

Shocking Aspects of Monetary Union: The Vulnerability of Regions in Euroland

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Abstract

The economic recession in Europe, triggered by the financial crisis of 2008-9 has rekindled the debate over whether Europe constitutes a viable single currency area. A key issue concerns the relationship between regional economic cyclicality and monetary union: in the absence of a common automatic fiscal stabilization mechanism and with limited geographical mobility of factors, the greater the asymmetry of shocks across the regions making up a currency area, the more that area departs from an optimal single currency space as far as monetary policy is concerned. Our aim in this paper is to investigate whether the regions in the Eurozone have become more or less similar in their vulnerability and resilience to economic shocks since the monetary union. Using predictions based on a spatial panel model with random effects, an endogenous spatial lag and spatially autoregressive errors, we find that a common contractionary shock across the Eurozone has its biggest impact on the most geographically isolated regions, which are precisely those peripheral regions in Euroland that are suffering the most acute sovereign debt crisis, and which are among the lowest productivity regions of the EU. The implications of these results for the debate over European monetary and fiscal integration are discussed.

JEL Classification:

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1. Introduction

Barely a decade after its creation in 1999, the European single currency area (the Eurozone) experienced its first systemic shock – a banking and financial crisis of historical proportions. Although the financial crisis of 2008 originated in overleveraged banks and mortgage institutions in the United States and UK, it quickly spread to infect banks and financial markets across much of the European Union. The major contraction in economic activity it caused, and from which many European countries are still struggling to recover, compounded the initial impact of the financial meltdown, with the consequence that several members of the Eurozone found themselves facing mounting sovereign debt problems, particularly Greece, Spain, Portugal, Cyprus and Ireland, although Italy and France, and even Germany have not escaped. And while outside the Eurozone, and certainly nowhere near as badly affected as some of the beleaguered countries inside it, the UK has also faced similar difficulties. As the ratio of public debt to national GDP rose across Europe, as national credit ratings fell, and as the costs of borrowing increased, so governments imposed harsh austerity programmes designed to reduce public spending and the debt overhang. ‘Austerians’ have argued that such ‘fiscal consolidation’ has been necessary to restore economic stability and revive economic growth. ‘Anti-Austerians’ have opposed such measures on the grounds that excessive public spending cuts have made overcoming both the debt crisis and the recession more difficult, that austerity has delayed rather than promoted economic recovery: they point to the continued rise in debt to GDP ratios, horrendously high unemployment rates, especially amongst young people, sharply declining real incomes and struggling public services, as evidence to support their argument. The debate between the ‘Austerians’ and the ‘anti-Austerians’ is akin to that between Hayek and Keynes in the inter-war years over how to recover from the Great Slump of that period (see, for example, Skidelsky, 2010).

What the European crisis has also done is to rekindle a debate over whether and to what extent Europe actually fulfils the criteria regarded as necessary for it to function as a coherent and stable unified monetary system. Is Euroland a viable monetary union? There is a large body of economic theory about optimum currency areas and the conditions required for such an area to be able to withstand shocks and perturbations. One key issue concerns the relationship between regional economic cyclicality and monetary union. Thus some authors contend that monetary union can increase trade (especially intra-industry trade) as well as labour mobility, and that these effects will in turn reduce the asymmetry of economic shocks across regions (Frankel and Rose, 1998), a key condition for stable and successful monetary union. Others, in contrast, suggest that monetary union actually promotes increased regional economic specialization and agglomeration, which in its turn increases the vulnerability of regions to idiosyncratic shocks (Bayoumi and Eichengreen, 1993; Krugman, 1993). With limited cross-border labour mobility and the lack of a (federal) fiscal transfer mechanism, such increased asymmetry in economic shocks across regions means that a common monetary policy is less able to smooth over the shocks across the entire area and it can greatly exacerbate conditions in some regions, given that the latter do not have recourse to independent monetary policies for stabilization purposes (Martin, 2001).

These are clearly very pertinent issues in relation to the present crisis in Europe and to policy action intended to resolve the crisis and prevent a similar shock recurring in the future. Several relevant questions immediately arise. Have regions in the Eurozone become more or less similar in their vulnerability and resilience to economic shocks since monetary union (Tondl and Traistaru-Siedschlag, 2006; Barrios and de Lucio, 2003; Montoya and De Haan, 2008)? How have regions across the European Union, and especially as between those within the Eurozone compared to those without, been affected by the recent economic crisis? And what are the implications of these patterns for the future stability of Euroland? These are the questions that motivate this paper. Using time series data on output, employment and capital stocks for the regions of the European Union, and employing the idea of regional economic resilience (Fingleton, Garretsen and Martin, 2012; Martin, 2012), we use dynamic spatial panel models to assess the impact on Europe's regions to shocks to the Eurozone economy. We explicitly allow for spatial interaction and

temporal persistence effects to capture the dynamics of shocks across space and through time. Our findings suggest that a common contractionary shock across the Eurozone has its biggest impact on the most geographically isolated regions, which are precisely those regions and countries that are suffering the most acute sovereign debt crisis, and which are among the lowest productivity regions of the EU. The implications of these results for the debate over European monetary and fiscal integration are discussed.

2. Regional Requirements for an Optimum currency area

The basics of the theory on optimum currency areas (OCA) are well-known and date back to the classic works of Mundell (1961), McKinnon (1963) and Kenen (1969). The underlying premise is that there should be a high degree of homogeneity amongst the countries making up a currency area. Since monetary union entails surrender of individual national autonomy over exchange rate and other monetary policies, the homogeneity condition ensures that member countries are equally affected by external shocks (including financial shocks) and that none are unduly destabilised by the imposition of centralized currency area policies regarding the interest rate, exchange rate, national budgetary balance and the like. But as Magnifico (1973) in a highly prescient, but curiously neglected, discussion of European Monetary Union argued, the theory of optimum currency areas is not simply concerned with the external macro-geographical limits of currency unions - that is, which nations qualify for membership - but also with the *internal economic geography* of member states. Thus, as he argues, since national economies are merely the aggregates and averages of their constituent regional and subregional components, which are themselves the members of their respective national currency union, the homogeneity condition of OCA theory raises equally important issues at the regional level.

According to the standard OCA theory as it was developed in the 1960s, the homogeneity requirement is satisfied by three conditions (De Grauwe, 20XX): *symmetry*, *flexibility* and *integration*. Under the symmetry condition, economies should be roughly similar and synchronized, so that shocks are symmetrical in the sense that if, for example, a negative demand shock occurs, all the member countries and regions are affected in roughly the same way - that is, are equally vulnerable - and all are equally affected by any central currency area policies. There have been various views as to

what is meant by 'economic similarity' in this context. One version (McKinnon, 1963) stresses comparable degrees of 'economic openness' (ratio of tradable goods production to non-tradable goods production), the argument being that if the countries or regions making up a currency union have similar degrees of openness, shocks will be broadly symmetric across countries and regions. According to Kenen (1969), on the other hand, homogeneity is achieved via 'structural diversity' (diversity of exports) within the countries or regions of a single currency area since diversification reduces the incidence of idiosyncratic shocks.

But what if these conditions do not hold, and the countries and regions of a single currency area are affected in different ways by economic shocks? In this case a currency area can still be optimal provided labour is freely mobile geographically or wages are perfectly flexible. Indeed, in Mundell's (1961) original OCA model, optimality relates essentially to the state of the labour market. In his formulation, exchange rates can be fixed between countries and regions when labour moves freely between them, for then there is no need to change the terms of trade when a country or region encounters an external disturbance. Thus when there is mobility across all of the regions making up a nation, that whole nation is an optimum currency area. Further, when workers can move freely between any pair of countries, those countries can jointly form an optimum currency area and can peg their currencies one to the other. If on the other hand, there is no labour mobility between the countries or regions of a currency area, it may be very difficult to maintain full employment and price stability throughout the territory covered by the single currency. Other policies will then be needed.

It is here that the idea of an 'optimal policy mix', an issue not much considered by Mundell or McKinnon, but discussed by Kenen, comes to the fore. Monetary and fiscal policies must go hand in hand, and if there is to be an 'optimal policy mix' of these two instruments, they should have the same geographical domains. That is to say, the geographical domain of fiscal policy ought to coincide with the geographical domain of the currency area. Within a national currency area, a chief function of fiscal policy, using both sides of the budget (taxes and spending), is to offset or compensate for regional differences in economic fortune, whether in earned incomes or in unemployment rates. The large-scale transfer payments which operate automatically through a national tax-benefit system are not just

interpersonal but also inter-regional. When a region or community suffers a negative economic shock, a trade-balance deficit, and a rise in unemployment, its contributions to national taxes diminish, slowing the fall in its purchasing power and compressing the outflow on its balance of payments. At the same time, there is an inflow of national income support and unemployment and welfare benefits. Such automatic fiscal stabilizers can help even out the impact of external and other shocks across the regions of a nation (for discussions of the role of this mechanism in the US economy, see Blanchard and Katz, 1992; Krugman, 1993). In a national setting, then, a region's access to a major fiscal system compensates for not having its own currency or exchange rate. On a wider scale, to be optimal, a currency union comprising several countries – and hence the various regions within those member states - also requires fiscal integration to support monetary integration. It is precisely this aspect of economic integration that was missing in the formation of the Eurozone in Europe.

When the plans for Economic and Monetary Union (EMU) materialized in the 1990s in the wake of the 1990 Maastricht Treaty, OCA theory from the 1960s was called upon to discuss whether the EU could be considered to be a common currency zone. The consensus in the academic debate in the run up to EMU was that, at the time, the EU as a whole certainly did *not* constitute an OCA (see, for instance, Bayoumi and Eichengreen, 1993). With intra-European labour mobility and wage flexibility being low, and in the absence of a (federal) EU-wide system of fiscal transfers, the asymmetry of demand and supply shocks between essentially the northern and southern EU candidate members of Euroland was considered too large and too persistent for these countries together to form a monetary union. How was it then that despite this conclusion, a number of northern and southern members of the European Union nevertheless entered into monetary union, irrevocably fixing exchange rates in 1999 and replacing their currencies by the Euro in 2002?

