Fostering the potential endogenous development of European regions: a spatial dynamic panel data analysis of the Cohesion Policy on regional convergence over the period 1980-2005

Salima Bouayad Agha, Nadine Turpin, Lionel Vedrine

Fostering the potential endogenous development of European regions: a spatial dynamic panel data analysis of the Cohesion Policy on regional convergence over the period 1980-2005

SALIMA BOUAYAD-AGHA, NADINE TURPIN, LIONEL VÉDRINE

Fostering the potential endogenous development of European regions: a spatial dynamic panel data analysis of the Cohesion Policy on regional convergence over the period 1980-2005

Salima Bouayad-Agha[*]

Nadine Turpin [†]

Lionel Védrine[‡]

July 2010

In this paper, we use a conditional-convergence econometric model to investigate whether the Cohesion Policy and the structural funds this policy mobilises, affect the European economies in such a way that the poorer regions catch up with the rich ones. In this model, regional convergence depends on policy treatment and regional economic structure, proxied by investment per capita and the demographic growth rate. The main originality of the model

---

[*]TEPP − GAINS, Université du Maine, Avenue Olivier Messiaen 72085 Le Mans Cedex 9.
[†]Cemagref, UMR 1273 Métafort, 24 avenue des Landais, 63172 Aubière Cedex.
[‡]Cemagref, UMR 1273 Métafort, 24 avenue des Landais, 63172 Aubière Cedex.

is its specification, dealing with temporal and spatial issues at the same time. Econometric estimations rely on a dataset of 143 EU14-NUTS1/NUTS2 regions observed over more than 25 years (from 1980 to 2005). Generalized Method of Moment estimation enables us to obtain consistent estimates of the beta-parameter along with estimates of the impact of regional policies and regional economic structure on regional growth. Our results suggest that Objective 1 programmes have a direct effect on regional GDP p.c. growth rates, whereas total structural funds do not. We interpret this result as an Objective 1 programme added-value, compared to total structural funds. However, these results do not mean that the non-Objective 1 structural funds have no impact on overall growth in the EU (e.g. through a technology diffusion effect) but they do not allow additional growth specifically in these regions, when we consider the spatial dependences. Moreover, consideration of the spatial dimension of the panel brings to light a still significant, but less important, impact of structural funds on convergence.

Keywords: Dynamic panels, GMM, Regional Convergence, Spatial Dependence, Structural Funds

JEL: C21, C23, O52, R11, R15

1 Introduction

European Cohesion Policy investments aim at improving the competitive position of regional policies by encouraging regions to provide public goods, such as networks of transport and energy, environmental quality, investments in education and research-development. In other words, the Cohesion Policy fosters regional development by various means, like competitiveness enhancement, infrastructure improvement, active labour market facilities, innovation enhancement or sustainable development. The public goods provided result from public and private expenditure. The policy seeks to add value

beyond simple investments, with a multi-levels governance model to involve local and regional actors in the design and delivery of the policy. This governance model enables regions to activate the most appropriate drivers to foster their development, and to design projects in a bottom-up approach.

The Cohesion Policy has relied on the same principles since 1988. The policy directs funds towards a limited number of "objectives", with a focus on the least developed regions; funding is based on multi-annual programming with ongoing analysis and evaluation; the design and implementation of the programmes involve regional, national and EU actors, and additionality ensures that EU expenditure is not substituted for national investment. The focus on the least developed regions concentrates funding on the Objective 1 regions, that represent about 25 % of the European population, and benefit from 64 % of the allocated funds (for the last programme).

The policy was renewed for seven years in 2007. A debate has just been launched with a view to continuous improvement of the policy, based on a public consultation about the budget review and the territorial cohesion strategy (European Commission, 2008). At this stage, it is important to evaluate the impact of past Structural Funds (SF) expenditure to assess whether structural policies are effectively leading to a narrowing of disparities of wealth between EU regions.

This paper evaluates the impact of SF on the convergence process between European regions over the 1980-2005 period. This analysis raises two issues, a methodological issue because we need to extend the neoclassical growth model towards impact analysis of the Cohesion Policy, and an empirical one because the convergence is linked to spatial and temporal phenomena that have to be assessed simultaneously.

Many of the analyses of the impact of structural funds on regional growth are based on the neoclassical Solow growth model (Solow, 1956; Swan, 1956). Roughly speaking, this model predicts a convergence of income among regions having a similar economic structure. Hence, the growth of capital-scarce regions is temporarily stimulated above

the region's usual steady-state growth level, when SF finance physical capital. The most recent studies attempt to conciliate the standard convergence approach equation and the classical spatial economy (New Economic Geography and Urban Economics). Despite a recent growing literature on this topic, the results have been ambiguous, depending upon the model specification, the data used, the estimation strategy (see for recent surveys: Arbia et al., 2008; Esposti and Bussoletti, 2008) as well as underlying models. Existing studies on European regional growth have given varying results. In some cases findings are conditioned by other development drivers than investment or population growth: for instance, institutional quality of member states (Ederveen et al., 2006) or choice in expenditure target (Rodriguez-Pose and Fratesi, 2004). Moreover, literature results stress that cross-section studies tend to overestimate the growth induced by the Cohesion Policy because this approach can't capture the unobserved heterogeneity among regions. On the one hand, empirical studies using linear dynamic panel data models (Esposti and Bussoleti, 2008) seem to correct for this issue, but ignore the spatial dependence. On the other hand, the spatial cross-section analyses focus on the spatial effects, but ignore the temporal dynamic properties of the convergence process.

The main contribution of our study is to combine both dynamics: spatial and temporal. In this context, we use a new econometric approach based on the study of a Spatial Dynamic Panel Data model (SDPD). Although its development is at an early stage, we can estimate this model by using a Generalized Method-of-Moments (GMM) estimator. In line with several studies using panel data in other contexts, this specification provides more information and data variability, thereby controlling for both unobserved heterogeneity and reducing problems with collinearity among our variables (two main related problems in growth empirics).

Indeed, measuring a speed of convergence is not sufficient to analyse whether the SF foster the development of lagging EU regions, and we have to design an appropriate econometric approach to conduct such an impact analysis. It is not straightforward to

identify the causal impact of public policy: the identification would require observing the outcome of a region in case of policy intervention and the potential outcome of this same region without policy intervention. This issue, notable with non-experimental data, is relevant to our study because allocation criteria of Objective 1 eligibility, and to a lesser extent structural funds allocation, are highly correlated with regional income per capita (European Commission, 2004). Moreover, we could expect severe misspecification when the spatial spillover effects are not considered in the analysis. If the Cohesion Policy affects the growth process of a particular region, this change may also affect the growth rate of neighbouring regions. Indeed, the omission of the spatial spillover effects can produce biased estimates of Cohesion Policy impact. Lastly, the diversity of channels through which the fund effect could contribute to additional growth complicate the study of these policy effects over the long term.

We find empirical evidence that the Cohesion Policy fosters the endogenous development of Objective 1 regions in Europe. We interpret this result as an added-value of Objective 1 programmes, compared to total structural funds. Finally, our approach suggests that taking spatial dependence into account reduces the measured effect of the Cohesion Policy.

The remainder of the paper is organised as follows. The first section develops some theoretical and empirical considerations on the impact analysis of structural funds on convergence. Section 2 presents the econometric issues with regard to the spatial dynamic panel model. Section 3 describes the data used for assessing the parameters. Section 4 presents the results and Section 5 concludes.

2 Theoretical and empirical considerations: impact analysis of structural funds on convergence

2.1 Theoretical aspect of the convergence of European regions

From a theoretical perspective, three strands of literature provide insights into the effects of Cohesion Policy on European regional growth and convergence. The neoclassical growth model is the most often cited in this context. However, endogenous growth models seem to be more relevant because they focus on the mechanisms that allow public policies to influence long-run growth. Finally, the economic geography literature sheds light on the importance of spatial interdependencies and the effects of geographical location.

The benchmark in growth theories is the neo-classical framework, which emphasizes the role of capital accumulation. Solow (1956) and Swan (1956) models determine how economic policy can increase the growth rate by inducing more saving or investment. The main prediction of this type of model is the convergence of income among regions with a similar economy. Actually, the logic of the convergence process is straightforward. An economy converges towards a steady state as a result of decreasing marginal capital product. When capital is scarce, it is very productive, so it receives a high return, inducing economic agents to save more. Because of decreasing marginal capital product, the capital growth rate depends on the distance between its initial stock and its steady state value. In this steady state, regional income continues to grow, but this growth is determined by exogenous factors (technological change, demographic growth rate, depreciation rate...) mentioned below as structural characteristics. Indeed, regions with the same structural characteristics (saving rate, labour force qualification, and demographic growth rate) necessarily converge towards similar steady states. The Cohesion Policy, that finances physical capital, has two effects: it affects the convergence of an economy towards its steady state and it induces structural changes which modify the steady state income value of less developed areas. However, the way Cohesion Policy can induce this

6

structural change is not endogenous in the Solow model. Hence, the Solow model explains the development path for a given technology. Despite the extended Solow model proposed by Bajo-Rubio (2000), public intervention plays no part in the dynamics described by the model. Romer (1986), Barro (1990) and Lucas (1988) among others have proposed a new framework to capture the main role of the technological path and the way public policies can affect this path. The Cohesion Policy can affect regional long-term growth rates by promoting labour force training (model based on human capital development, Lucas 1988), increasing Research and Development (Romer, 1986) or, more generally, public infrastructure investment (Barro, 1990). Thereby, public policies can be directly considered as inputs in the production process or as factors to improve the "quality of other inputs" (such as technology or human capital).

The two approaches above can be considered as non-spatial, because the development of a given economy is considered separately from the other ones. The New Economic Geography (NEG) and Krugman's core-periphery models add a critical piece to the regional governance puzzle by explaining the concentration of economic activities and the productive advantages of spatial closeness. In this framework, two opposite directional spatial processes may be at work. On one hand, centripetal forces (like economies of scale, local innovation processes, transport costs or presence of demand for goods, among other drivers) tend to promote geographical concentration of economic activities. On the other hand, congestion costs (among others, real estate costs, wages and labour market costs, transport costs) tend to counteract concentration of economic activities. We can note the major role of transport costs which affect these two forces. In light of NEG theories, Cohesion Policy has an ambiguous impact on regional income convergence. As described by Martin (1998, 1999), transport infrastructure investments (between regions) can lead to an increase of spatial concentration by reducing these transport costs. However, public policies that facilitate technological diffusion spillover can be beneficial for less developed regions. Moreover, Fuest and Huber (2006) show in a two-regions model, that a subsidy

on investment in the poorer region unambiguously increases welfare if the labour markets are competitive. If there is unemployment in both regions, the effect of regional subsidies is weaker.

Although all these contributions are important to consider, almost all empirical studies investigating the impact of the Cohesion Policy are based on the neo-classical growth framework. Moreover, as stated by Mohl and Hagen (2010), it is not possible to identify the "correct" theory for the evaluation of Cohesion Policy. A spatial dynamic panel data model can be considered as a good compromise to summarize the main contribution of the three frameworks described above.

2.2 Empirical framework

2.2.1 Modelling β-convergence for spatial dynamic panel data

Firstly, we use the neo-classical framework as a benchmark. Following the specification of Barro and Sala-I-Martin (1992), several empirical studies rely on a β-convergence model where the GDP per capita (hereafter GDP p.c.) growth depends not only on the initial GDP level, but also on other conditioning variables (proxying the structural characteristics of the steady state). Regions do not have the same structural characteristics and thus converge towards different steady state income levels. The further a region finds itself far from its steady state, the faster its growth rate will be. In this case, convergence is conditional: economies converge towards the same growth rate, and a gap may persist in income level. This can be explained through the transitional dynamics of the GDP p.c. ($ln\,y_{i,t}$):

$$ln\,y_{i,t} - ln\,y_{i,t-1} = -ln\,y_{i,t-1}(1 - e^{-\lambda t}) + ln\,y_i^{\star}(1 - e^{-\lambda t}) \tag{1}$$

where $ln\,y_{i,t-1}$ is the initial GDP p.c. for region i, $ln\,y_i^{\star}$ is the steady state and λ is the rate of convergence.

This model implies conditional convergence: for a given steady state, the growth rate is higher for regions with low $ln\, y_{i,t-1}$.

Accordingly, the following general estimation equation is in line with the empirical growth literature (Durlauf *et al.*, 2006):

$$ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right) = (1+\beta_1)ln\left(\frac{Y_{i,t-1}}{pop_{i,t-1}}\right)+\beta_2 ln\left(\frac{I_{i,t}}{pop_{i,t}}\right)+\beta_3 ln\left(\frac{pop_{i,t}}{pop_{i,t-1}}\right)+\alpha_i+\mu_t+\varepsilon_{i,t} \quad (2)$$

where $\left(\frac{Y_{i,t}}{pop_{i,t}}\right)$, $\left(\frac{I_{i,t}}{pop_{i,t}}\right)$ are respectively the gross domestic product and the investment per capita and $ln\left(\frac{pop_{i,t}}{pop_{i,t-1}}\right)$ is the demographic growth rate. We introduce these last two variables because they partially determine the growth rate in the steady state.

Using panel data improves the determination of $ln\, y_i^\star$ growth rate by controlling for unobserved heterogeneity across regions (Islam, 1995) through the introduction of individual effects and time effects (respectively α_i and μ_t). Therefore, β_1 measures the GDP convergence conditional to investment per capita and population growth rate.

In the underlying neoclassical growth model, economies are assumed to be independent. However, several recent studies have emphasized that the closed economy assumption might not be valid and that we need to take into account the possible interdependence among countries or regions, which can be explained by spatial externalities. Moreover, empirical evidence suggests that the productivity of technological spillovers declines as the geographical distance between regions increases (Keller, 2002). Several recent papers provide an empirical analysis of spatial effects, spatial autocorrelation and heterogeneity of the growth process to account for spatial dependence often detected in cross-country growth regressions. In these spatial econometric specifications, the spatial lag is a "methodological" means of introducing the dissemination of technological knowledge:

$$ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right) = (1+\beta_1)ln\left(\frac{Y_{i,t-1}}{pop_{i,t-1}}\right) + \rho\sum_{j\neq i} w_{ij}.ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right) + \beta_2 ln\left(\frac{I_{i,t}}{pop_{i,t}}\right)$$

$$+\beta_3 ln\left(\frac{pop_{i,t}}{pop_{i,t-1}}\right) + \alpha_i + \mu_t + \varepsilon_{i,t} \qquad (3)$$

The concept of conditional convergence refers to convergence after differences in the steady states across different economies have been controlled for. This is why recent papers have developed a spatially-augmented Solow model which explicitly takes into account technological interdependence between countries using spatial externalities on total productivity (Ertur and Koch, 2007; Lopez-Bazo et al., 2004) and physical capital accumulation (Ertur and Koch, 2007). Ertur and Koch (2007) argue that spatial auto-correlation detected in empirical works must be explained at the theoretical level. Their model includes both physical capital externalities and spatial externalities in knowledge, implying spatial heterogeneity in the parameters of the production function leading to a steady-state value for region with spatial externalities and global technological inter-dependence. In the spatially augmented Solow models, a region's speed of convergence depends on its location so that we have to consider this effect in corresponding economet-ric specifications. To be able to assess the magnitude of this effect, Egger and Pfaffermayr (2006) suggest breaking the region's speed of convergence down into its "classical" part, and a remoteness effect.

2.2.2 Impact of Cohesion Policy on European convergence

After having presented an empirical specification without policy intervention, it needs to be extended towards impact evaluation of the policy, including structural funds, to assess the policy impact on conditional convergence.

Direct effect on regional development Empirical literature on the effectiveness of Cohesion Policy is most often based on the neo-classical growth framework. Firstly, the work of Aschauer (1989), Gramlich (1994), tends to provide empirical evidence of effectiveness of public investment concentrated on infrastructure improvement as a direct input of the production process. Hence, we can expect that structural funds directly affect regional growth rates as in Rodriguez-Pose and Fratesi (2004):

$$
\begin{aligned}
ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right) \;=\;& (1+\beta_1)ln\left(\frac{Y_{i,t-1}}{pop_{i,t-1}}\right) + \rho\sum_{j\neq i} w_{ij}.ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right) + \beta_2 ln\left(\frac{I_{i,t}}{pop_{i,t}}\right) \\
&+\beta_3 ln\left(\frac{pop_{i,t}}{pop_{i,t-1}}\right) + \beta_4 ln\left(\frac{SF_{i,t}}{pop_{i,t}}\right) + \alpha_i + \mu_t + \varepsilon_{i,t}
\end{aligned} \tag{4}
$$

Where $ln\left(\frac{SF_{i,t}}{pop_{i,t}}\right)$ is structural funds spending in region i for the current period t.

However, structural funds can also induce a structural change in receiving areas. In fact, regional distribution of public investment policy may increase the return of public investment in receiving regions. Public infrastructure produced with the support of structural funds may also affect industrial location and enhance regional attractiveness. Structural funds may generate positive benefit in a region by increasing both public and private investment per capita ($ln\left(\frac{I_{i,t}}{pop_{i,t}}\right)$) and by leading to a higher steady-state income value.

Is there an "added-value" Objective 1 programmes? Furthermore, we distinguish Objective 1 programmes from the others. Firstly because this programme concentrates most available funds on a few (less developed) regions. Here, we shall focus on assessing whether Objective 1 group membership enables valorising projects dynamics that can result in higher income levels (OECD, 2006). Initially, we introduce a Dummy variable ($OBJ1$) in the previous equations specifying eligibility for Objective 1 program. Then, we introduce a distinction between total structural funds (whichever programme) and

11

funds allocated for the Objective 1 programmes. As recently shown by Becker et al. (2010) using a quasi-randomized experimental method, Objective 1 status has a positive effect on the growth rate of the regions benefiting from this programme.

The equation (3) can be rewritten as:

$$
\begin{aligned}
ln \left(\frac{Y_{i,t}}{pop_{i,t}} \right) =\ & (1+\beta_1)ln \left(\frac{Y_{i,t-1}}{pop_{i,t-1}} \right) + \rho \sum_{j \neq i} w_{ij}.ln \left(\frac{Y_{i,t}}{pop_{i,t}} \right) + \beta_2 ln \left(\frac{I_{i,t}}{pop_{i,t}} \right) \\
& + \beta_3 ln \left(\frac{pop_{i,t}}{pop_{i,t-1}} \right) + \beta_4 ln \left(\frac{SF_{i,t}}{pop_{i,t}} \right) + \beta_5 OBJ1 \\
& + \beta_6 OBJ1.ln \left(\frac{SF_{i,t}}{pop_{i,t}} \right) + \alpha_i + \mu_t + \varepsilon_{i,t}
\end{aligned}
\tag{5}
$$

3 Econometric issues

3.1 Estimation in dynamic panel

The dynamic panel-data specification has become increasingly common in empirical growth-convergence studies. As the inclusion of the time-lagged-dependent variable in the equation might lead to inconsistent estimates, instrumental variable estimators are required. A commonly employed procedure to estimate the parameters in dynamic panel data with unobserved individual specific heterogeneity is to transform the model into first differences. Sequential moment conditions are then used where lagged levels of the variables are instruments for the endogenous differences and the parameters estimated by GMM (GMM-DIFF) (see Arellano and Bond, 1991; adopted by Caselli et al., 1996, (in the growth context)). In the first stage we eliminate individual effects by taking first differences (GMM-DIFF) or a forward orthogonal deviation (as suggested by Arellano and Bover, 1995). Assuming that the error terms $\varepsilon_{i,t}$ are serially uncorrelated, the time lag of the dependent variable in first differences ($\Delta y_{i,t-1}$) is instrumented with the levels of the dependent variable $y_{i,t}$ starting with lag two $y_{i,t-2}$ and earlier lagged levels.

For small samples, the GMM-DIFF estimator may still yield biased coefficients. Lagged levels of the variables are weak instruments for the first differences and the imprecision of this estimator is greater as the individual effects are significant and as the variables are persistent over time (Blundell and Bond, 1998). The system GMM (GMM-SYS) augments the GMM-DIFF by simultaneously estimating, in terms of differences and levels, the two equations being distinctly instrumented (Arellano and Bover, 1995). However, this estimator is valid under a strong assumption that implies no correlation between fixed effects and the deviation of from the long run means (Blundell and Bond, 1998). Efficiency relies on the "proper" choice of instruments, so the choice between the two estimators (GMM-DIFF, GMM-SYS) is made using a common test of over-identification restrictions: the Difference-in Hansen test checks the validity of a subset of instruments. As pointed out by Roodman (2009) a large number of instruments (due to increasing time periods) can overfit endogenous variables and lead to an incorrect inference, so that the Hansen test of instruments set must be carefully interpreted. This issue can also affect GMM-DIFF estimates: the bias resulting from too many instruments does not result from their total number, but from the number of instruments for each equation (Okui, 2009). These problems prove to be serious when T is too large for a given N. In empirical applications, the instrument number can be restricted by collapsing the instruments (combining the instruments in subsets) in order to avoid redundancy between different time periods.

3.2 Estimation in spatial dynamic panel

Various convergence studies have found evidence for model misspecifications if the spatial interdependencies of regional growth are ignored (Arbia et al., 2008). Within the framework of regional analysis working on a dynamic panel specification, Badinger et al., (2004) applied a GMM estimator to spatially filtered variables; Elhorst (2005) suggested a maximum likelihood estimation of models that were dynamic both in space and

time; and Piras and Arbia (2007) extended panel-data models with spatial error auto-correlation to a convergence analysis of European (EU) regions. Spatial error model and spatial lag model are two different approaches to addressing the issue of spatial dependence (Anselin, 2001). The first is a nuisance form of spatial dependence and includes a spatial autoregressive process in the error term. In the second specification, often considered as a spatial autoregression model, interactions among regions are characterized by a spatially lagged dependent variable. In line with recent literature (Beck et al., 2006, Blonigen et al., 2007) this specification would seem to be more appropriate to quantify how the growth rate of a region is affected by the growth rate in the surrounding regions. According to Anselin (2001) and Abreu et al. (2005), the addition of a spatially lagged dependent variable causes simultaneity and endogeneity problems and thus a candidate consistent estimator should lie between the OLS and Within estimates. There is a relatively recent development in the literature on spatial dynamic panel data (SDPD). Elhorst (2005) suggests an unconditional maximum likelihood estimator for an SDPD model with either a spatial lag or a spatial error structure under a restrictive assumption of no additional explanatory variables. Yu et al., (2008) and Lee and Yu (2010a) provide the asymptotic properties of a quasi-maximum likelihood for an SDPD model with exogenous explanatory variables. More recently, Korniotis (2010) proposed a solution based on Hahn and Kuersteiner's Corrected Bias Least Square Dummy Variable (2002) and instrumental methods (Anderson and Hsiao, 1982) extended to allow for the spatial effect. Moreover these various estimators may be complementary, depending on which specification is considered. For instance, Korniotis (2009) focuses on a "time-space recursive" model whereas Yu and Lee (2009) work on a "time-space dynamic" specification.

3.3 Extended moment conditions for spatial dynamic panel data

We consider that GMM estimators present several important advantages. First, GMM enables each special case of the general specification to be estimated with only a few

modifications to moment restrictions. Furthermore, GMM allows the possible serial correlation of additional variables to be considered by introducing different moment restrictions on the explanatory variables. Let us consider the "time-space simultaneous" specification (as equation (2) above):

$$y_{i,t} = \alpha y_{i,t-1} + \rho \sum_{j \neq i} w_{ij} . y_{i,t} + x_{i,t}\beta + (\eta_i + \nu_{i,t}) \tag{6}$$

We restrict our attention to the stable case, i.e. with $|\alpha| < 1, |\rho| < 1, |\phi| < 1$.

We consider moment restrictions involving no correlation between first-differenced errors and earlier lagged levels of $y_{i,t-1}$ (as described in section 2.1):

(i) $E(y_{i,s}\Delta\varepsilon_{i,t}) = 0$ for $s = 1, \ldots, T-2$ and $t = 3, \ldots, T$.

Let $x_{i,t}$ be defined as a vector of current and lagged values of additional explanatory variables. Depending on what is assumed about the correlation between $x_{i,t}$ and the two components of the error term, we can design different moment conditions (Bond, 2002):

- if $x_{i,t}$ is strictly exogenous

    (ii) $E(x_{i,s}\Delta\varepsilon_{i,t}) = 0$ for $s = 1, \ldots, T$ and $t = 3, \ldots, T$.

- if $x_{i,t}$ is weakly exogenous

    (iii) $E(x_{i,s}\Delta\varepsilon_{i,t}) = 0$ for $s = 1, \ldots, T-1$ and $t = 3, \ldots, T$.

- if $x_{i,t}$ is strictly endogenous

    (iv) $E(x_{i,s}\Delta\varepsilon_{i,t}) = 0$ for $s = 1, \ldots, T-2$ and $t = 3, \ldots, T$.

As previously mentioned, the spatial lag is strictly endogenous. Therefore, the moment restrictions described above are not sufficient to provide an unbiased and consistent estimation.

As mentioned in the previous section, structural funds commitments are strongly correlated with initial GDP, which implies an obvious endogeneity problem for this variable. This correlation is mainly the result of the reform of the Cohesion Policy in 1988 (eligi-

bility criteria, and allocation of funds based on national and regional characteristics such as unemployment, GDP p.c., population density). Hence, we consider this variable as endogenous, whatever the specification and the selected moment condition sets. Moreover, we partly use regional European Regional Development Fund (ERDF) allocations for the period 1980-89, that are not affected by selection bias between the Objective 1 programmes and any other. In this context, we can use the reform of 1988 as an exogenous variation of structural funds allocation to estimate the Objective 1 programmes added-value, compared to others[1].

The choice of moment restrictions on other explanatory variables (investment per capita and demographic growth rate) is less clear. Thus, our choice will be more pragmatic (see section 4). As suggested by Bond (2002), we use a Hansen diff test to discriminate between different moment restriction sets on these additional variables.

An obvious solution is to estimate (3) with further moment restrictions considering $\sum_{j \neq i} w_{ij}.y_{i,t}$ as an endogenous variable. This spatial lag means that spillovers spread immediately, affecting all spatial units. These additional moment restrictions are written in the same way as (i):

(v) $E(\sum_{j \neq i} w_{ij}.y_{i,s} \Delta \varepsilon_{i,t}) = 0$ for $s = 1, \ldots, T-2$ and $t = 3, \ldots, T$.

Spatially-weighted explanatory variables $\sum_{j \neq i} w_{ij}.x_{i,t}$ can be used to instrument the spatial lag term. The exogenous part of the spatial lag variability is identified using a "spatially-weighted model". The validity of this procedure requires the following moment restrictions (with $\sum_{j \neq i} w_{ij}.x_{i,t}$ exogenous):

(vi) $E(\sum_{j \neq i} w_{ij}.x_{i,t} \Delta \varepsilon_{i,t}) = 0$ for $t = 3, \ldots, T$.

---

[1]The introduction of additional instruments, as distance to Bruxelles (as suggested in Dall'erba and Le Gallo, 2008) doesn't improve the precision of our estimation neither alter the significance of our estimates on the effectiveness of Cohesion Policy. Hence, we do not report these results anymore.

4 EU structural funds and O1 regions

4.1 Data description

The analysed dataset has been designed according to econometric issues described in Section 2. We use a panel dataset of 143 regions in 14 member states of EU-15 (see Appendix A which describes the sets of regions included and excluded in the sample). Owing to missing data, a small number of regions are excluded, among which several are eligible on Objective 1 programmes (New German Lander, French overseas etc...). We use NUTS2 data level for the main part of our sample, except for Germany and the United Kingdom for which data on structural funds regional allocation are available at NUTS1 level[2]. Finally, our dataset represents 90% of overall EU-15 regions and 80 % of Objective1 regions. The 143 regions are observed over a period to 25 years (1980-2005).

Data variables related to equations (1) to (4) come from the Cambridge Econometrics database[3]. The gross domestic product (GDP) and investment (provided by Cambridge Econometrics in 1995 constant euros) have been transformed into logarithms of per capita terms $\left(ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right)\right)$, $ln\left(\frac{I_{i,t}}{pop_{i,t}}\right)$ in order to consider the scale effect. The demographic growth rate is measured from the total population data dynamics $\left(ln\left(\frac{pop_{i,t}}{pop_{i,t-1}}\right)\right)$.

For the estimation, we consider five aggregated time periods (1980-84, 1985-89, 1990-94, 1995-99 and 2000-2005) to avoid short-run variations in GDP growth rates due to business-cycle effects. The accurate number of years required to avoid short-run variations is still discussed in the literature (see Temple, 1999, for an analysis). Temple (1999) recommends 5 or 10 years long periods, but we preferred to follow the approach proposed by Badinger (2004) and chose quinquennial time periods to collect information from at least two periods before the beginning of the policy. The 1980-2005 period has been

---

[2]Nomenclature of Territorial Unit Statistics (NUTS) provides homogenisation of sub-national boundaries into the European Union. Although the level of decision reference for Cohesion Policy is the NUTS2 level, some Member States use statistical NUTS 1 level for the simple reason that it corresponds to a real administrative level in their own territorial organisation (e.g. Lander in Germany).

[3]The Cambridge Econometrics database is available at http://www.camecon.com

split into 5 periods (1980-84, 1985-89, 1990-94, 1995-99 and 2000-05) that include three different policy programs (1989-93, 1994-99 and 2000-06). Thereby, we have a panel on 572 observations of 143 regions during 5 periods. Of course, the dynamic panel specification restricts this panel to 4 periods because of the autoregressive term ($ln\left(\frac{Y_{i,t-1}}{pop_{i,t-1}}\right)$). The variable measuring the regional allocation of structural funds comes from the 11th annual report on the structural funds (1999). Data in this report are collected only in NUTS1 level for Germany and the United Kingdom. For data before 1989, we use ERDF allocation collected in the 14th annual report of the ERDF (1988). Finally, all variables are expressed in 1995 euros.

4.2 Spatial weight matrix specification

The spatial weight matrix is used to evaluate the covariance of characteristics across regional locations. While a variety of weighting matrices may be constructed, in order to allow spatial interaction, the empirical literature chooses weights based on arc distance or contiguity between regions (Abreu et al., 2005). Thus, we have chosen a geographical definition of neighbourhood based on arc distance between regions in order to define the W matrix. More precisely we have chosen a k-nearest neighbours weight specification,$w_{ij}(k)$ representing the element of matrix in row i and column j :

$$\begin{cases} w*_{ij}(k) = 0 & if & i = j \\ w*_{ij}(k) = 1 & if & d_{ij} \leq d_i(k) \\ w*_{ij}(k) = 0 & if & d_{ij} \geq d_i(k) \end{cases}$$

$d_i(k)$ is the distance between the centroids of regions i and j, and $d_i(k)$ is a cut-off distance based on the distance of k-nearest neighbour for region i. The interactions are assumed to be negligible above this distance. Although we have constructed W with k=10, the results are similar with k=5, 15 and 20.

So, the matrix is row-standardised $w_{ij}(k) = \frac{w*_{ij}(k)}{\sum_j w*_{ij}(k)}$ to provide easier interpretation (each weight may be interpreted as the region's share in the total spatial effect of the

sample) and to make parameter estimates more comparable.

k-nearest neighbours seems the best weight matrix to represent spatial interaction in our sample : this specification leads to each region having the same number of neighbouring regions (k), including islands, in our sample, and to reducing the heterogeneity problem of regional superficies (Anselin, 2002).

4.3 Income dynamics in European regions

Table 1 depicts the dynamics of GDP p.c., investment per capita, demographic growth rate and spatially lagged GDP for Objective 1 (O1) regions and other regions in Europe. For every time period, O1 regions exhibit a GDP per capita far lower than the European average. The difference between O1 and non-O1 regions increases from the 1980-84 period to 1985-89 on, and then slowly decreases till today.

Figure 1 highlights the difference in GDP p.c. and growth rate between O1 regions and Non-treated regions before and after the reform of the Cohesion Policy which introduced Objective 1 programme eligibility. Although the GDP p. c. gap remains relatively stable before and after the 1988 Cohesion Policy reform, one can see that the growth rates are slightly different and much more important for treated regions just before the reform and at the end of the period considered, suggesting that the catch-up process is at work within a conditional convergence framework. From 1995 to 2005 the regions' growth rates vary too much to conclude that regions seem to converge towards country-specific steady state GDP levels, but the growth-rate gap is stable. This process is liable to spread out first among the neighbouring regions and then disseminate over the whole European space. Observed spatial correlations highlight an obvious spatial dimension of regional convergence (see Figure 2).

Figure 2 graphs the GDP-per-capita geographic pattern relative to the EU-14 average GDP level for the 5 periods. The regions are split into 6 classes, from below 50 % of the European average to more than 150 % of this average. For the first period, regions with

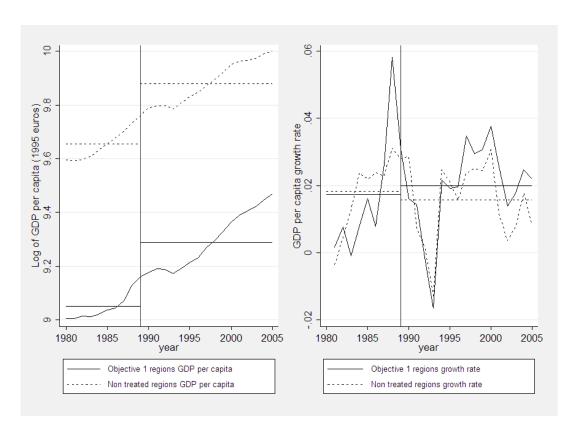| Variable	1980-84	1985-89	1990-94	1995-99	2000-05
$ln(\frac{Y_{i,t}}{pop_{i,t}})$					
Total sample mean (std)	9.44(0.40)	9.54(0.39)	9.63(0.39)	9.71(0.38)	9.81(0.37)
O1 regions mean (std)	9.01(0.32)	9.09(0.31)	9.18(0.28)	9.27(0.29)	9.41(0.29)
Other regions mean (std)	9.60(0.29)	9.71(0.27)	9.80(0.27)	9.87(0.26)	9.96(0.26)
$ln(\frac{I_{i,t}}{pop_{i,t}})$					
Total sample mean (std)	7.82(0.47)	7.95(0.44)	7.99(0.41)	8.08(0.37)	8.21(0.34)
O1 regions mean (std)	7.44(0.36)	7.54(0.33)	7.62(0.30)	7.73(0.27)	7.93(0.28)
Other regions mean (std)	7.96(0.43)	8.11(0.36)	8.14(0.36)	8.21(0.30)	8.32(0.30)
$\sum\limits_{i \neq j} w_{ij}.ln(\frac{Y_{i,t}}{pop_{i,t}})$					
Total sample mean (std)	9.46(0.34)	9.55(0.34)	9.64(0.34)	9.72(0.34)	9.84(0.32)
O1 regions mean (std)	9.10(0.33)	9.18(0.33)	9.26(0.31)	9.35(0.32)	9.48(0.30)
Other regions mean (std)	9.60(0.24)	9.70(0.22)	9.78(0.23)	9.86(0.21)	9.96(0.21)
$ln(\frac{pop_{i,t}}{pop_{i,t-1}})$					
Total sample mean (std)		2.84(1.39)	3.37(1.19)	3.28(1.24)	3.29(1.30)
O1 regions mean (std)		3.01(1.45)	2.73(1.26)	3.12(1.37)	3.42(1.34)
Other regions mean (std)		2.78(1.36)	3.55(1.11)	3.33(1.20)	3.26(1.29)
$ln(\frac{SF_{i,t}}{pop_{i,t}})$					
Total sample mean (std)	3.34(1.59)	3.43(1.53)	4.87(1.05)	5.05(1.19)	5.29(1.35)
O1 regions mean (std)	5.07(0.87)	4.79(0.82)	6.16(0.64)	6.33(0.64)	6.83(0.49)
Other regions mean (std)	2.74(1.32)	2.69(1.29)	4.26(0.50)	4.55(0.95)	4.68(1.06)

Tab. 1: Descriptive Statistics

Fig. 1: Annual versus Before/After intervention income and growth by treatment status (authors' calculation, Cambridge Econometrics database)
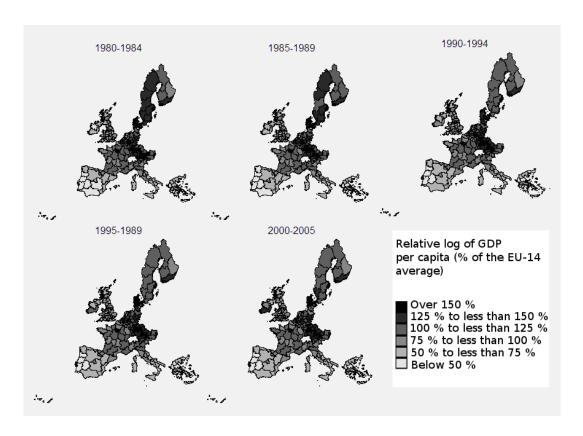
FIG. 2: Geographic pattern of the GDP per capita relative to the EU-14 average GDP level for the 5 periods (authors' calculation, Cambridge Econometrics database, adapted from Bouayad-Agha and Védrine, 2010)

income below 50% of the EU average can be found mainly in the southern periphery and most of them are in Greece or Portugal. A small number (7) of these regions had GDP p.c. below 50% of the EU average over the whole period. More precisely these are in Spain (1), Greece (3) and Portugal (3). Except these particular regions, the GDP p.c. spatial pattern between 1980-1984 and 2000-2005 is more dynamic in the periphery. Most regions in Spain, Greece, Ireland or Portugal experienced growth rates above the average EU-14 growth rate , while the most spectacular result is for Ireland, even if only two regions are concerned.

5 Estimation results : impact analysis of structural funds on regional convergence

The results are summarized in Tables 3 to 6. In keeping with the structure of Section 2, we present the results of specifications for which the variables are successively introduced. We start with the estimation of a neoclassical growth equation (Table 3) as a benchmark specification. Then, we introduce a spatial lag (Table 3) and the structural fund commitments directly in our estimations (Table 4), as previously carried out by Rodriguez-Pose and Fratesi (2004) in a static panel framework, and Dall'erba and Le Gallo (2008) in a spatial cross-section analysis. Whatever the misspecification, when the spatial spillover effects are not considered in the analysis, it is of interest to analyse if consideration of the impact of structural funds slightly changes the results presented previously. For that comparative purpose, Table 5 reports some estimation results of the impact of structural funds in a simple dynamic panel data framework. Structural funds may increase investment per capita leading to a higher steady-state income value. We investigate how robust are the estimated results when omitting the investment variable within a specification that includes the structural funds, and we check if the latest effect is stronger (Table 6, Appendix B). As ignoring spatial dependencies in residuals leads to potentially misleading estimates and incorrect statistical inference, we will first analyse the spatial properties of the residuals before presenting the estimation results and validity tests. To the best of our knowledge, the spatial Lagrange multiplier (LM) tests have not yet been extended to SDPD ; therefore the specifications previously presented cannot be tested directly. We check for spatial autocorrelation in the error term using the LM-test in static panel data developed by Baltagi et al., (2003, 2007) and Baltagi and Liu (2008). The results are summarized in Table 2. The result of the LM joint test for no spatial autocorrelation and no random effects tends to confirm that at least one of these two components is present in the error term (1369.03) with a p-value of 1%. The presence of

LM test descripion	Statistic	p.value
Baltagi *et al.* (2003)		
Joint test (H_0: absence of spatial		
autocorrelation and/or random effects)	1369.03	0.01
Conditional test of spatial autocorrelation		
(H_0: absence of spatial autocorrelation,		
assuming random effects are non null)	15.50	<0.01
Marginal test of spatial autocorrelation		
(H_0: absence of spatial autocorrelation)	14.28	<0.01
Marginal test of random effects		
(H_0: absence of random effects)	0.001	0.50
Baltagi *et al.* (2007)		
Two dimension marginal test		
(H_0: absence of spatial		
autocorrelation and serial correlation)	563.90	<0.01
Baltagi and Liu (2008)		
Marginal test of spatial lag		
(H_0: absence of spatial lag)	47.38	<0.01

Table 2: LM tests for spatial dependence, random effects and serial correlation

spatial correlation has been detected by a conditional LM test for spatial autocorrelation given the presence of random regional effects (15.50 with a p-value of less than 1%). The simple LM test for a missing spatially lagged dependent variable is significant (47.38).

The consistency of the GMM estimator relies on the validity of the lagged values of the autoregressive and spatial autoregressive terms as instruments for the regression. Using an orthogonality condition between the first-differenced error terms and lagged values of the dependent variables, we have to ensure, with specification tests, that these assumptions are justified. Firstly, the AR(2) test (Arellano and Bond, 1991) examines the absence of second order serial correlation properties of the residuals in levels (null hypothesis).

Failure to reject this hypothesis could supply evidence to validate moment restriction for the autoregressive term. The p-values associated with this test (reported at the end of each table) lend further support to our estimates as they fail to reject absence of second order serial correlation. Secondly, the overall validity of the moment conditions is checked by the Hansen test. However, too many instruments lead to inaccurate estimation of the optimal weight matrix, biased standard errors and, therefore, incorrect inference in these overidentification tests.

In order to check the sensitivity of our results to the number of instruments, we present alternative instrument sets. The first one uses the full set of instruments available for autoregressive terms and spatial autoregressive terms (full lag instruments). The second restricts it to the nearest lags which can be used for each variable (second lag instruments only). Finally the third collapses it (Roodman, 2009). Structural funds commitments are always treated as endogenous, whatever instrument sets are used. In order to have significant lags to estimate the effect of the first programming period, we introduce the regional ERDF allocation for the period 1980-89. The reform of 1988, which introduced the objective definition, and eligibility criteria, is used as an exogenous variation to estimate the Objective 1 programmes value-added. Overall validity tests do not indicate problems with instrument validity and orthogonality conditions used by first-differenced GMM estimators for Table 4 and 5 (i.e. estimates with our key equation including structural funds effects on development). Table 3 reports weak identification problems for the traditional neo-classical convergence equation and its spatial extended version. Hence, the results of these estimations need to be interpreted carefully. We did not use system-GMM because the additional instruments of the level equation are not valid.

The regression results (Table 3) of the neo-classical convergence equation are mostly consistent with the predictions obtained by previous studies (Caselli et al., 1996 ; Esposti and Bussoletti, 2008). For the traditional convergence equation, the autoregressive term coefficient is around 0.71 for Least Square Dummy Variable (LSDV) and 0.88 when the

	POLS	LSDV	GMM-DIFF			POLS	LSDV	S-GMM-DIFF		
			Full lag instruments	Second lag instruments only	Collapsed instruments			Full lag instruments	Second lag instruments only	Collapsed instruments
$ln(\frac{Y_{i,t-1}}{pop_{i,t-1}})$	0.881***	0.707***	0.842***	0.867***	0.866***	0.854***	0.409***	0.482***	0.495***	0.503***
	(0.01)	(0.02)	(0.07)	(0.08)	(0.08)	(0.01)	(0.03)	(0.13)	(0.13)	(0.13)
$\sum_{i\neq j} w_{ij}.ln(\frac{Y_{i,t}}{pop_{i,t}})$		0.247***				0.041***	0.454***	0.408**	0.400**	0.393**
		(0.02)				(0.01)	(0.03)	(0.14)	(0.14)	(0.14)
$ln(\frac{I_{i,t}}{pop_{i,t}})$	0.112***	0.247***	0.178***	0.165***	0.166***	0.107***	0.148***	0.136***	0.134***	0.134***
	(0.01)	(0.02)	(0.04)	(0.04)	(0.04)	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)
$ln(\frac{pop_{i,t}}{pop_{i,t-1}})$	-0.002	-0.006*	-0.007*	-0.007*	-0.007*	-0.001	-0.004	-0.004*	-0.005*	-0.005*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$constant$	0.325***	0.908***				0.234***	0.160			
	(0.05)	(0.15)				(0.06)	(0.13)			
Observations nb.	572	572	429	429	429	572	572	429	429	429
r^2	0.985	0.908				0.985	0.937			
AR(2)			-0.612	-0.644	-0.642			-1.174	-1.174	-1.176
(AR(2) p.value)			(0.542)	(0.520)	(0.521)			(0.240)	(0.241)	(0.240)
Hansen J			29.900	26.147	26.375			14.519	9.579	10.911
(Hansen J p.value)			(0.000)	(0.000)	(0.000)			(0.105)	(0.088)	(0.053)
Hansen-Diff J			45.44	36.93	34.62			36.33	37.25	16.10
(Hansen-Diff J p.value)			(0.00)	(0.00)	(0.00)			(0.000)	(0.000)	(0.007)
Instruments nb.			5	4	4			13	9	9

TAB. 3: Estimation of neo classical convergence equation and its spatially extended version (eq(1) and (2))

Pooled Ordinary Least Square (POLS) estimator is used. As expected, the coefficient estimated by GMM lies close to 0.85 and falls between the theoretical bounds provided by LSDV and POLS (Caselli et al., 1996). Investment per capita (demographic growth rate) has a significant and positive (negative) effect on regional development. These results are consistent with the Solow model predictions (expected coefficients sign).

The introduction of the spatial autoregressive term $\sum_{j \neq i} w_{ij}.ln\left(\frac{Y_{i,t}}{pop_{i,t}}\right)$ implies a fall of the $(1 + \beta_1)$ coefficient (from 0.8 to 0.5), while the coefficients associated with investment and demographic growth change very slightly (the last five columns of Table 3). Within the SDPD specification, we find empirical evidence of conditional convergence of European regions. Convergence (here net of spatial spillover) is faster when we consider the impact of neighbouring income on regional development. This process is strongly affected by spatial dependence. In fact, the spatial lag coefficient (0.4) suggests a strong significant impact of spatial spillover effects between European regions in their dynamics of development. The simple dynamic panel specification that takes into account the structural funds as an additional variable allows us to compare the results with previous studies (Table 6). The structural funds seem to directly affect regional development, but not with the expected sign (negative significant effect). However, the effect becomes positive for the structural funds allocated in Objective 1 programmes. The magnitude of the effect is comparatively important (0.05). This impact is in line with previous results (Mohl and Hagen, 2010; Bussoletti and Esposti, 2008, in a non spatial dynamic panel framework).

The direct effect of structural funds on regional development is displayed in Table 4. First, the effect of total structural funds is not significant. Furthermore that additional variable does not significantly affect the estimated parameter of the autoregressive term (the coefficient still remains around 0.5 within a very similar confidence interval) and neither spatial lag coefficient (around 0.37) nor other additional variables. The Objective 1

27

	S-GMM-DIFF			S-GMM-DIFF		
	Full lag instruments	Second lag instruments only	Collapsed instruments	Full lag instruments	Second lag instruments only	Collapsed instruments
$ln(\frac{Y_{i,t-1}}{pop_{i,t-1}})$	0.473***	0.516***	0.530***	0.477***	0.512***	0.529***
	(0.14)	(0.13)	(0.14)	(0.13)	(0.13)	(0.14)
$\sum_{i\neq j} w_{ij}.ln(\frac{Y_{i,t}}{pop_{i,t}})$	0.411**	0.394**	0.384**	0.393**	0.373**	0.361**
	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
$ln(\frac{I_{i,t}}{pop_{i,t}})$	0.135***	0.129***	0.129***	0.129***	0.124***	0.122***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
$ln(\frac{pop_{i,t}}{pop_{i,t-1}})$	-0.004**	-0.004**	-0.004**	-0.004**	-0.005**	-0.005**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$ln(\frac{SF_{i,t}}{pop_{i,t}})$	-0.0001	-0.002	-0.002	0.0001	-0.001	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$OBJ1$	0.013	0.017*	0.018*	-0.080	-0.095*	-0.106*
	(0.01)	(0.01)	(0.01)	(0.05)	(0.06)	(0.06)
$OBJ1.ln(\frac{SF_{i,t}}{pop_{i,t}})$				0.016*	0.019**	0.021**
				(0.01)	(0.01)	(0.01)
Observations nb.	429	429	429	429	429	429
AR(2)	-1.297	-1.303	-1.308	-0.727	-0.630	-0.584
(AR(2) p.value)	(0.195)	(0.193)	(0.191)	(0.467)	(0.528)	(0.560)
Hansen J	15.013	9.572	11.067	12.504	7.244	7.013
(Hansen J p.value)	(0.091)	(0.088)	(0.050)	(0.186)	(0.203)	(0.220)
Hansen-Diff J	25.51	24.13	8.18	31.13	38.38	28.85
(Hansen-Diff J p.value)	(0.001)	(0.001)	(0.043)	(0.000)	(0.000)	(0.001)
Instruments nb.	15	11	11	16	12	12

TAB. 4: Estimation of SPDP with direct effect of structural funds (eq(3) and (4))

dummy variable which captures programme eligibility effect is significant[4]. The eligibility for the Objective 1 programmes affects the regional development of less-developed areas. The effect of structural funds allocated in Objective 1 programmes is significantly positive (the last three columns in Table 4). These results are consistent with the evidence provided by Mohl and Hagen (2010) in a short-medium term evaluation (1995-2006) with annual data. The size of this coefficient is smaller than in the non-spatial case (0.02 instead of 0.05). As mentioned in section 1.2, structural funds may generate a positive benefit in a region by increasing both public and private investment per capita and leading to a higher steady-state income value. We test the robustness of our results by estimating equation (4) without investment per capita (Table 7, Appendix). This omission significantly affects the value of the autoregressive term which falls to around 0.25 and the value of the spatial lag coefficient which increases from 0.37 (Table 4) to around 0.8. However, beyond the change in value of these coefficients (due to the omission of a key variable, investment per capita), the main results with regard to the impact of structural funds are not affected. Total structural fund commitments don't significantly affect European regional growth, whereas funds allocated in Objective 1 programmes do. We can mention, however, that the coefficient associated with Objective 1 funds rises slightly following the omission of the investment per capita.

6 Conclusion

The aim of this paper is to empirically investigate the impact of Cohesion Policy on European regional convergence. Using a dynamic panel dataset of 143 regions over the period 1980-2005, including information from before application of the policy, we extend the current literature by considering spatial dependencies and impact analysis together within a spatial dynamic panel specification. The broadness of our datasets enables such

---

[4]This effect is also significant in a specification without the variable measuring the structural funds allocated for Objective 1 program

consideration.

Within the framework of a spatial dynamic panel specification, we find empirical evidence that the Cohesion Policy fosters the endogenous development of Objective1 regions in Europe. Moreover, our results confirm that the Cohesion Policy, that aims at counterbalancing the effects of GDP concentration over the richest regions, attains this objective. Our results suggest that Objective 1 programmes have a direct effect on regional GDP p.c. growth rates, whereas total structural funds do not. We interpret this result as an Objective 1 programmes added-value, compared to total structural funds. However, these results do not mean that the non-Objective 1 structural funds have no impact on overall growth in the EU (e.g. through a technology diffusion effect) but they do not allow additional growth specifically in these regions, when we consider the spatial dependences. This framework could be extended to take into account the potential diffusion effects implied by a structural change induced by structural funds expenditure in the more advanced regions.

Such insights confirm that the bottom-up design of projects, along with the involvement of regional, national and EU actors in the design, implementation and evaluation of the programmes, has the capacity of fostering the endogenous development potential of the lagging regions of Europe. As such, it may not be very important to concentrate on the specific drivers in each region in an overall convergence analysis. But much remains to be explored concerning this system of governance, both about its impact on the allocation of structural funds and about its influence on policy effectiveness.

Analysing the spatial dimension of the panel data, we find that regional spillovers do have an impact on regional development. The Cohesion Policy counterbalances the negative effect on regional development that occurs when the richest regions concentrate income and activities on themselves. It is however our opinion that improving regional spillovers can contribute to foster the endogenous development of regional clusters, as has been demonstrated with Interregional Cooperation Programmes (Interreg). The last

point stresses that the Cohesion Policy is implemented along with other EU policies (like agricultural policies, industrial regulations) that can favour or hamper the effects of this policy. Extending our analysis towards national redistributive effects, national pensioning strategies and regional clustering can help to design more efficient policies toward regional development. Moreover, it would be interesting to use this type of model (SDPD) to simulate the diffusion effects due to structural policy in Europe. This study may be considered a first step in estimating the equation that determines steady state income and in simulating the effect of an increase of this steady state (as a shock due to structural funds expenditure) on neighbouring outcomes. However, this proposition requires taking into account the impact of this shock on regional and national behaviour respectively (e.g. in public investment) in order to not rely on too restrictive assumptions (such as the assumption that the shocks are proportional to the amount of funds allocated to regions).

Acknowledgements

References

ABREU, M., H.L.F. DE GROOT & FLORAX, R. J. G. M. (2005) Space and Growth : a Survey of Empirical Evidence and Methods. Region et Développement, 21, 13-44.

ANDERSON, T.W. & HSIAO, C. (1982) Formulation and estimation of dynamic models using panel data, Journal of Econometrics, 18, 47-82.

ANSELIN, L. (2001) Spatial Econometrics. IN BALTAGI, B. H. (Ed.) Theoretical Econometrics. Blackwell Publishing.

ANSELIN, L. (2002) Under the hood issues in the specification and interpolation of spatial regression models. Agricultural Economics, 27, 247-267.

ANSELIN, L., L. LE GALLO & JAYET, H. (2007) Spatial panel econometrics. IN MATYAS, L. & SEVESTRE, P. (Eds.) The Econometrics of Panel Data Fundamentals and Recents Developments in Theory and Practice. Springer Berlin Heidelberg.

ARBIA, G., LE GALLO, J. & PIRAS, G. (2008) Does evidence on regional economic convergence depend on the estimation strategy ? Outcomes from analysis of a set of NUTS2 regions. Spatial Economic Analysis, 3, 209-224.

ARELLANO, M. & BOND, S. (1991) Some tests of specification for panel data : Monte Carlo evidence and an application to employment equations. Review of Economic Studies, 58, 277-297.

ARELLANO, M. & BOVER, O. (1995) Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, 68, 29-51.

ASCHAUER, D.A. (1989) Is public infrastructure productive ? Journal of Monetary Economics, 23(2), 177-200.

BADINGER, H., MÜLLER, W. G. & TONDL, G. (2004) Regional convergence in the European Union, 1985-99 : a spatial dynamic panel analysis. Regional Studies, 38, 541-253.

BAJO-RUBIO, O. (2000) A further generalization of the Solow growth model : the role of the public sector. Economic Letters, 68(1), 79-84.

BALTAGI, B.H. & LIU, L. (2008) Testing for random effects and spatial lag dependence in panel data models, Statistics and Probability Letters, 78, 3304-3306.

BALTAGI, B.H., SONG, S.H., JUNG, B.C. & KOH, W. (2007) Testing for serial correlation, spatial autocorrelation and random effects using panel data. Journal of Econometrics, 140(1), 5-51.

BALTAGI, B.H., SONG, S.H. & KOH, W. (2003) Testing panel data regression models with spatial error correlation. Journal of Econometrics, 117, 123-150.

BARRO, R.J. (1990) Government Spending in a Simple Model Of Endogenous Growth. Journal of Political Economy, 98(5), 103-126.

BARRO, R. J. & SALA-I-MARTIN, X. (1992) Convergence. Journal of Political Economy, 100, 407-443.

BECK, N., GLEDITSCH, K. S. & BEARDSLEY, K. (2006) Space Is More than Geography : Using Spatial Econometrics in the Study of Political Economy. International Studies Quarterly, 50, 27-44.

BECKER, S.O., EGGER, P.H. & VON EHRLICH, M. (2010) Going NUTS : The effect of EU structural funds on regional performance. Journal of Public Economics, In Press.

BLONIGEN, B. A., DAVIES, R. B., WADDELL, G. R. & NAUGHTON, H. T. (2007) FDI in space : Spatial autoregressive relationships in foreign direct investment. European Economic Review, 51, 1303-1325.

BLUNDELL, R. & BOND, S. (1998) Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87, 115-143.

BOND, S. (2002) Dynamic panel data models : a guide to micro data methods and practice. Portuguese Economic Journal, 1, 141-62.

BOUAYAD-AGHA, S. & VEDRINE, L. (2010) Estimations Strategies for a Spatial Dynamic Panel using GMM. A New approach to the Convergence Issue of European Regions. Spatial Economic Analysis, 5(2), 205-228.

CASELLI, F., ESQUIVEL, G. & LEFORT, F. (1996) Reopening the convergence debate : A new look at cross-country growth empirics. Journal of Economic Growth, 1, 363-389.

DALL'ERBA, S. & LE GALLO, J. (2008) Regional convergence and the impact of European structural funds 1989-1999 : A spatial econometric analysis. Papers in Regional Science, 82(2), 219-244.

DURLAUF, S., JOHNSON, P. & TEMPLE, J. (2006) Growth econometrics, Amsterdam, North Holland, P. Aghion and S. Durlauf (Eds), Handbook of Economic Growth.

EDERVEEN, S., DE GROOT, H. & NAHUIS, R. (2006) Fertile soil for structural funds ? A panel data analysis of the conditional effectiveness of European cohesion policy. Kyklos, 59, 17-42.

EGGER, P. & PFAFFERMAYR, M. (2006) Spatial convergence. Papers in Regional Science, 85(2), 200-215.

ELHORST, J. P. (2003) Specification and Estimation of Spatial Panel Data Models. International Regional Science Review, 26, 244-268.

ELHORST, J. P. (2005) Unconditional Maximum Likelihood Estimation of Linear and Log-Linear Dynamic Models for Spatial Panels. Geographical Analysis, 37, 85-106.

ERTUR, C. & KOCH, W. (2007) Growth, technological interdependence and spatial externalities : theory and evidence. Journal of Applied Econometrics, 22(6), 1033-1062.

ESPOSTI, R. & BUSSOLETTI, S. (2008) Impact of Objective1 funds on regional growth convergence in the European union : a panel-data approach. Regional Studies, 42, 159-173.

EUROPEAN COMMISSION (2004) Fourth report on economic and social cohesion. European commission, Directorate general for regional policy.

EUROPEAN COMMISSION (2008) Growing regions, growing Europe - Fifth progress report on economic and social cohesion - communication from the Commission to the European Parliament and the Council (COM (2008) 371). European commission, Direc-

torate general for regional policy.

FUEST, C. & HUBER, B. (2006) Can regional policy in a federation improve economic efficiency ? Journal of Public Economics, 90(3), 499-511.

GRAMLICH, E.M. (1994) Infrastructure Investment : A Review Essay. Journal of Economic Literature, 32(3), 1176-1196.

HAHN, J. & KUERSTEINER, G. (2002) Asymptotically Unbiased Inference for a Dynamic Panel Model with Fixed Effects when both n and T are large, Econometrica, 70, 1639-1657.

ISLAM, N. (1995) Growth Empirics : A Panel Data Approach. The Quarterly Journal of Economics, 110, 1127-1170. KELLER, W. (2002) Geographic localization of international technology diffusion. American Economic Review, 92, 120-142.

KORNIOTIS, G.M. (2010) Estimating Panel Models with Internal External Habit Formation. Journal of Business and Economic Statistics, 28(1), 145-158.

KUKENOVA, M. & MONTEIRO, J. A. (2008) Spatial dynamic panel model and system GMM : a Monte-Carlo investigation. Munich personnal RePEc archive paper n°11569.

LEE, L.F & YU, J. (2010a) A Spatial Dynamic Panel Data Model with Both Time and Individual Fixed Effects, Econometric Theory, 26(2), 564-597.

LEE, L.F & YU, J. (2010b) Estimation of Unit Root Spatial Dynamic Panel Data Models, Econometric Theory, forthcoming.

LOPEZ-BAZO, E., VAYA, E. & ARTIS, M. (2004) Regional Externalities and Growth. