURES 3 – 6 HERE]

The results challenge mainstream expectations. For instance, the countries providing the unemployed with larger unemployment benefits seem to have experienced lower post-crisis increases (or even small reduction) in average unemployment rates. This may reflect the positive demand effects of unemployment benefits, which may have offset the negative effects of the crisis. The same applies to the case of trade union density. Again this may reflect the role of unions in accepting wage concessions in return for preserving employment, which in turn stabilizes unemployment in a recession. More relevantly, our analysis suggest that labour market institutions at the time of the crisis have very poor explanatory power, if any, of the pre-post crisis change in unemployment records. The R squares associated to the four correlations portrayed in Figures 1 to 4 are all very small. Hence, cross-country variance in labour market institutions in 2008 explains a negligible part of cross-country variance in pre/post crisis unemployment dynamics.

As a robustness check, we have repeated this analysis by taking into account countries' deviations from cross-country average values (as in Blanchard and Wolfers (2000)). The results do

[19] In this section of the paper, we use data about *actual* unemployment rates rather than about the NAIRU in order to stay as close as possible to the original line of reasoning and empirical analysis put forward by Blanchard and Wolfers (2000). For the same reason, we take 5-year average values of unemployment as dependent variable in our correlation analysis.

[20] In order to have more observations and make our analysis more reliable, we extended the sample of eurozone countries to include small economies (Luxemburg) and "latecomers" eurozone member countries (Estonia, Slovenia and Slovakia) for which data about labour market institutions are available.

[21] The focus of the final section of our work is restricted to the effects that the 2007-2008 financial crisis might have caused on structural unemployment in eurozone countries by interacting with rigid labour market institutions. The time and spatial horizons of our analysis are much narrower, the number of observations available smaller, and, as a consequence, the statistical method we adopt simpler. The simple correlation analysis we present here is to intend as a "prime-facie" empirical evidence of the role of the interaction between a (specific) economic shock and country-specific labour market institutions in determining recent changes in unemployment.

not change. Whilst we now obtain a positive correlation between unemployment benefits and pre/post crisis changes in average unemployment (i.e. deviation from sample mean), the explanatory power of all four labour market institution variables remains minimal (or even decreases). After all, heterogeneity in labour market institutions across the eurozone does not explain much of the diversity in unemployment records in the wake of the last financial shock.

5. Conclusions

In this paper, we address the problem of secular stagnation, and the connected evolution of structural unemployment, in the eurozone in the aftermath of the 2007-2008 financial and economic crisis. We adopt a core-periphery perspective to address this issue. We do so in order to analyse whether secular stagnation manifested itself with different degrees of intensity in the core and the periphery of the eurozone as a consequence of their technological and productive asymmetries.

We find that secular stagnation, i.e. a statistically significant slowdown in the dynamics of potential GDP, is a eurozone-wide problem. The depth of the problem, however, differs remarkably in the core and in the periphery, and the emergence of diverging trends is clear. After 2008, the dynamics of potential GDP slowed down dramatically more in peripheral countries than in the core. In the same vein, whilst structural unemployment did change in the latter, it has risen dramatically in the former. Post-crisis NAIRU in the periphery is now twice that observed in the core.

Given this evidence, we then investigate the determinants of structural unemployment in both sets of countries. Capital accumulation is always significant in all specifications and in all sets of eurozone countries. On top of this, fiscal policy also matters. In normal times, austerity measures may increase the NAIRU directly, by cutting public investment, and indirectly, by depressing entrepreneurs' animal spirits and private investment even further. Both facts show that demand-side factors might be extremely relevant, if not major determinants of structural unemployment.

Moreover, supply-side factors matter. However, they are quite different from those most commonly spotted by mainstream theory. In this paper, we find that the technology and productive capabilities of an economy, hence its non-price competitiveness, are fundamental to explain structural unemployment, in particular in structurally more fragile peripheral countries. These factors may determine the NAIRU by also affecting fiscal policy decisions and by "reshaping" the way some labour market institutions affect structural unemployment itself. In this sense, labour market institutions, when significant, do not display consistent effects on the NAIRU throughout core and peripheral economies, and their effects may often be at odds with what is suggested by mainstream theory. For instance, stronger union density and more generous unemployment benefits may help to reduce the NAIRU in peripheral economies.

The above findings bring a number of important policy implications. First, eurozone cross-country heterogeneity in labour market institutions does not explain much, if anything, of cross-country post-crisis heterogeneous changes in unemployment records and potential GDP dynamics. What seems to be more relevant, at least for peripheral countries, are the level of technological and productive development, and the macro conditions enabling such countries to implement expansionary policies boosting demand. In structurally (i.e. technologically) weaker peripheral economies, internal demand is relatively more important than external demand as a source of employment and economic dynamics. As a consequence, the exposure of peripheral eurozone countries to much tougher financial turbulences and the implementation of fiscal austerity explain most part of post-crisis eurozone core-periphery divergence. Second, the persistent emphasis of EU institutions on labour market deregulation as the main way to reduce the NAIRU and "homogenize" it across eurozone countries looks misplaced and even counterproductive. In our view, two different