A first explanation is that EMU should not been seen in the light of OCA theory to begin with, that is not in economic cost-benefit terms, but instead primarily as a political project: witness the well-known Maastricht convergence criteria, the fulfillment of which served as an entry ticket into EMU. Those criteria were politically motivated (largely to safeguard Germany against ending up in an EMU with high-inflation and fiscally

imprudent countries), and had no relationship whatsoever with OCA theory.¹ A second explanation is that although it was acknowledged that the Eurozone countries did not constitute an OCA at the time, OCA theory could be amended to allow for the fact that EMU would by itself lead to less asymmetric shocks, increased labour mobility and more (trade) openness, thereby endogenizing the aforementioned conditions of symmetry, flexibility and integration, with the result that Euroland would become an OCA thanks to the very creation of EMU. In the first years of EMU, the 'endogeneity version' of OCA theory (Frankel and Rose, 1998; Rose, 2004) was widely accepted and was argued to have some empirical backing (De Grauwe and Mongelli, 2005), in terms of convergence in per capita GDP between the northern (core) and southern (peripheral) EMU countries. A third explanation why EMU took off despite being at odds with 'classic' OCA theory was the fact that OCA theory stems from the 1960s, the heyday of Keynesianism, when the focus was on (correcting) short-term business cycles and less on long-run economic growth. In the 1990s and also in the first decade of EMU, the years of the so-called 'Great Moderation', business cycles were deemed less and less relevant and the focus was very much on the (neo-classical) determinants of long-run economic growth. The assumption was that a nominal price like the exchange rate can at best only have temporary real consequences because of initial price and wage stickiness and that in the long run changes in the nominal exchange rate do not imply changes in the real exchange rate (because nominal prices and wages will in the end adjust as well), which minimizes the main cost of monetary union, the loss of the nominal exchange rate as an adjustment mechanism, considerably. Combined with the neo-classical belief in convergence and thus the 'catching-up' of peripheral EMU countries, this provided a case for EMU by essentially discarding the classic OCA theory altogether.

So in the build up to EMU as well as in its first years prior to the outbreak of the 2008 crisis, standard OCA theory was either ignored (the Maastricht Treaty), amended (the endogenization of OCA criteria) or simply

¹ It is therefore somewhat ironic that Robert Mundell was awarded the Nobel prize in economics for inter alia his work on OCA theory in 1999, the year that also marks the start of EMU where the insights of Mundell et al on OCAs were by and largely ignored. Even though EMU can be seen as largely politically driven, the political ramifications of a starting a monetary union without anything near a political union in place were also at the time ignored (De Grauwe, 2005).

cast aside (as being outdated). As a consequence, it was all too easily forgotten that the original OCA theory was not only about the criteria for nation states to form a monetary union, but also about whether or not sub-national *regions* should do so. As Magnifico (op cit) had highlighted long before EMU occurred, while countries may satisfy the OCA criteria for the formation of a supra-national monetary union, such as the Eurozone, some of their constituent sub-national regions may not. From an empirical perspective this argument was already highly relevant at the start of EMU, for while the alleged convergence that supported the case for EMU could be observed at the inter-country level, at the inter-regional level divergence was occurring both within individual member states and across the EU taken as a whole (Martin, 2001; Puga, 2002).

From a theoretical viewpoint, the argument that EMU would foster labour mobility and trade integration, and hence increased symmetry amongst member states, was criticized because contrary to the endogenization version of OCA, increased factor mobility and trade arising from monetary integration could actually lead to increased regional instability and asymmetry. According to Krugman (1991, 1993) both theory and US historical experience suggested that the European Union regions would become increasingly specialized as a result of monetary integration, and that as they became more specialised so they would become more vulnerable to region-specific (and regionally uneven) shocks. Regions in a European monetary zone would, of course, be unable to respond with counter-cyclical monetary or exchange rate policies. Furthermore, in an environment of increased factor mobility, such shocks will tend to have permanent effects on regional output, and possibly also employment. Both endogenous growth theory and the New Economic Geography models predict that the increased geographical mobility of factors, especially labour but also capital, promoted by economic and monetary integration, tends not to perform a compensating role, thereby re-establishing regional symmetry, but instead is likely to reinforce the existing concentration of economic activity and growth in the more prosperous, less shock-prone regions. Thus, in the absence of a common fiscal stabilization mechanism, monetary union could well intensify regional economic disparities across the Eurozone, and put additional pressure on both Eurozone member states and the European Commission to increase discretionary assistance to lagging regions. Krugman was not arguing against EMU; but he was arguing that the

lack of a common fiscal system and institutional framework could mean that monetary union could increase rather than attenuate regional differences in vulnerability to and recovery from shocks.

Traditionally, OCA theory focuses on demand or supply shocks that are essentially temporary deviations from the (exogenous) trend growth path of the national or regional economy of interest. The adjustment time and path may differ across areas and various shocks but the assumption is that eventually we are dealing with one-off shocks that take the economy only temporarily away from its trend growth path. As we have argued elsewhere (Martin 2012; Fingleton, Garretsen and Martin, 2012), this view about the resilience of an economy to shocks is rather limited, because shocks may also have permanent, hysteretic effects on a region's trend growth path. The introduction of monetary union amongst several EU countries could well have had such an effect: this is essentially Krugman's point about the possible permanent effects on regional growth arising from monetary union. The financial crisis that broke in 2008, arguably the worst since that of the early-1930s, is another such major shock, this time distinctly adverse in nature, that may result in negative hysteretic effects in particular regions.

Essentially, then, the relationship between monetary union and regional economies across Europe involves several interrelated issues. First, there is the question of the implications of monetary integration for regions. Does monetary integration, via its effects on trade and factor mobility, lead to increased synchronicity and homogeneity of shocks across regions, as some argue? Or, as others contend, does it accentuate regional specialisation and uneven development, and hence regional differences in vulnerability to shocks? On the other hand, there are implications of regional development and cyclical sensitivity for the success and stability of monetary union. If monetary (and associated economic) union does indeed lead to regional convergence and cyclical harmonization, then the pressure on fiscal stabilisation and regional discretionary assistance in the event of a major shock to the currency area is reduced. But if monetary union leads to regional divergence and greater disparities in regional vulnerability, then a major shock will exert considerable pressure on the need for fiscal stabilization and discretionary regional assistance. These issues have come to the fore in the recent financial crisis and associated recession in Europe.

In many ways the recent, indeed still ongoing, crisis in Europe represents the first major negative shock to European monetary union. It has exposed the questions of an 'optimal policy mix', the lack of a centralised fiscal stabilisation mechanism, the disparities in economic performance between member states, and indeed whether in fact the Eurozone is a viable single currency area. It has also highlighted the regional dimensions of monetary union. The rest of the paper is intended to throw some light on this regional dimension.

3. Growth in Unison? European Regional Productivity and Employment Growth in and outside Euroland, 1980-2011

The starting point is to explore whether and to what extent the formation of the Eurozone has promoted *ex post facto* the regional requirements needed for that area to function as a meaningful and successful single monetary space. That is to say, has the very process of European monetary union itself 'endogenised' over time the conditions needed for its effective existence and operation, as suggested by Frankel and Rose (1998), Rose (2004), and De Grauwe and Mongelli (2005), as discussed above? More specifically, has there been a convergence in regional productivity and employment growth among the Eurozone members, and has there also been an increase in symmetry across regions in their exposure to fluctuations and perturbations in productivity and employment growth? And how do the regions across the Eurozone states compare to those across non-Eurozone states in these respects? The evidence provided in this section serves a stepping stone from the OCA theory in section 2 to the model estimations in section where we will investigate the impact on of the 2007/8 crisis on the Eurozone and non-Eurozone regions. Given the vital importance attached in OCA theory to symmetric economic conditions (before and in the wake of the establishment of a monetary union), answering the questions above will help us to make sense of the subsequent spatial model estimations in sections 4 and 5.

Figures 1 and 2 near here

We start with the question how Eurozone states compare to non-Eurozone states first. Figures 1 and 2 show, respectively, the variance of regional

productivity (GVA per worker)² and employment growth, year by year, for the 205³ regions of EU states with continuous series from 1980 to 2011 belonging to the Eurozone⁴ and the regions of those EU states that are not Eurozone members⁵. Such variances provide one measure of the degree of regional symmetry discussed in the previous section: the lower the variance, the more similar are regions in their susceptibility to temporal volatility and fluctuations in economic activity, and hence, other things being equal, the more similar they are likely to react to system-wide shocks *ceteris paribus* the more they are qualified to constitute a monetary union according to the OCA theory from section 2. Figures 1 and 2 indicate that in general over the 1980-2011 period studied here, the year-to year variance of both regional employment growth and regional productivity growth has tended to be less volatile across the Eurozone countries than across the non-Eurozone states, especially from the mid-1990s onwards. In addition, there is some suggestion, again especially from the mid-1990s onwards, that the degree of regional symmetry has been greater (the regional variance has been lower) in the Eurozone states than in those outside the Eurozone. On the face of it, the evidence in Figures 1 and 2 might be interpreted as lending some support to the argument that, on regional symmetry grounds at least, those EU member states that joined the Euro were to some extent better placed to do so than those countries that remained outside EMU. Eyeballing Figures 1 and 2, there is also a clear tendency that after the start of EMU in 1999 and before the start of the 2008 crisis, the variance of both employment and productivity growth is markedly lower for the Eurozone countries compared to the non-Eurozone countries which might be looked upon as evidence of the modern version of OCA theory that argues that monetary union itself would enforce more symmetry among its member states.

² The regional data used in this and the following section of the paper are from the European Regional Economic Data Base compiled by Cambridge Econometrics, to whom we wish to express our gratitude for being given access. They refer to NUTS2 regions. Gross value added is measured in €2005M .

³ Note that we have in addition data for 50 regions in the Czech republic, Hungary, Latvia, Lithuania, Poland, Slovenia, and Slovakia that are also used for the estimation of the model in Section 5.

⁴ Regions in Austria, Belgium, Germany (those with continuous data from 1980), Spain, Finland, France, Greece, Italy, Lux, Netherlands (most), Portugal.

⁵ Regions in Switzerland, Denmark, Norway, Sweden, the UK.

But this *prima facie* evidence based on Figures 1 and 2 on the question whether Euroland constitutes anything resembling an OCA ignores at least 2 important issues. The first is the regional or intra-Eurozone dimension and the second is that the real test for Euroland occurred in 2008 when the first major shock hit the Eurozone (as well as the non-Eurozone) and we could actually observe whether or not the various countries and region of Euroland reacted similarly to this shock. This is the topic of section 4 where we estimate a spatial panel model for the Eurozone and non-Eurozone regions.

Focusing in the remainder of this section on the regional dimension, Figures 1 and 2 thus ignore differences *within* the Eurozone itself, and particularly between the ‘northern’ ‘core’ member states (Austria, Belgium, Germany, Finland, France and Luxembourg) and ‘southern’ ‘peripheral’ member states (Greece, Ireland, Italy, Spain, and Portugal). If we look at these two parts of Euroland it is clear that not only was there a significant regional productivity gap between these two broad areas prior to the establishment of monetary union in 1999 with the irrevocable fixing of the exchange rates, but also that *after* 1999 that gap actually widened as productivity growth among regions in the southern Eurozone states leveled off whilst productivity⁶ among regions in northern Eurozone countries continued to grow, at least up to the onset of the crisis in 2007-08 (Figure 3). In terms of productivity – and productivity is key to regional economic performance and the ability of regions to resist and recover from recessionary, competitive and financial shocks – it would seem that monetary union may well have promoted *divergence* rather than convergence between the more productive northern members and less productive southern members of the Eurozone.

Figures 3 and 4 near here

Further, as Figure 4 shows, there are significant differences in the variance of productivity growth rates across regions as between northern and southern areas of the Eurozone. More specifically, there is much more

⁶ Defined as GVA in €2005M divided by employment measured in thousands of workers.

symmetry amongst the regions in the northern members of the Eurozone than amongst the regions in the southern members. Although there is a discernible increase in symmetry in both groups over the whole period, and especially the southern member states up the late-1990s, so that by the end of that decade regional symmetry had become similar across both parts of the Eurozone, in the period since monetary union the variance of regional productivity growth in the southern states has *risen* again relative to that in the northern states. A not dissimilar picture holds for regional employment growth (Figure 5). Again, the variance of annual regional employment growth rates across the southern Euro states is consistently higher than that in the northern states. On this evidence at least, then, it would seem that the northern regions of the Eurozone meet the symmetry condition required for an OCA, whereas the southern regions do not. Nor is there any overwhelming indication that monetary union has led to an endogenisation of symmetry among the latter. In effect, there would appear to be two 'eurozones', a northern one which conforms better to the symmetry requirement of an OCA, and a southern one much less so.

Figure 5 near here

With the OCA theory of section 2 in mind, the evidence provided through Figures 1-5 leads to the following conclusions. Based on a comparison of the variance in employment and productivity growth for the period 1980-2011, the Eurozone as whole was and is arguably better placed to constitute a monetary union than our set of non-Eurozone regions in Europe. In addition, the growth variance declined more in Eurozone in the wake of the establishment of monetary union. In this respect the current Eurozone was thus probably better suited than its non-Eurozone counterpart to form a monetary union. But this alleged increase of Eurozone symmetry masked large and increasing employment and productivity differences within the Eurozone, in particular between the (northern) core and (southern) peripheral countries and regions of Euroland. In that respect this is really the tale of 2 Eurozones. In the run-up to the actual start of EMU, Bayoumi and Eichengreen (1993) already predicted that Euroland did not constitute an OCA precisely because of diverging economic developments and reaction to shocks between the northern member states (gathered around Germany) and the of member of what effectively became Euroland in 1999. With more than a decade of EMU experience since then, it seems that their prediction was right when it comes to the asymmetric economic development between

northern and southern Euroland. What this implies from the point of view of OCA theory and in particular how well Euroland, despite these persistent intra-regional asymmetries, dealt with its first major shock, the aftermath of the 2007/8 crisis, is the topic of the next section. Armed with the OCA theory and the empirical evidence from the present section, we want to establish how the various Eurozone and non-Eurozone regions were affected and if the shock impact can be traced back to the OCA theory and regional employment and productivity trends outlined above.

4. Specifying a Counterfactual Model

Against the background of the OCA theory and the empirical evidence in section 3 on regional employment and productivity differences, the aim in the remainder of this paper is to estimate how the shock of the financial crisis that broke in 2008 has impacted the different Eurozone and non-Eurozone regions across the EU. We thereby focus specifically on regional employment as the key variable of interest, not only because the labour market was the focus of Mundell's(1961) original OCA theory, but also because, along with the impact of the crisis on sovereign debt across EU states, the impact on the labour market (and unemployment) has caused most concern among many of the member countries. We shall see that it is precisely the peripheral regions and countries of the Eurozone, which we have already shown to be somewhat detached from the Eurozone core, that have felt a much more pronounced negative impact than did the Eurozone core, again pointing to the sub-optimal performance of the Eurozone as a whole as a properly functioning common currency area. Our approach is to create counterfactual employment series over the four year period 2008-2011 across 255 EU regions, based on an assumption that there was no financial crisis. By comparing counterfactual and the observed employment growth, we obtain a measure of the impact of the crisis impact across EU regions over the 2008-11 period.

Figure 6 near here

The approach is illustrated, in stylised form, in Figure 6. The contractionary effect of the crisis, which is assumed to start at time t , lowers a region's employment from its peak level a to a trough level of b . The task is then to estimate a counterfactual employment path for the region under the assumption that the crisis and consequent recession did not occur, shown in

Figure 6 in stylised form as the pecked line. Then a measure of the impact of the crisis on the region's employment at any point in time in the recovery phase, say $t+k$, could then be given by comparing the actual level of regional employment, d , at that time with the corresponding counterfactual level, e . Alternatively, we could measure the extent of recovery from the contractionary trough by comparing cd and ce .

Our approach is to commence with a reduced form without alluding specifically to a theoretical model underpinning the reduced form. Our interest is not in adhering to a specific theory, but rather to create a more general empirical model that is consistent with the observed data and which can be the basis of our counterfactual analysis. The empirical model we adopt treats employment in region i at time t (E_{it}) as a dependent variable and the levels of output (Q_{it}) and capital (K_{it}) as drivers of employment, as given by equation (1). Even though this empirical relationship is evidently consistent with several different theoretical assumptions, for example a Cobb-Douglas production function, a static Verdoorn law or urban economics theory with profit maximising assumptions at the micro level, our data do not allow us to distinguish between these different theories, each of which produces equifinal outcomes, and between which we are agnostic. This theory-neutrality is a feature of other attempts to assess the impact of shocks on Euroland, for example Bayoumi and E'green (1993) adopt a largely a-theoretical approach in their VAR methodology.

$$\ln E_{it} = \beta_0 + \beta_1 \ln Q_{it} + \beta_2 \ln K_{it} \quad (1)$$

We assume that the employment level in region i is not independent of employment levels in other regions. Economic interdependence between regions is assumed to depend on trade, with employment levels in trade partners being mutually interdependent⁷. We capture interregional trade by the (time-constant) matrix W , with trade values standardised so that each row of W comprises exports shares from each region to all other regions.

⁷ Following a Leontieff expansion, the presence of $\rho_1 WE_t$ in equation (2) can be interpreted as the spillover of the effects of changes in output and capital in importing regions on the level of employment in an exporting region. Similarly, the effects of changes in the errors in the trading partners will be felt as impacts on the exporting region's employment level.

Given⁸ W , and writing in matrix notation so that E_t , Q_t and K_t are $N \times 1$ vectors, our model enhanced by interregional employment interdependence becomes

$$\ln E_t = \rho_1 W E_t + \beta_0 + \beta_1 \ln Q_t + \beta_2 \ln K_t + \varepsilon_t \quad (2)$$

where $t = 1, \dots, T$ and the error term ε_t captures all other unobservable effects influencing the level of employment.

We model localised error interdependence using an autoregressive error process, in this case based on the standardised contiguity matrix M .

$$\begin{aligned} \varepsilon_{it} &= \rho_2 \sum_{k=1}^N m_{ik} \varepsilon_{kt} + u_{it} \\ \varepsilon_t &= (I - \rho_2 M)^{-1} u_t \end{aligned} \quad (3)$$

The matrix M is the counterpart of matrix W but in this case M is based on a matrix of 1 and 0s denoting whether or not a pair of regions share a common border. Standardising this matrix of 1s and 0s results in M , with proportions in rows of M summing to 1.

These errors are a function of a compound error process as in (4) in which there is a time invariant region-specific component μ_i and a remainder component v_{it} that varies across regions and time. The time invariant component μ_i allows for unobservable sources of individual heterogeneity across regions and the remainder component v_{it} picks up the effects of transient shocks.

$$\begin{aligned} u_{it} &= \mu_i + v_{it} \\ \mu_i &\sim iid(0, \sigma_\mu^2) \\ v_{it} &\sim iid(0, \sigma_v^2) \\ \text{cov}(\mu_i, v_{it}) &= 0 \end{aligned} \quad (4)$$

⁸ The detail of how interregional trade flows were obtained is given in Appendix A.

The model we are describing involves two different autoregressive spatial processes, one for the endogenous variable and one for the errors. Further details of such random effects models are given in Baltagi et al(2012) and Baltagi (2013). We obtain parameter estimates for the structural part of this model via instrumental variables (or more precisely instrumental variables estimators with non-spherical disturbances), and the parameters of the autoregressive error process are obtained via GM estimation for spatial panels (without the endogenous spatial lag) given by Kapoor, Kelejian and Prucha(2007). Fingleton(2008) gives a related estimator for a spatial panel model with an endogenous spatial lag but with spatial moving average rather than spatial autoregressive errors. The debate regarding the suitability of random versus fixed effects is ongoing; there are arguments that can be made on both sides of the debate that are beyond the scope of the present paper. However one important feature of our preferred random effects specification is that we can succinctly capture, in a few parameters, unobservable and potentially spatially autocorrelated interregional heterogeneity. With fixed effects, we would in effect be fitting a model with $N = 255$ dummy variables, one for each region, which would potentially impact the precision of our estimates, since we would be basing our parameter estimates only on the within-region variation, rather than the between variation which is such a dominant and long-run feature of our data (Partridge, 2005; Elhorst, 2010).

The data used in the model estimation cover the period from 2000 up to and including 2007, so the period *after* the start of EMU but before the outbreak of the crisis. Since the adopted estimator is well documented in the references cited, we omit detail in order to save space.

5. The Actual and Expected Regional Impact of the Crisis

Table 1 indicates that there is a significant autoregressive endogenous spatial lag effect and we can reject the null hypothesis that $\rho_l = 0$, indicating that regions' employment levels are not independent of each other, but are related according to the (start-of-period) intensity of interregional trade, as reflected in the matrix W . Also we see that a 1% increase in output incurs an approximately 0.5% increase in the level of employment⁹. Holding the other variables constant, we estimate a negative effect of capital, with 1% increase in the level of capital associated with a fall in employment of approximately 0.09%, although this is statistically insignificant. With regard to the error components, there is a significant autoregressive effect, reflecting the fact that residuals in contiguous regions tend to be similar, due perhaps to localised shocks spilling across region boundaries. The

Table 1: Estimates for Eurozone and Non-Eurozone regions, 2000-2007

variable	parameter	Parameter estimate	Standard error	t ratio
<i>constant</i>	β_0	0.0440	0.0031	14.23
<i>WlnE</i>	ρ_l	0.2943	0.0224	13.12
<i>lnQ</i>	β_1	0.5230	0.0466	11.23
<i>lnK</i>	β_2	-0.0931	0.0705	-1.32
	ρ_2	0.4208	0.0654	5.88
	σ_μ^2	0.2200		
	σ_v^2	0.0010		

Note. The estimated moments of the null ρ_2 distribution were obtained from 100 Bootstrap replications, with mean equal to 0.0363 and standard deviation equal to 0.0654. The estimated ρ_2 exceeds all values occurring in the null distribution.

presence of the error process in the model necessarily captures these effects and provides more reliable standard errors and tests of significance. As

⁹While the Table 1 parameter estimates are of interest, they do not tell the whole story. To see this one should consider the marginal effects rather than that of the parameter estimates themselves, see LeSage and Pace (2009).

anticipated, interregional heterogeneity, as measured by the variance of the assumed time-invariant random effects $\sigma_{\mu_s}^2$, is large relative to the remainder variance σ_v^2 .

We use the parameter estimates given in Table 1 combined with projected levels of $\ln Q$ and $\ln K$ in order to predict employment levels and growth over the period 2008-11 under the counterfactual. Our predictor is an adaptation of the best linear unbiased predictor (BLUP) of Goldberger(1962), which is

$$\hat{y}_{iT+s} = X_{iT+s}\hat{\beta} + \omega'\Omega^{-1}\hat{\varepsilon} \quad (5)$$

which predicts the value of the dependent variable y in region i at future period $T + s$ using future values of X , estimates of coefficients β plus a correction term. The correction term is a function of $\omega = E[\varepsilon_{iT+s}\varepsilon]$ which is the covariance between errors ε and future error ε_{iT+s} , the NT by NT error covariance matrix Ω and error vector $\hat{\varepsilon}$. It is interesting to note that Baltagi et al(2012) show that in the presence of (either autoregressive or moving average) spatial error dependence, the BLUP is the same regardless of whether spatial error dependence is present or absent, and is equal to

$$\hat{y}_{iT+s} = \left(X_{iT+s}\hat{\beta} + \frac{\sigma_{\mu}^2}{\sigma_1^2}(l_T' \otimes l_i')\hat{\varepsilon} \right) \quad (6)$$

in which

$$\sigma_1^2 = T\sigma_{\mu}^2 + \sigma_v^2$$

l_T is a T by 1 vector of ones, and l_i is the i 'th column of N by N identity matrix I_N .

Despite its apparent complexity, in essence the correction term simply modifies the forecasts by adding a fraction of the mean of the estimated errors, taking the mean over time for each region. Thus

$$\hat{y}_{T+s} = X_{T+s}\hat{\beta} + c$$

in which the vector of corrections c is given by

$$c = T \frac{\sigma_{\mu}^2}{\sigma_1^2} \bar{\varepsilon}_i$$

and the error means are

$$\bar{\varepsilon}_i = \sum_{t=1}^T \hat{\varepsilon}_{it} / T$$

Given the presence of the autoregressive spatial lag in equation (2), A natural modification to the Goldberger linear predictor (Fingleton, 2009) gives

$$\hat{y}_{T+s} = (I_N - \rho_1 W)^{-1} (X_{T+s} \hat{\beta} + c) \quad (7)$$

In order to operationalise (7), we use the parameter estimates given in Table 1 together with the known values of W and M . Applying equation(7) using the $\ln Q$ and $\ln K$ series actually observed through the forecast period 2008-2011 as matrix X supports the use of this method to create counterfactual employment series. Figure 7 shows the scatterplot of actual log employment versus predicted log employment using the actual values rather than the counterfactual values for the year 2011, indicating that our predictor is producing realistic predictions, with the Pearson product moment correlation equal to 0.99. If we examine growth rates, then the link is weaker but still positive, with Pearson product moment correlation for growth over the period from 2008 to 2011 equal to 0.381. In contrast, as we would anticipate, the actual and counterfactual employment growth correlation over the period 2008-2011 is much lower, equal to -0.14, reflecting the fact that the prediction from 2008 uses counterfactual $\ln Q$ and $\ln K$ series as matrix X in equation (7). Appendix B gives details of how the counterfactual series were obtained.

Figures 7 and 8 near here

Figure 8 shows the difference between actual and predicted counterfactual employment levels (in natural logs) for the year 2011, equivalent to the distance d to e in stylized Figure 6 for each region. The outcome is a variegated pattern, with darker shading highlighting regions with a greater employment shortfall attributable to the recessionary shock. The regions with a negative employment difference are quite mixed, but notably include the Eurozone periphery and a large number of non-Eurozone regions (including many regions in Eastern Europe). It is evident that the Eurozone core by 2011 had not seen a sharp contraction in employment, with the exception of a limited number of regions, like in the rural parts of Central France.

While Figure 8 is confined to a single snapshot taken in 2011 as to the level of employment, Figures 9,10 and 11 focus on employment *growth* over the whole period 2008-11. These show more distinct evidence of the impact of the recessionary shock in the Eurozone periphery. The actual employment growth over 2008-11 is illustrated by Figure 9, with dark shading representing negative growth, which is typically associated with peripheral Europe. Alongside the extreme case of Latvia, with a dramatic 27% fall in employment over 3 years, we also see considerable reductions in the other Baltic states, and also in many peripheral regions of the South and West where a 10% loss is not atypical, although there are exceptions in parts of Southern France, Portugal and Italy. In contrast many Central and Eastern regions of the EU, especially in the UK, Germany and Poland, saw employment *gains*. Figure 10 gives predicted employment growth as produced by our model under the counterfactual. On the whole growth is positive but with noticeable heterogeneity in Eastern Europe, where typically growth is well above zero, although a handful of regions are predicted to experience negative growth. Figure 11 shows the difference between actual and counterfactual employment growth over the period 2008-11.

Figures 9, 10 and 11 near here

Note that in stylized Figure 6, with parallel counterfactual and actual recovery paths, there would be zero difference in growth over the period, even though the region's recovery path is at a much lower employment level than the counterfactual. In contrast to levels differences, differences in growth amount to measures of differences in the slopes of the actual and counterfactual recovery growth paths, with a negative growth difference

indicating that the shock has set economies on paths diverging away from counterfactual recovery paths. In contrast, a positive difference indicates that the actual employment level is moving towards the counterfactual level, implying that the shock is ultimately leading to convergence, or to even employment levels that are higher than under the counterfactual. Figure 11 illustrates the differentiated impact of the negative shock, especially highlighting the peripheral regions (Ireland, Spain, the Baltic states and Greece) which fared much worse than they would otherwise have done, together with some regions of Eastern Europe. For these regions, actual employment levels are diverging away from the counterfactual recovery levels. In contrast in many regions of the Eurozone core employment growth does not differ substantially from what we anticipate in the absence of the negative shock, so we can infer that while employment levels may possibly have been lowered, the situation was not worsening.

Relating these outcomes to the OCA theory of Section 2, it is evident that the early academic consensus predicting sub-optimality in the absence of automatic fiscal stabilization and significant labour market flexibility in the face of shocks has been realised. There has evidently been a true lack of homogeneity (symmetry, flexibility and integration) across regions, and the hoped-for endogenization process has not materialised. Moreover, convergence and other neo-classically motivated arguments relating to the unimportance of nominal exchange rates that might allow one to dismiss the conditions required for an optimum currency area have not withstood the test of the most severe recession since the 1930s. Some countries and their constituent regions that have relinquished autonomy over exchange rate and other monetary policies have got very little back in return. They have lost employment, and suffered large rises in unemployment, and although there has also been some adjustment in the form of outmigration and lower wage levels, rigidities in the labour market evidently have not allowed wages to fall to the extent needed to retain employment and limited labour outmigration has instead led to unemployment increases. It is true that within the Eurozone, those regions of the core, which are closely connected to the economic powerhouse of German regions, suffered less in terms of employment loss (see Figure 7) and in terms of employment growth (figure 11). In contrast peripheral Eurozone members were unable to withstand the severe negative shock in 2008. This is despite the fact that at the outset the peripheral Eurozone members were seemingly better positioned to participate in EMU than were the non-Eurozone members, and did benefit

through the tranquil period in the run-up to the crash, as investment funds flooded into what became overheated property markets. But when it came to the acid test of the 2008 shock, they lacked the adjustment mechanisms needed to avoid a severe negative impact, as is evident in the employment data we have considered. Many non-Eurozone regions were better able to weather the storm of the Great Recession of 2008/9, partly because of their individual exchange rate flexibility, which was obviously not an option for those more peripheral Eurozone members tied to monetary policy of the European Central Bank dominated through the sheer size of their economies by the big three Eurozone members Germany, France and Italy.

6. Conclusions and Implications

In his study of European monetary union, written well before unification actually took place, Magnifico (1973) raised concerns about the implications of unifying regions with disparate inflationary propensities into a single currency area. Our concern in this paper has been with the issue of regional disparities in productivity under monetary union, since productivity influences how regions that are subject to a single currency will react to and recover from shocks. One of the conditions often cited in optimum currency area (OCA) theory is that such an area requires symmetry among its constituent regions, that is minimal differences among regions in their susceptibility to shocks. One version of the theory argues that even if such symmetry is initially absent, monetary union itself will promote – endogenise – the required symmetry. Using data back to 1980, we find evidence that the degree of symmetry (variance) across regions in the Eurozone as a whole does seem to have increased (declined) over time, and especially since 1999, compared with that across non-Eurozone regions. However, comparing regions in southern or peripheral Eurozone states with regions in northern or central Eurozone countries, we find that the latter have consistently been less stable than the former, in terms of both productivity and employment growth, both before and after the formation of Euroland. In this respect, there are two Eurolands: a stronger and more stable core zone, and a weaker, less stable southern and peripheral one. Indeed, as Figure 3 showed, after 1999 the peripheral regions of the Eurozone fell progressively behind the northern central one in terms of productivity.

It is against this background that the dramatic recessionary shock, caused by the financial crisis of 2008, took place across Europe. Using a counterfactual methodology, we find that that it was precisely the southern and peripheral regions of the Eurozone that were most affected by the crisis. In effect, this major shock has shown that, in line with OCA theory and with pre-monetary union trends across the EU, joining a single European currency dominated by and centred around a strong economic core (focused on Germany) may be beneficial to peripheral member regions in good economic times (such as the boom years of 2000-2007 when capital flowed from the core to the more peripheral parts of Euroland), but it may prove highly disadvantageous once a major shock like the financial crisis of 2008 occurs, since the scope for independent monetary intervention no longer exists. At the same, time the Eurozone lacks a centralized fiscal stabilization mechanism by which to provide counter-cyclical intervention.

Figure 12 near here

The shock associated with the financial crisis has had a number of (compounding) dimensions. It started with a dramatic cut back in credit by banks across the EU (provoked by the exposure of major banks to the collapse of the sub-prime mortgage market in the US, and the resultant meltdown in the value of mortgage backed bonds and associated derivatives on global financial markets). The credit crunch, and the corresponding fall in economic confidence, in turn triggered a major recession across the EU. This in its turn put considerable pressure on public finances in several EU member states, some of which were also encumbered with bailing out failed banks. In some southern Eurozone states (particularly Greece and Italy) public spending and public debt to GDP ratios had already been high prior to the recession (Figure 12). In others, however, (Spain, Cyprus and Ireland) public debt ratios were actually below that of Germany. But in both cases the particular vulnerability of these southern and peripheral regions to the crisis and recession served to drive up their debt ratios substantially. This put immense strain on the European monetary system itself, and exposed the lack of an integrated fiscal stabilization system or other intra-Euroland adjustment mechanisms. To compound matters, as EU countries have responded to their public debt problems by large scale fiscal consolidation and austerity measures, so the concern is that these too will affect different

regions differently, and will delay recovery in those most dependent on public sector activities and jobs.

The lessons to be learned from the first decade and a half of EMU and the build up to and consequences of the 2008 financial crisis for the future of the regions of Euroland are fourfold. First, since the current regions of Euroland do not constitute an optimum currency area in terms of symmetry of economic stability, the future sustainability of the monetary union calls for a more even economic development across Euroland and better adjustment mechanisms, like more fiscal integration, to deal with regional asymmetries. Second, as the 'boom' period 2000-2007 period exemplified, convergence between core and peripheral in good economic times, partly stimulated by the creation of EMU itself, may be more apparent than real, thereby giving the false impression that monetary union was better able to deal with shocks than was really the case as the ensuing Great Recession showed. Thirdly, EU countries wishing to join Euroland should think twice about doing so. The entry criteria for EMU, like in the Maastricht Treaty that formed the entry ticket to EMU in 1999, still emphasize nominal convergence whereas the first years of EMU have shown that real convergence, both in terms of economic growth and the functioning of labour and goods markets, is what really counts. In this respect the differences between the regions of the non-Eurozone countries and (west) German regions are still so large that the loss of monetary independence may prove to be costly, particularly when recession hits. Fourth and finally, as is clear from our comparison of the actual and counterfactual employment for the regions of Euroland, the impact of the crisis has not only varied markedly between countries but also *within* countries. The latter is, as such, nothing new, but both with the current crisis and previous pre-EMU shocks, these regional or intra-national disparities sharpen the debate about the Euro and its future. The fact that the fall-out of the financial crisis of 2008 almost led to a break up of EMU is also due to the lack of political unification that helps to adjust for imperfect economic symmetry between regions. In this sense the vulnerability of the regions in Euroland is not only caused by lack of economic coherence but also by the historical uniqueness of EMU being a monetary union without anything near political and fiscal union to support its long term stability.

Appendices

A. The regional bilateral trade estimates

The basis of the interregional trade estimates are known international bilateral trade flows, which are then subject to a process of allocation to regions using the Chow-Lin best linear disaggregation method (Chow and Lin, 1971). This was initially developed to disaggregate annual time series into, for example, quarterly series (see Abeysinghe and Lee , 1998) , but more recently it has been applied to spatial data, for example by Doran and Fingleton (2013), Vidoli and Mazziotta (2010) and Polasek et al. (2010). In a similar application to the trade flow disaggregation carried out in this paper, Ruan and Lin (2009) consider freight data for US counties, and Doran and Fingleton(2013) create inter MSA trade flows from published inter-State trade data.

The basis of the approach is to fit a model to the known bilateral trade flows, thus in our case we have data for aggregate trade values¹⁰ between 21 EU counties (t_N), thus giving 420 observations for the year 2000 , and we model this by country level variables, namely great circle distances¹¹ (G_N) and national employment levels (E_N) in 2000. Given regression parameter estimates β_N , and estimated regression residuals e_N , we obtain regional bilateral trade flows (t_R) by applying the estimated β_N to the same variables (G_R, E_R) measured at the regional level, and adding an equal share of national level residuals to each region within a country. More formally, we carry out the following calculations. First we perform a regression at the national levels, estimating the model

$$\ln t_N = [\text{const}_N \quad \ln G_N \quad \ln E_N] \beta'_N + e_N \quad (\text{B1})$$

Subsequently we construct regional level bilateral trade flows using

$$\ln t_R = [\text{const}_R \quad \ln G_R \quad \ln E_R] \hat{\beta}'_N + VD'(DVD')^{-1} \hat{e}_N \quad (\text{B2})$$

¹⁰ Downloadable from <http://cid.econ.ucdavis.edu/data/undata/undata.html>; see also Feenstra et al (2005).

¹¹ These are the means of each country's interregional distances.

in which V is an n by n ($n = 255$) identity matrix and D is a c by n ($c = 21$) matrix with 1s in each country's row indicating those regions which are within the country, and 0s indicating those regions which are not.

B. Estimating the counterfactual series

To obtain the counterfactual employment predictions, we first fit vector autoregressive models, one per region, to provide input series contained within matrix X of our linear predictor. The vector autoregressions are estimated using $\ln Q$ and $\ln K$ series which have been modified to eliminate business cycle and shock effects (see Fingleton and Palombi, 2013, Doran and Fingleton, 2013). Thus we estimate the vector autoregressions using moving average¹² data instead of the observed series, and each region's model contains dummy variable(s) (D_1 , and possibly D_2) to allow for the slowdown in GVA growth across the EU in the years 2002-3 and, where the series is sufficiently long, also in 1993. Thus we obtain predicted series for each region of $\ln Q$ and $\ln K$ extending over the period 2008-11 by estimating

$$\ln \tilde{Q}_t = \tau_0 + \tau_1 \ln \tilde{Q}_{t-1} + \tau_2 \ln \tilde{Q}_{t-2} + \tau_3 \ln \tilde{K}_{t-1} + \tau_4 \ln \tilde{K}_{t-2} + D_{1t} + D_{2t} + \zeta_t \quad (C1)$$

$$\ln \tilde{K}_t = \kappa_0 + \kappa_1 \ln \tilde{Q}_{t-1} + \kappa_2 \ln \tilde{Q}_{t-2} + \kappa_3 \ln \tilde{K}_{t-1} + \kappa_4 \ln \tilde{K}_{t-2} + D_{1t} + D_{2t} + \zeta_t \quad (C2)$$

in which the moving averages of $\ln Q$ and $\ln K$ (denoted by $\tilde{\cdot}$ s) are the joint endogenous variables. This is written with two lags, but in practice the number of lags for each region is estimated on the basis the goodness of fit of models with 2, 3 and 4 lags, fitted to data over the period up until 2007. For most regions, the start date for estimation is 1980, disregarding years lost because of lagging the data, but for some regions, especially the new entrants, it is 1990 or 1991.

These region-specific models then provides the basis for dynamic forecasts of $\ln Q$ and $\ln K$ using standard methods¹³, so the one-step ahead (2008) predictions are based on the estimated coefficients $\boldsymbol{\tau}$ and $\boldsymbol{\kappa}$ together with the lagged values of the endogenous variables. Two-step ahead forecasts are based on these one-step ahead forecasts, and so on. Since each step uses

¹² Each moving average is the mean of the year plus the preceding 3 years' observed data.

¹³ As described for example in the Stata manual under the heading 'fcast compute'.

the predictions of the step preceding it, these are referred to as dynamic forecasts.

References

- Abeysinghe, T. and Lee, C. (1998) Best linear unbiased disaggregation of annual GDP to quarterly figures: the case of Malaysia, *Journal of Forecasting*, 17, pp. 527-537.
- Baltagi, B. H. (2013) *Econometric Analysis of Panel Data* (5th Edition), Chichester: Wiley.
- Baltagi, B.H., Bresson, G. and Pirotte, A. (2012) Forecasting with spatial panel data, *Computational Statistics and Data Analysis*, 56, pp. 3381-3397.
- Barrios, S. and de Lucio J. J. (2003) Economic integration and regional business cycles: Evidence from the Iberian regions, *Oxford Bulletin of Economics and Statistics*, 65, pp.497-515.
- Bayoumi, T. and Eichengreen, B. (1993) Shocking Aspects of European Monetary Integration, in Torres, F. and Giavazzi, F. (Eds) *Adjustment and Growth in the European Union*, Cambridge: Cambridge University Press, pp. 193-229.
- Chow, G. and Lin, A.-I. (1971) Best Linear Unbiased Interpolation, Distribution and Extrapolation of Time Series by Related Series, *The Review of Economics and Statistics*, 53, pp. 372 – 375.
- De Grauwe and F.P. Mongeli, (2005), Endogeneity of Optimum Currency Areas. What Brings Countries Sharing a Single Currency Closer Together, *ECB Working Paper Series*, 468, European Central Bank, Frankfurt.
- Doran, J. and Fingleton, B. (2013) *US Metropolitan Area Resilience: Insights from Dynamic Spatial Panel Estimation*, BEG Working Paper, School of Economics, University College Cork.
- Elhorst, J. P. (2005) Unconditional maximum likelihood estimation of linear and log-linear dynamic models for spatial panels, *Geographical Analysis*, 37, pp. 85-106.
- Elhorst, J.P. (2010) Spatial panel data models, in Fischer, M.M. and Getis, A. (Eds) *Handbook of Applied Spatial Analysis*, Berlin : Springer-Verlag, pp. 377-405.

- Feenstra, R. C., Lipsey, R. E. , Deng, H., Ma, A. C. and Mo, H. (2005) World Trade Flows : 1962-2000, *NBER Working Paper Series*, Working Paper 11040, <http://www.nber.org/papers/w11040>
- Fingleton, B. (2008) A Generalized Method of Moments estimator for a spatial panel model with an endogenous spatial lag and spatial moving average errors, *Spatial Economic Analysis*, 37, pp. 27-44.
- Fingleton, B. (2009) Prediction using panel data regression with spatial random effects, *International Regional Science Review*, 32, pp. 195-220.
- Fingleton, B. Garretsen, H. and Martin, R.L. (2012) Recessionary Shocks and Regional Employment: Evidence on the Resilience of UK Regions, *Journal of Regional Science*, 52, pp. 109-133.
- Fingleton, B. and Palombi, S. (2013) Spatial panel data estimation, counterfactual predictions, and local economic resilience among British towns in the Victorian era, *Regional Science and Urban Economics*, 43, pp. 649-660.
- Frankel, J.A. and Rose, A.K. (1998) The Endogeneity of the Optimum Currency Area Criteria, *European Economic Review*, 108, pp. 1009-1025.
- Goldberger, A.S. (1962) Best linear unbiased prediction in the generalized linear regression model, *Journal of the American Statistical Association*, 57, pp. 369-375.
- Kapoor, M., Kelejian, H. and Prucha, I. (2007) Panel data models with spatially correlated error components, *Journal of Econometrics*, 140, pp. 97 - 130.
- Kenen, P.B. (1969) The Theory of Optimum Currency Areas: An Eclectic View, in Mundell, R.A. and Swoboda, A.K. (Eds) *Monetary Problems of the International Economy*, Chicago: Chicago University Press, pp.
- Krugman, P. (1993) Lessons of Massachusetts for EMU, in Torres, F. and Giavazzi, F. (Eds) *Adjustment and Growth in the European Union*, Cambridge: Cambridge University Press, pp. 241-261.
- LeSage, J. and Pace, K. (2009). *Introduction to Spatial Econometrics*, Boca Raton : CRC Press.
- McKinnon, R.I. (1963) Optimum Currency Areas, *American Economic Review*, 53, pp. 717-724.
- Magnifico, G. (1973) *European Monetary Unification*, London: Macmillan.

- Martin, R.L. (2001) EMU versus the Regions? Regional Convergence and Divergence in Euroland, *Journal of Economic Geography*, 1, pp. 51-80.
- Martin, R.L. (2012) Regional Economic Resilience, Hysteresis and Recessionary Shocks, *Journal of Economic Geography*, 12, pp. 1-32.
- Montoya, L.A. and De Haan, J. (2008) Regional Business Cycle Synchronization in Europe? *International Economics and Economic Policy*, 5, pp. 123-137.
- Mundell, R.A. (1961) A Theory of Optimum Currency Areas, *American Economic Review*, 51, pp. 657-665.
- Partridge, M. (2005) . Does income distribution affect U.S. state economic growth?, *Journal of Regional Science*, 45, pp. 363–394.
- Polasek, W., Verduras, C. and Sellner, R. (2010) Bayesian Methods for Completing Data in Spatial Models, *Review of Economic Analysis*, 2, pp. 194-214.
- Puga, D. (2002), European Regional Policy in the Light of Recent Location Theories, *Journal of Economic Geography*, 2, pp. 372-406.
- Rose, A.K. (2004), A Meta Analysis of the Effects of Common Currencies on International Trade, *NBER Working Paper*, 10373, Cambridge Mass.
- Ruan, M. and Lin, J. (2009) Generating county-level freight data using freight analysis framework (FAF2.2) for regional truck emissions estimation, *Transport Chicago*, Chicago.
- Skidelsky, R. (2010) *Interpreting the Great Depression: Hayek versus Keynes*, Paper presented at the Institute for New Economic Thinking, London April 8.
- Tondl, G., Traistaru-Siedschlag, I. (2006) *Regional Growth Cycle Synchronisation within the Euro Area*, Working Paper 173, Economic and Social Research Institute, Dublin.
- Vidoli, F. and Mazziotta, C. (2010) Spatial Composite and Disaggregate Indicators: Chow-Lin Methods and Applications, *Proceedings of the 45th Scientific Meeting of the Italian Statistical Society*, Padua.

Figure 1: The Variance of Regional Employment Growth Rates in Eurozone and non-Eurozone states, 1981-2011

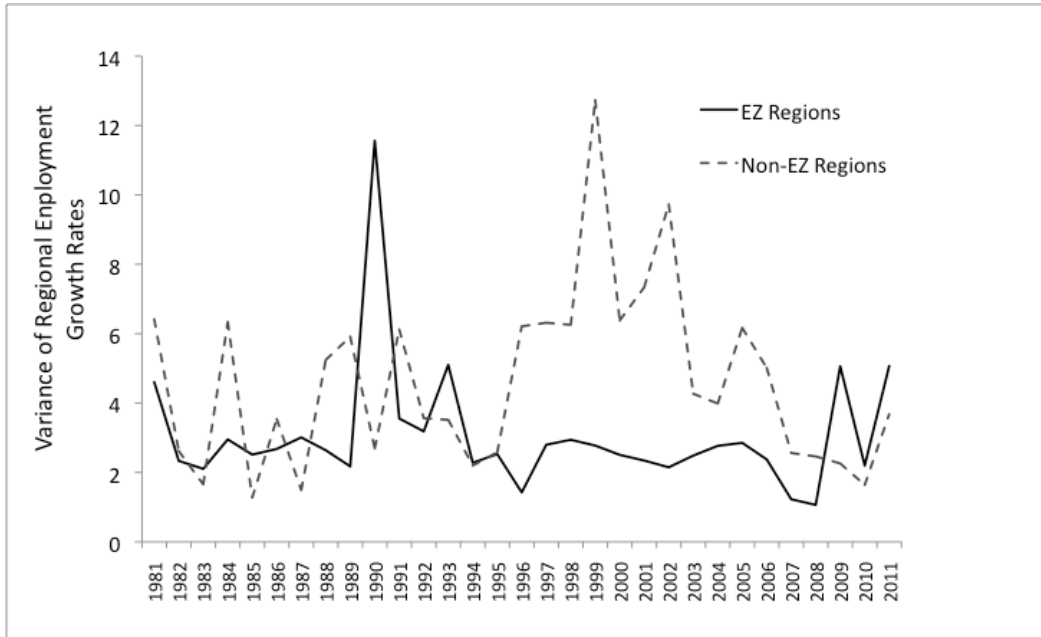


Figure 2: The Variance of Regional Productivity Growth Rates in Eurozone and non-Eurozone states, 1981-2011

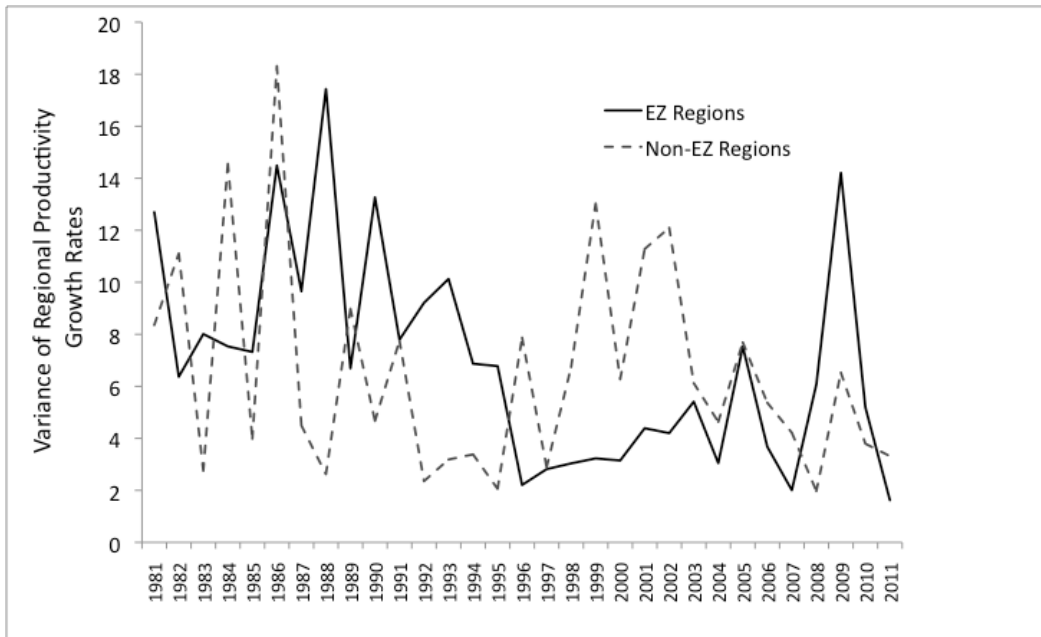


Figure 3: Regional Productivity Levels in Northern and Southern Eurozone States, 1980-2011

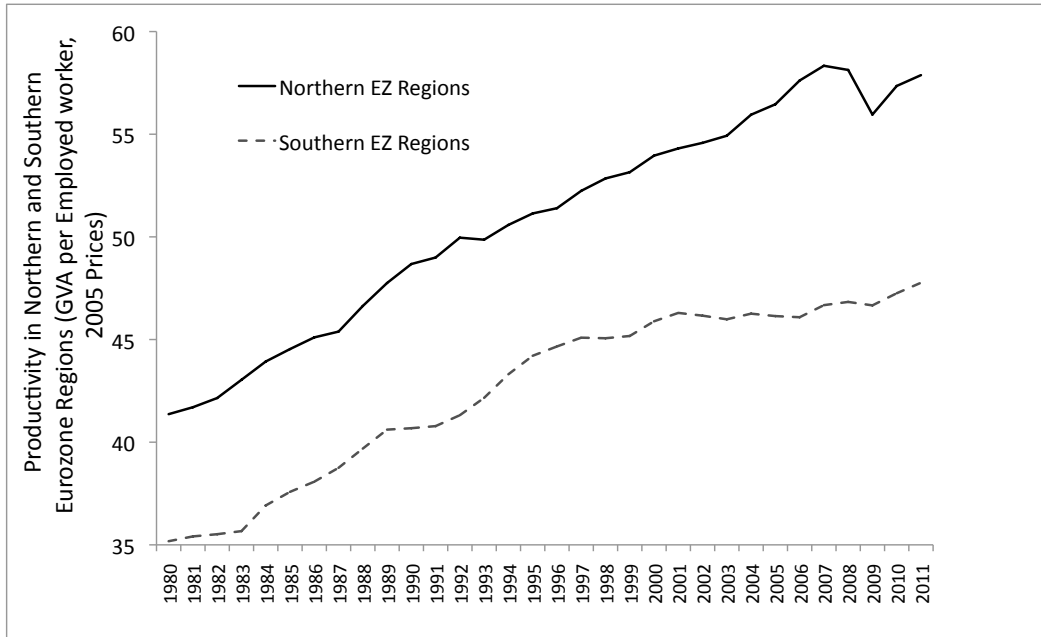


Figure 4: The Variance in Regional Productivity Growth in Northern and Southern Eurozone States, 1981-2011

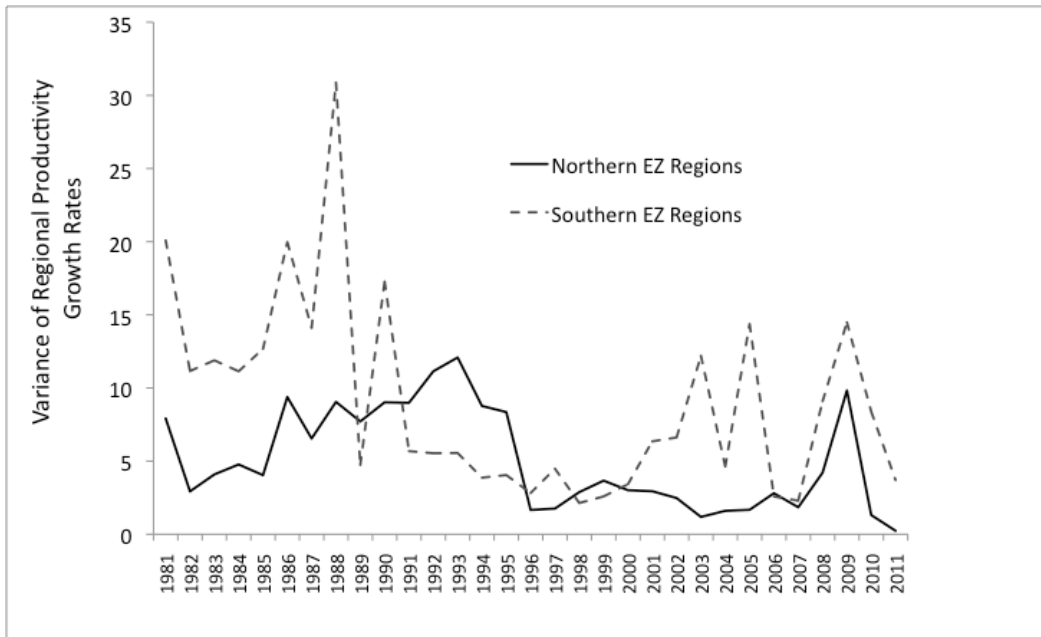


Figure 5: The Variance in Regional Employment Growth in Northern and Southern Eurozone States, 1980-2011

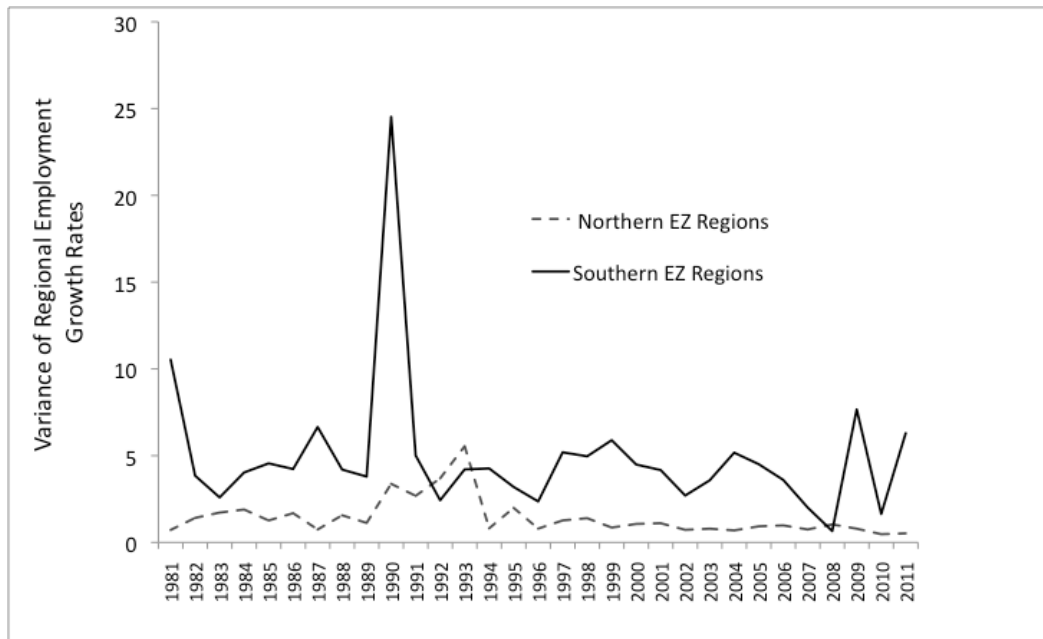


Figure 6: Estimating the Regional Impact of a Contractionary Shock

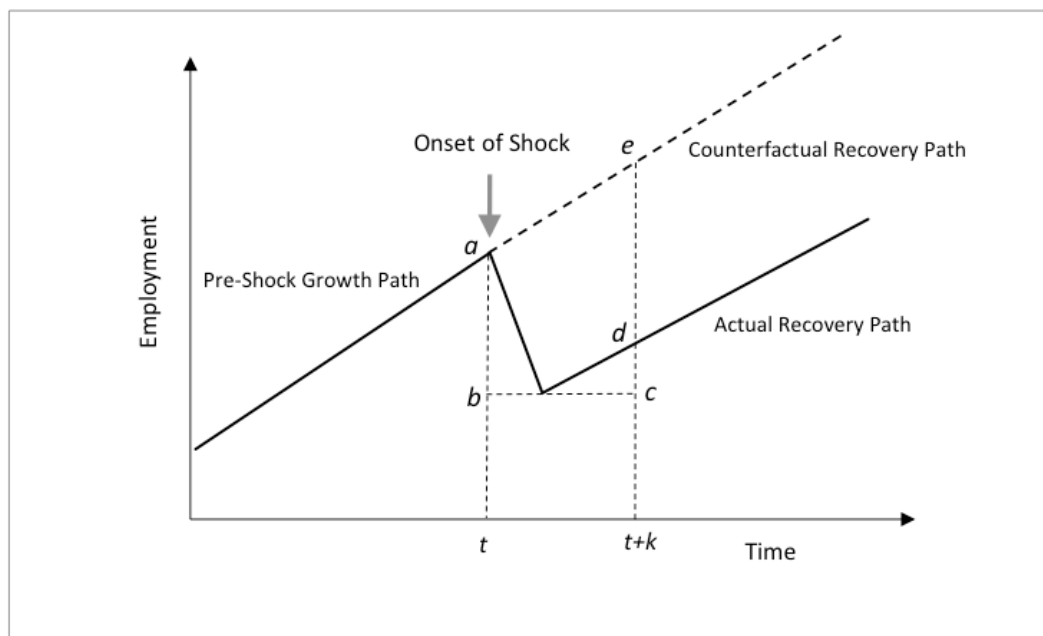


Figure 7: Observed and Predicted Employment Levels 2011

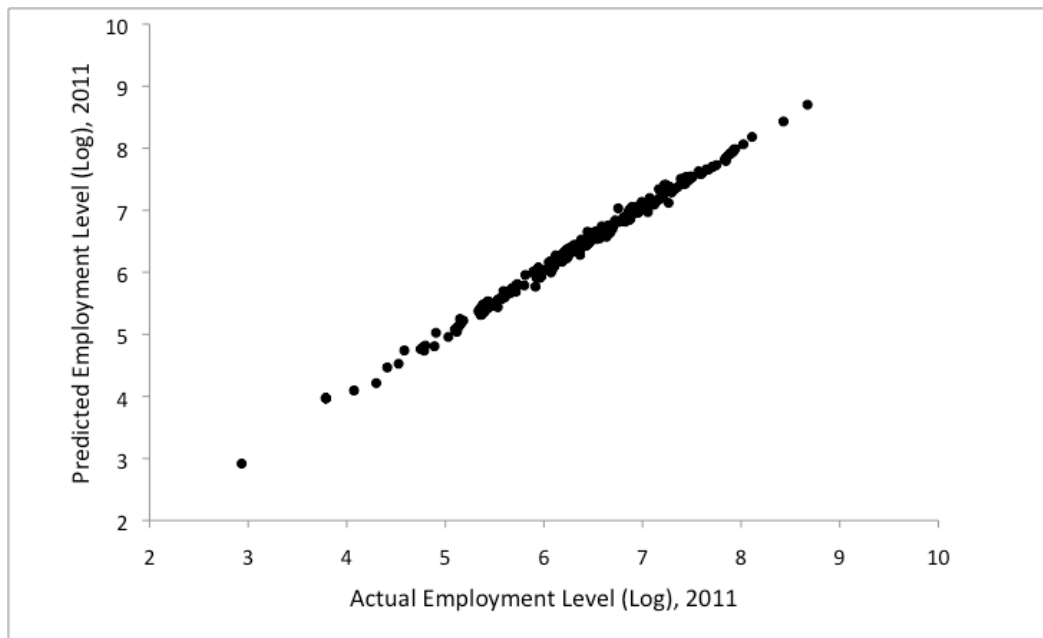


Figure 8: Difference between Actual and Predicted (Log) Employment Level, 2011

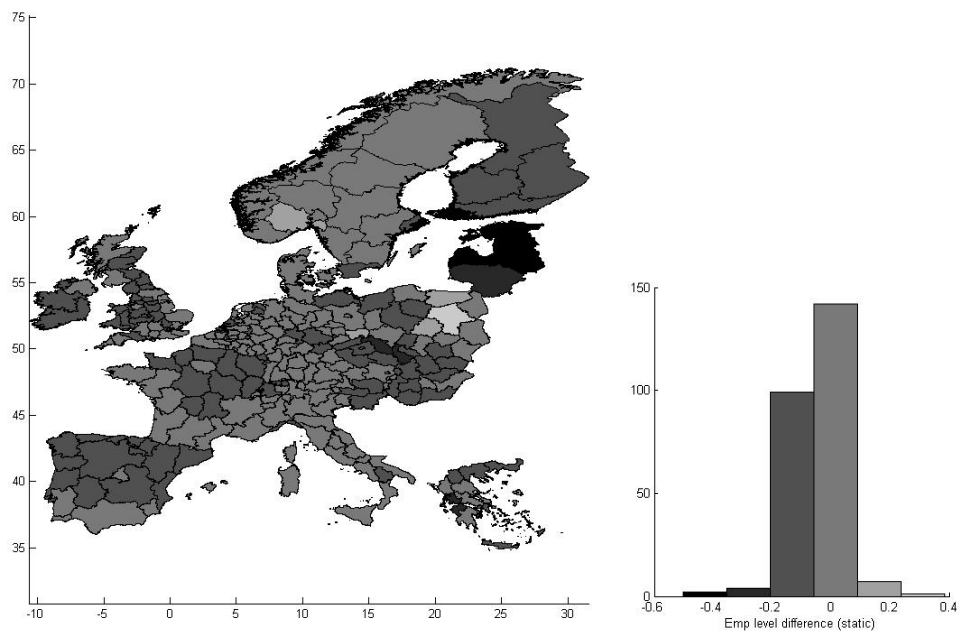


Figure 9: Actual Employment Growth 2008-11

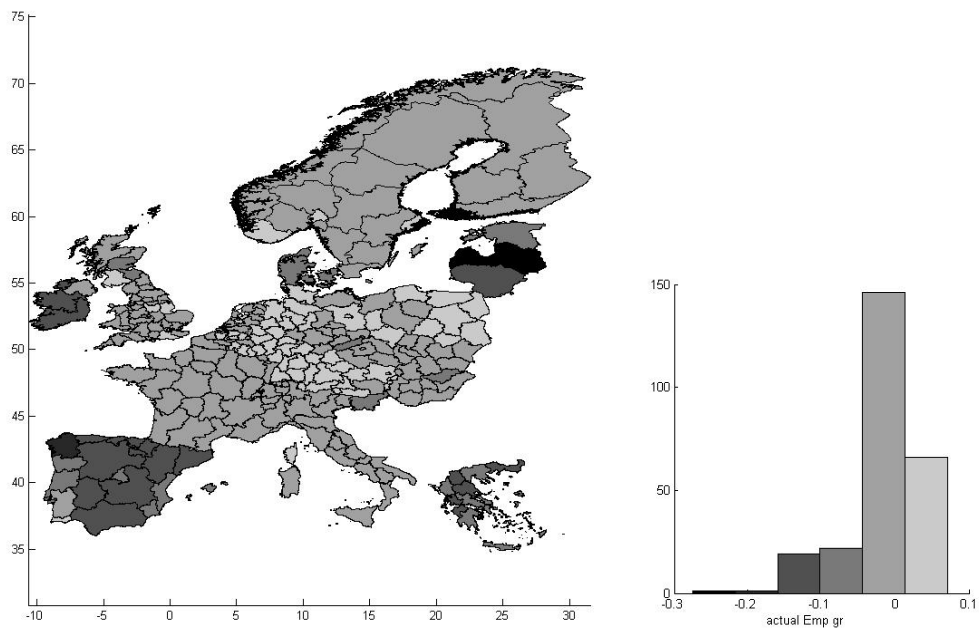


Figure 10: Predicted Employment Growth, 2008-11, under Counterfactual

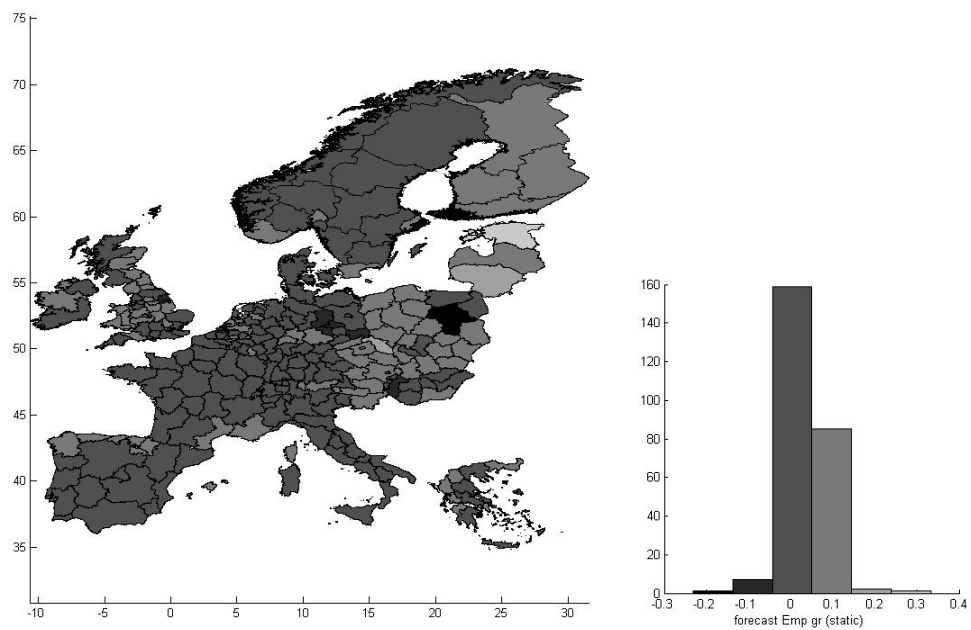


Figure 11: Difference between Actual and Predicted Employment Growth , 2008-11

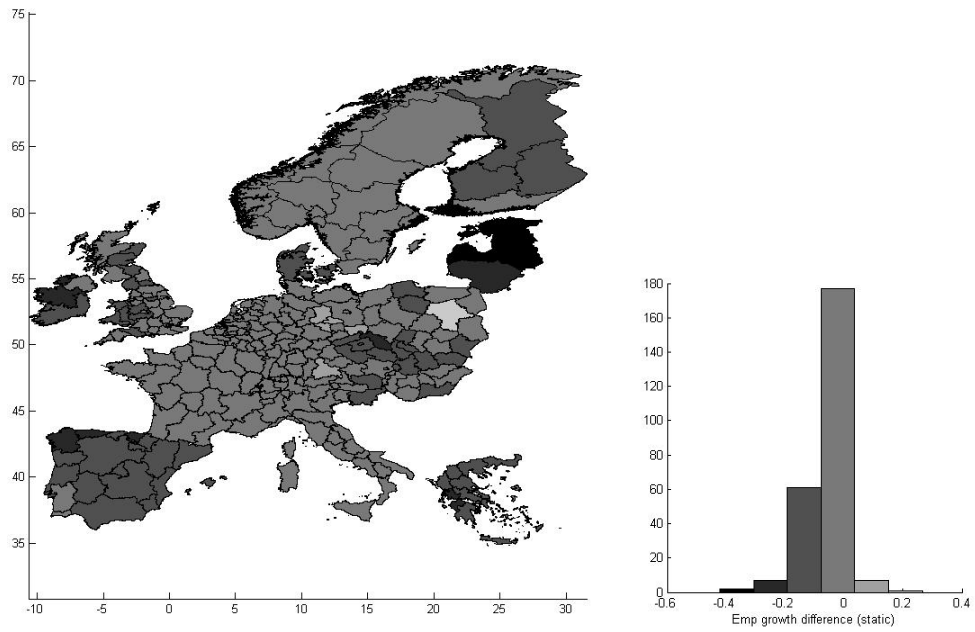
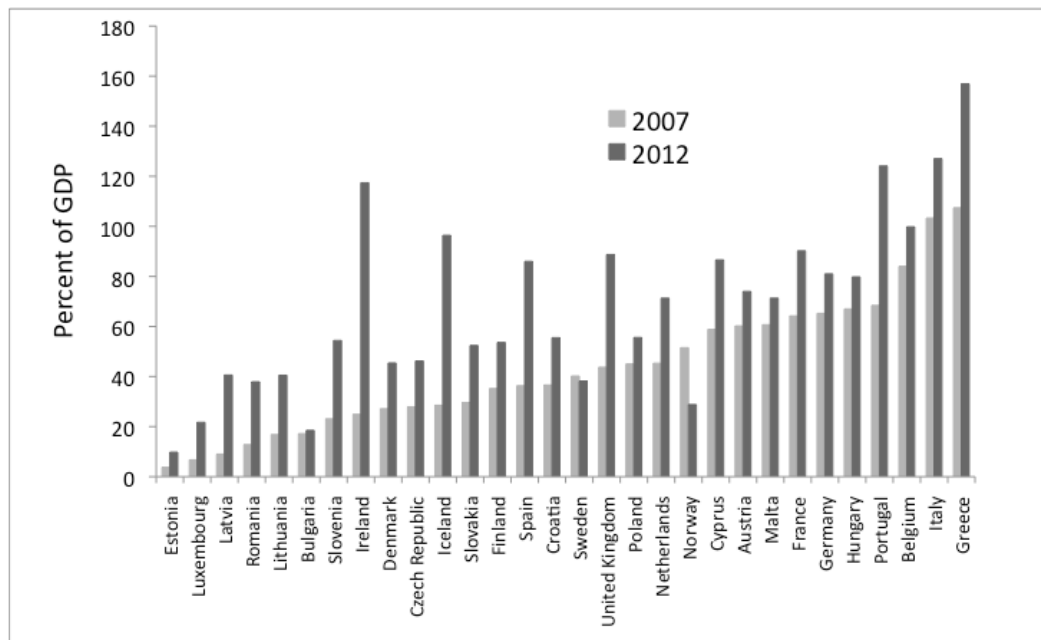


Figure 12: General Government Gross Debt (As Percent of GDP), in EU Member States, 2007 and 2012



Notes: Data for 2007 not available for Croatia; 2009 figure used instead. Norway and Iceland added for comparison. The indicator is defined (in the Maastricht Treaty) as consolidated general government gross debt at nominal value, outstanding at the end of the year in the following categories of government liabilities (as defined in ESA95): currency and deposits, securities other than shares excluding financial derivatives, and loans. General government sector comprises the subsectors: central government, state government, local government and social security funds. Basic data are expressed in national currency, converted into euro using end-year exchange rates for the euro provided by the European Central Bank (ECB).