sets of policies are far more urgent and important. On the one hand, the asymmetric responses of core and peripheral eurozone countries to common shocks have their roots in long-lasting differences in technological and productive capabilities. If so, it is of paramount importance to first reduce the core-periphery technological gap via long-term industrial policies in order to then be able to implement common labour market and macro policy. On the other hand, European policy makers should better look at reforms ensuring homogeneous macro-financial conditions across eurozone countries, and avoid the exposure of the periphery to fierce financial turbulences. The completion of the eurozone banking union and the creation of a central fiscal authority are obviously in order. Such macro reforms, together with industrial policies targeting the persisting eurozone core-periphery technological gap, are the only credible responses to the centrifugal forces (and the ensuing uneven development), that were dormant before 2008 and the financial shock helped to awake.

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Tables and Figures

Table 1.A. Potential GDP growth rate: pre-crisis (1999-2008) and post-crisis (2009-2017) structural break analysis and core-peripheral gap.

Potential GDP growth rate	Before-crisis (1999-2008) country sub-sample averages	After-crisis (2009-2017) country sub-sample averages	Pre- and post-crisis **within** sample difference
Core	2.151 (0.093)	0.996 (0.064)	-1.155*** (0.116)
Periphery	2.373 (0.205)	- 0.436 (0.179)	-2.809*** (0.275)
Pre- and post-crisis **between** samples difference	No -0.221 (0.203)	Yes 1.432*** (0.1656)	

Source: Authors' computation on the basis of data from AMECO dataset (2018)

Table 1.B. Net capital stock growth rate: pre-crisis (1999-2008) and post-crisis (2009-2017) structural break analysis and core-peripheral gap.

Net capital stock growth rate	Before-crisis (1999-2008) country sub-sample averages	After-crisis (2009-2017) country sub-sample averages	Pre- and post-crisis **within** sample difference
Core	1.934 (0.065)	1.132 (0.0487)	-0.802*** (0.083)
Periphery	3.104 (0.183)	.0435 (0.164)	-3.060*** (0.248)
Pre- and post-crisis **between** samples difference	-1.169*** (0.169)	1.088*** (0.146)	

Source: Authors' computation on the basis of data from AMECO dataset (2018)

Table 1.C. Trend TFP growth rate: pre-crisis (1999-2008) and post-crisis (2009-2017) structural break analysis and core-peripheral gap.

Trend TFP growth rate	Before-crisis (1999-2008) country sub-sample averages	After-crisis (2009-2017) country sub-sample averages	Pre- and post-crisis **within** sample difference
Core	0.723 (0.061)	0.131 (0.058)	-0.592*** (0.084)
Periphery	0.261 (0.158)	-0.309 (0.189)	-0.570* (0.245)
Pre- and post-crisis **between** samples difference	0.462*** (0.149)	-0.045* (0.085)	

Source: Authors' computation on the basis of data from AMECO dataset (2018)

Table 1.D. Working age population growth rate: pre-crisis (1999-2008) and post-crisis (2009-2017) structural break analysis and core-peripheral gap.

Working age population growth rate	Before-crisis (1999-2008) country sub-sample averages	After-crisis (2009-2017) country sub-sample averages	Pre- and post-crisis **within** sample difference
Core	0.411 (0.053)	0.385 (0.090)	-0.026 (0.104)
Periphery	0.586 (.136)	-0.234 (0.060)	-0.821*** (0.149)
Pre- and post-crisis **between** samples difference	-0.174 (0.129)	0.619*** (0.121)	

Source: Authors' computation on the basis of data from AMECO dataset (2018)

Table 1.E. Labour force participation rate: pre-crisis (1999-2008) and post-crisis (2009-2017) structural break analysis and core-peripheral gap.

Labour force participation rate	Before-crisis (1999-2008) country sub-sample averages	After-crisis (2009-2017) country sub-sample averages	Pre- and post-crisis **within** sample difference
Core	65.55	64.01 (.52)	-1.53** (.716)
Periphery	61.74	59.61 (.78)	-2.13* (1.10)
Pre- and post-crisis **between** samples difference	3.80*** (0.860)	4.40*** (0.90)	

Source: Authors' computation on the basis of data from AMECO dataset (2018)

Table 1.F. NAIRU: pre-crisis (1999-2008) and post-crisis (2009-2017) structural break analysis and core-peripheral gap.

NAIRU	Before-crisis (1999-2008) country sub-sample averages	After-crisis (2009-2017) country sub-sample averages	Pre- and post-crisis **within** sample difference
Core	7.18 (0.268)	6.689 (0.232)	-0.492 (0.358)
Periphery	10.22 (0.407)	13.255 (0.487)	0.358*** (0.631)
Pre- and post-crisis **between** samples difference	-3.045*** (0.467)	-6.56 *** (0.488)	

Source: Authors' computation on the basis of data from AMECO dataset (2018)

Table 2. OLS-PCES estimations (I.A – I.C): labour market institutions.

	(I.A) Full sample	**(I.B) Core**	**(I.C) Periphery**
EmP	-1.242** (0.470)	-0.972 (0.638)	-0.148 (0.554)
AlmP	-0.173*** (0.021)	-0.126*** (0.019)	-0.488*** (0.081)
UD	0.053** (0.019)	0.028 (0.025)	0.010 (0.027)
UnB	0.037** (0.011)	0.080*** (0.015)	-0.047 (0.025)
Cons	3.670* (1.699)	1.245 (1.387)	9.023*** (2.443)
N	314	174	140
R^2	0.804	0.872	0.766

Notes: * p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors in brackets.

Table 3. OLS-PCES estimations (II.A – II.C): labour market institutions and technological capability.

	(II.A) Full sample	**(II.B) Core**	**(II.C) Periphery**
EmP	-1.901*** (0.513)	-1.411 (0.751)	-0.021 (0.426)
AlmP	-0.204*** (0.026)	-0.133*** (0.024)	-0.493*** (0.044)
UD	0.030 (0.023)	0.027 (0.024)	-0.112*** (0.029)
UnB	0.054*** (0.011)	0.087*** (0.015)	-0.114*** (0.024)
TC	-2.848*** (0.718)	-0.587 (0.825)	-16.086*** (1.093)
Cons	9.495*** (2.790)	2.955 (2.871)	14.319*** (2.151)
N	314	174	140
R^2	0.816	0.873	0.897

Notes: * p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors in brackets.

Table 4. Expanded OLS-PCES estimations. (III.A – III.C): labour market institutions and macro shock variables; (III.D – III.F): inclusion of the technological capability index (TC).

	(III.A) FS	**(III.B) Core**	**(III.C) Per.**	**(III.D) FS-TC**	**(III.E) Core-TC**	**(III.F) Per.-TC**
EmP	0.051	0.155	1.907***	-0.131	0.335	0.938
	(0.242)	(0.466)	(0.576)	(0.297)	(0.542)	(0.517)
AlmP	-0.086***	-0.076***	-0.155*	-0.095***	-0.072**	-0.322***
	(0.018)	(0.015)	(0.074)	(0.021)	(0.017)	(0.055)
UD	0.031*	0.054**	-0.024	0.028*	0.055**	-0.086**
	(0.013)	(0.017)	(0.029)	(0.013)	(0.017)	(0.030)
UnB	0.006	0.065***	-0.122***	0.010	0.062***	-0.134***
	(0.009)	(0.012)	(0.023)	(0.009)	(0.013)	(0.020)
ACCU	-0.906***	-1.311***	-1.182***	-0.875***	-1.310***	-0.466**
	(0.087)	(0.151)	(0.166)	(0.088)	(0.152)	(0.150)
LTI	0.174**	-0.134	0.218**	0.172**	-0.124	0.183***
	(0.058)	(0.082)	(0.070)	(0.056)	(0.082)	(0.039)
TFP	12.603	17.665*	6.632	12.205	18.663*	5.824
	(7.659)	(6.937)	(9.234)	(7.587)	(6.988)	(5.711)
TOTS	3.629	-6.227	-3.434	3.722	-5.887	-0.658
	(3.975)	(4.453)	(5.704)	(3.992)	(4.403)	(4.040)
TC				-0.616	0.262	-13.095***
				(0.462)	(0.509)	(1.375)
Cons	6.949***	6.783***	9.389***	8.058***	5.968**	11.961***
	(0.999)	(1.354)	(2.217)	(1.437)	(1.908)	(2.041)
N	314	174	140	314	174	140
R^2	0.881	0.940	0.855	0.882	0.940	0.921

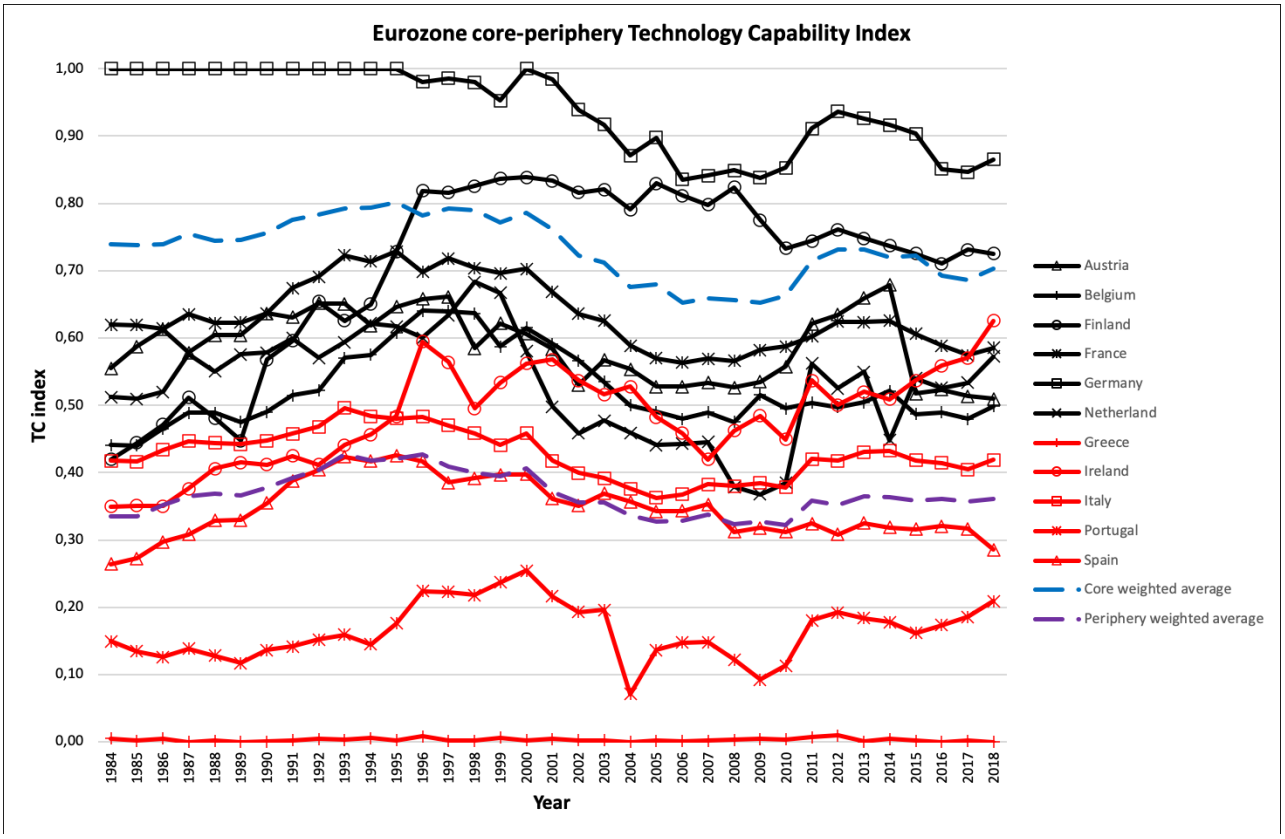
Notes: * p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors in brackets.

Table 5. Full OLS-PCES estimations. (IV.A – IV.C): *CAPB* and interaction with *TC* index added.

	(IV.A) CAPB	**(IV.B) CAPB+TC**	**(IV.C) CAPB+TC+CAPB*TC**
EmP	-2.019*** (0.476)	-2.135*** (0.510)	-2.296*** (0.516)
AlmP	-0.075*** (0.013)	-0.080*** (0.016)	-0.077*** (0.015)
UD	0.003 (0.023)	0.004 (0.023)	0.006 (0.023)
UnB	0.071*** (0.013)	0.075*** (0.014)	-0.080*** (0.013)
ACCU	-0.472*** (0.090)	-0.462*** (0.095)	-0.464*** (0.090)
LTI	0.049 (0.044)	0.047 (0.043)	0.055 (0.041)
TFP	8.551 (4.769)	8.335 (4.753)	9.356* (4.716)
TOTS	-2.395 (3.046)	-2.468 (3.005)	-2.237 (2.921)
CAPB	0.082*** (0.018)	0.080*** (0.018)	-0.128 (0.101)
CAPB*d_{per}	0.073 (0.055)	0.072 (0.055)	0.219* (0.085)
CAPB*d_{cris}	-0.162*** (0.044)	-0.159*** (0.043)	-0.165*** (0.043)
TC		-0.339 (0.432)	-0.391 (0.462)
CAPB*TC			0.178* (0.084)
Cons	9.244*** (1.190)	9.707*** (1.325)	9.819*** (1.316)
N	251	251	251
R^2	0.860	0.860	0.862
Wald test for $\delta_1 + \delta_3 = 0$ (p-value)	0.0025		
Wald test for δ_1 and $\delta_3 = 0$ (p-value)	0.0000		
Wald test for $\delta_1 + \delta_3 = 0$ (p-value)		0.0029	
Wald test for δ_1 and $\delta_3 = 0$ (p-value)		0.0000	
Wald test for $\delta_1 + \delta_3 = 0$ (p-value)			0.129
Wald test for δ_1 and $\delta_3 = 0$ (p-value)			0.015

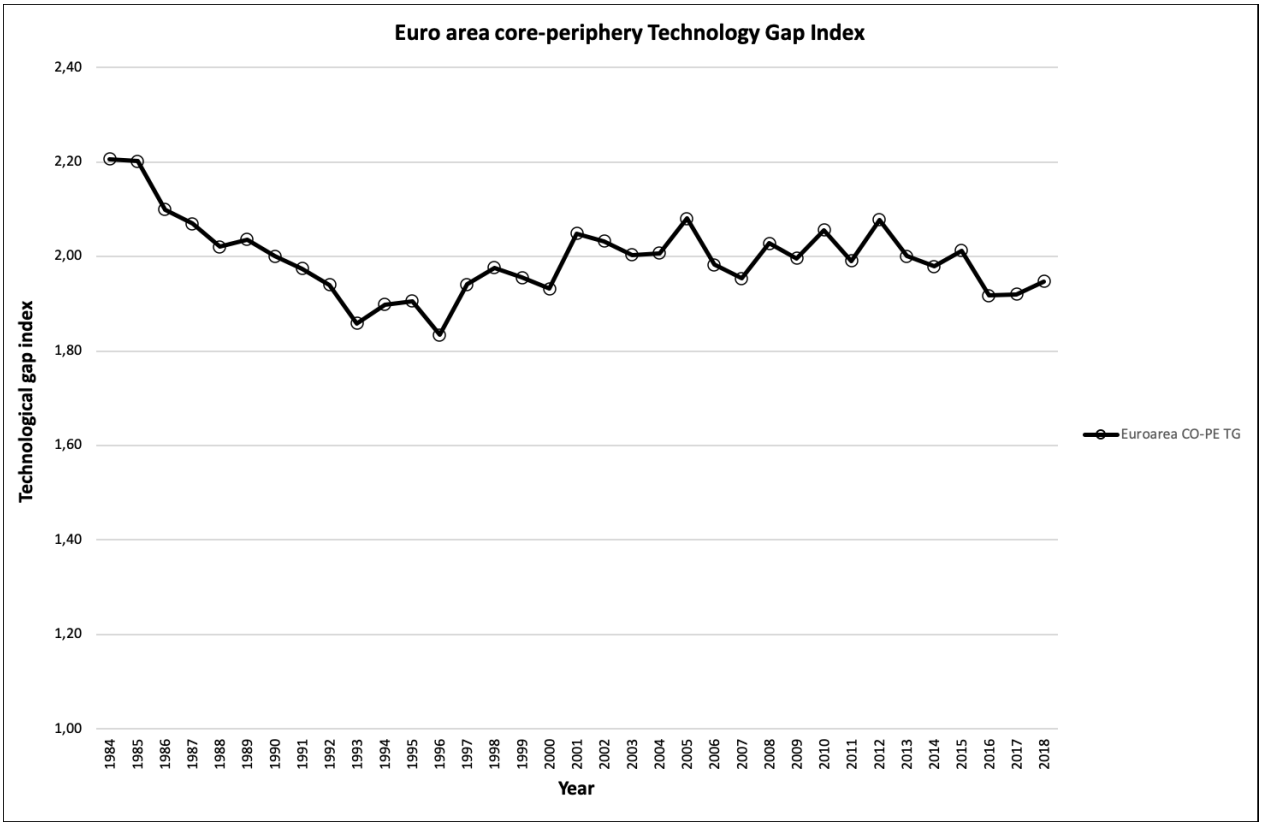
Notes: * p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors in brackets. Time series for cyclically-adjusted primary balances start from different years (see years in parentheses) in different countries: Austria (1991); Belgium (1985); Finland (1985); France (1985); Netherlands (1985); Ireland (1999), Greece (1988), Germany (1991), Portugal (1995), Italy (1998), Spain (2000).

Figure 1. Technology Capability index in core and peripheral eurozone countries, 1984 – 2018.



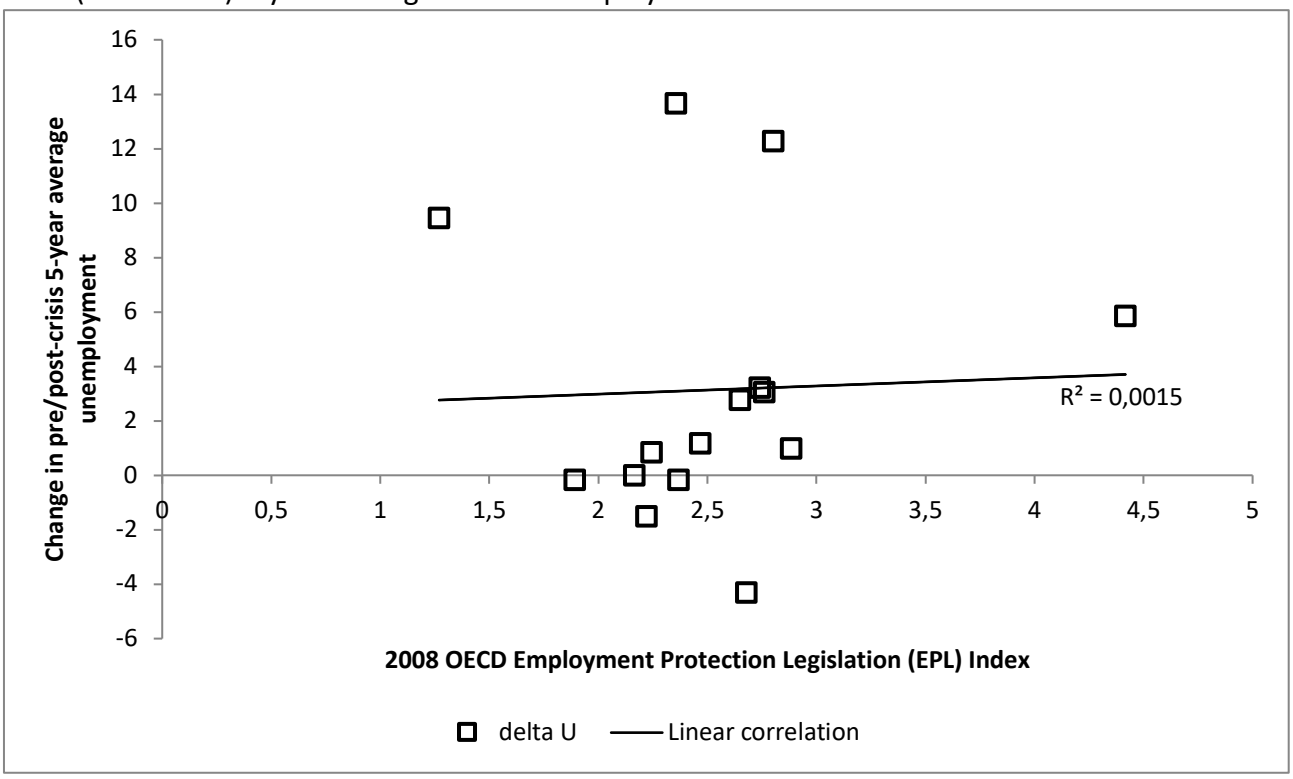
Source: Authors' computations on the basis of data from UN-COMTRADE (for export shares) and WIPO (for patents) datasets (2020).

Figure 2. Core-periphery technological gap, 1984 – 2018.



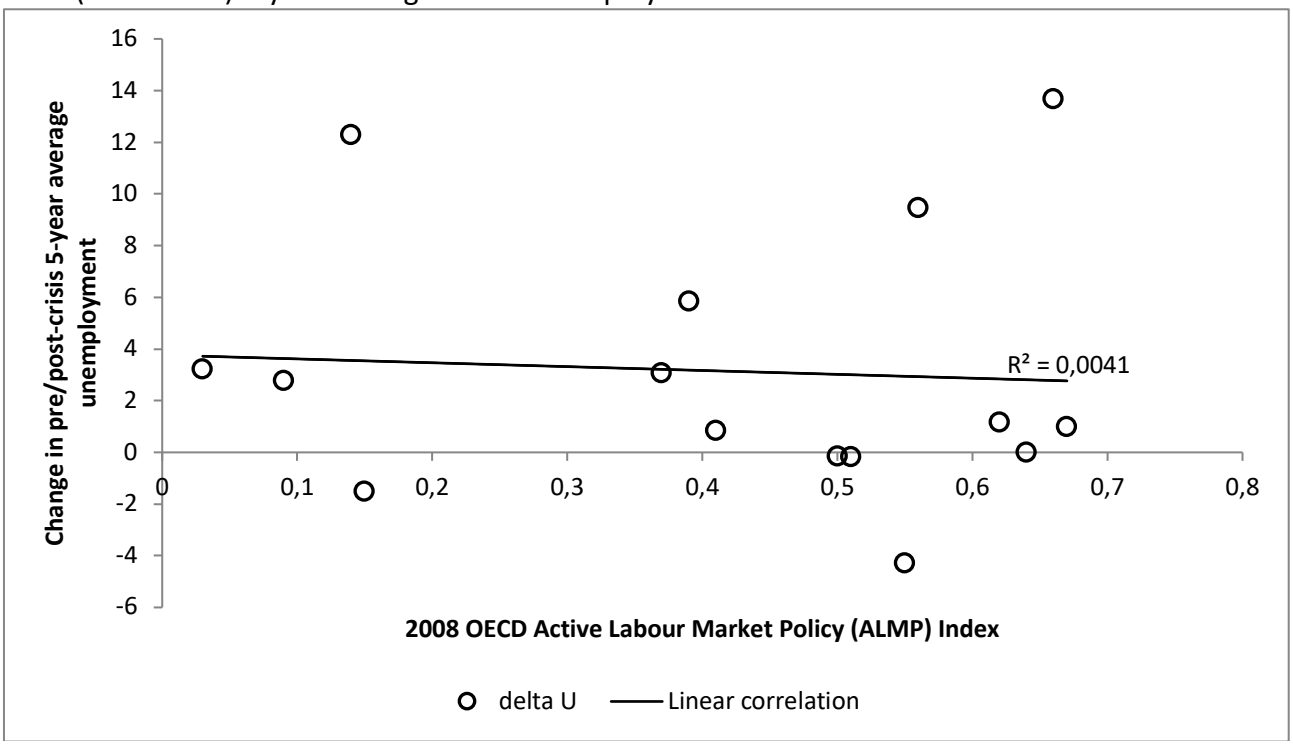
Source: Authors' computations on the basis of data from UN-COMTRADE (for export shares) and WIPO (for patents) datasets (2020).

Figure 3. Correlation between 2008 (OECD) EmP index and change in pre-crisis (2003-2007)/post-crisis (2010-2014) 5-year average actual unemployment.



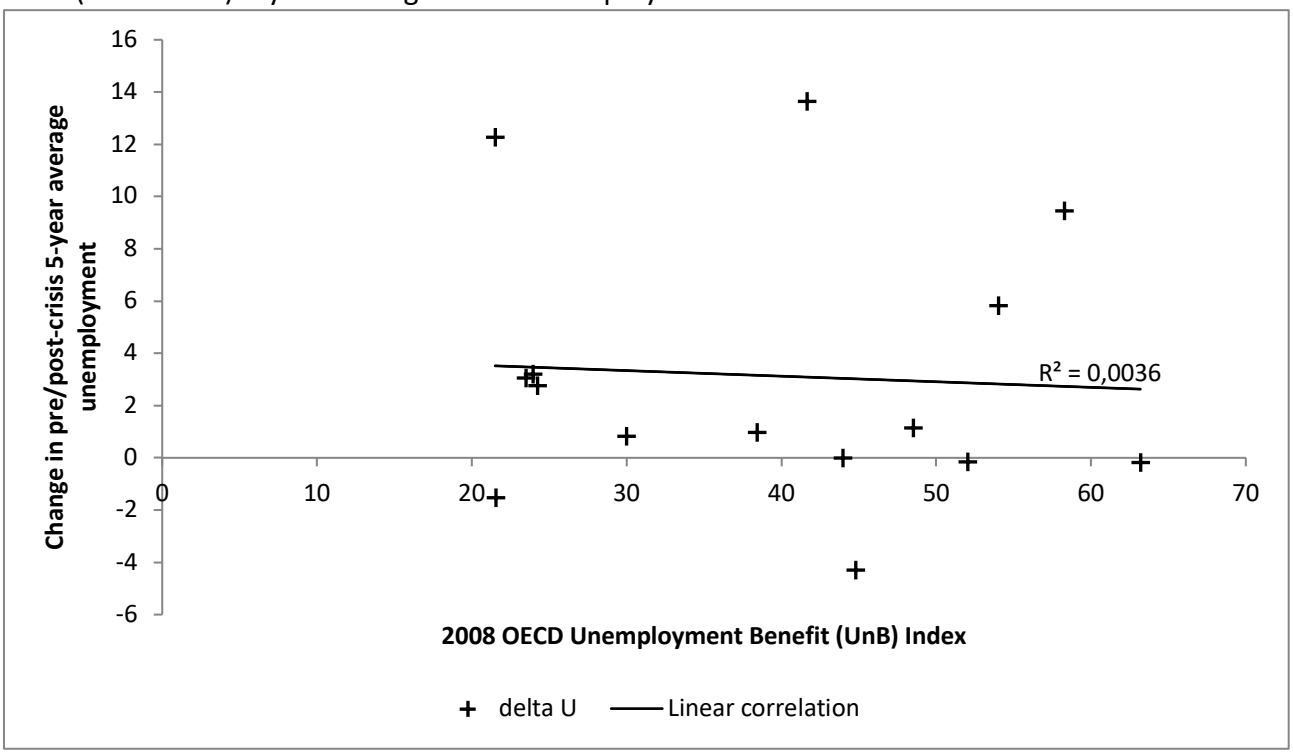
Source: Authors' computations on the basis of data from AMECO (for unemployment) and OECD (for labour market institutions) datasets (2018).

Figure 4. Correlation between 2008 (OECD) ALMP index and change in pre-crisis (2003-2007)/post-crisis (2010-2014) 5-year average actual unemployment.



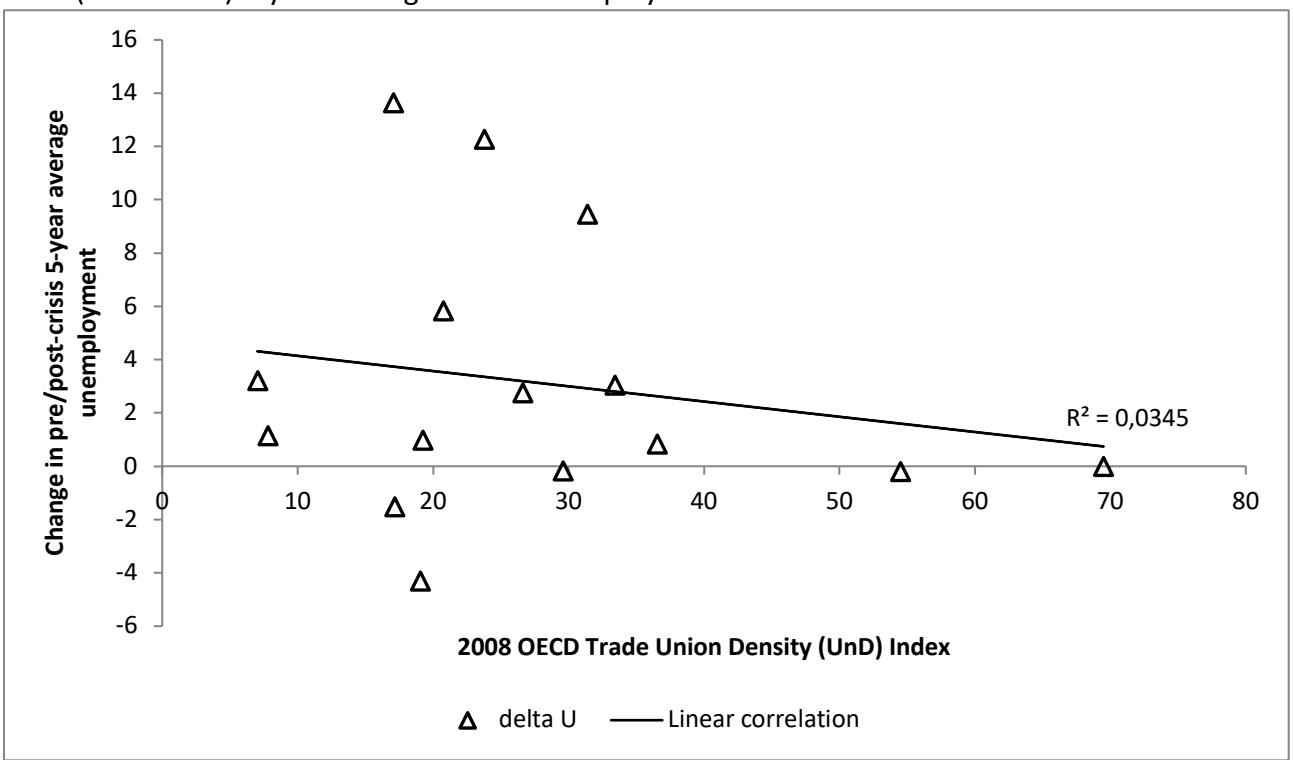
Source: Authors' computations on the basis of data from AMECO (for unemployment) and OECD (for labour market institutions) datasets (2018).

Figure 5. Correlation between 2008 (OECD) UnB index and change in pre-crisis (2003-2007)/post-crisis (2010-2014) 5-year average actual unemployment.



Source: Authors' computations on the basis of data from AMECO (for unemployment) and OECD (for labour market institutions) datasets (2018)

Figure 6. Correlation between 2008 (OECD) UnD index and change in pre-crisis (2003-2007)/post-crisis (2010-2014) 5-year average actual unemployment.



Source: Authors' computations on the basis of data from AMECO (for unemployment) and OECD (for labour market institutions) datasets (2018).

Appendix

Table A.1. Fischer unit root test based on augmented Dickey-Fuller test

Variable	**p-value (Inverse normal)**
NAIRU	0.0006
EmP	0.0491
UD	0.0000
AlmP	0.0000
UnB	0.0000
TC	0.0000
ACCU	0.0000
LTI	0.0000
TFP	0.0000
TOTS	0.0000
CAPB	0.0000

Table A.2. List of econometric tests for autocorrelation, heteroskedaticity and panel data cross-sectional dependence.

	Test	**Test Statistic and Hypothesis test**	**Conclusion**
Autocorrelation	Woolridge test for serial correlation	H0: no first order correlation Prob > F = 0.0000	There is autocorrelation in panel data
Heteroskedasticity	LR Maximum likelihood test	H0: constant variance Prob > chi2 = 0.0000	There is heteroscedasticity in panel data
Cross-sectional Dependence	Pearson test	H0: cross sectional independence Pr = 0.0708	There is cross sectional dependence.

Table A.3. List of variables in the regression analysis: Definition, data source and time spell.

Variable	**Definition**	**Source and time period**
NAIRU	Non-accelerating inflation rate of unemployment	OECD, 1985 – 2014
Labour market institutions variables		
Employment Protection Legislation (EmP)	Strictness of employment protection, individual and collective dismissals (regular contracts)	OECD, 1985 – 2014
Active Labour Market Policy (ALMP)	Public expenditure and participant stocks in LMP (in % of nominal GDP), divided by the unemployment rate	OECD, 1985 – 2014
Unemployment benefits (UnB)	Net unemployment benefit replacement rate spliced with gross unemployment benefit replacement rate.	OECD, 1985 – 2014
Trade Union Density (UD)	Share of workers affiliated to a trade union as percentage of the labour force	OECD, 1985 – 2014
Technological Capability variable		
Technology Capability Index (TC)	Share of medium-to-high-tech manufacturing exports over total country exports Share of granted patents per million inhabitants	COMTRADE, 1985 – 2014 WIPO, 1985 – 2014
Macroeconomic shock variables		
Terms of Trade Shock (TOTS)	Yearly growth rate in the terms of trade index (i.e., import share over GDP times log of relative import-GDP prices)	OECD, 1985 – 2014
Real long term interest rates (LTI)	AMECO nominal long-term interest rate minus annual GDP deflator	AMECO, 1985 – 2014
TFP shock (TFP)	Yearly growth rate in Total Factor Productivity	AMECO, 1985 – 2014
Demand side variables		
Capital Accumulation (ACCU)	Real gross fixed capital formation/real net capital stock (*100)	AMECO, 1985 – 2014
Cyclically Adjusted Primary Budget Balance (CAPB)	IMF-computed structural fiscal budget net of interests (as a % of potential GDP)	IMF, 1985 – 2014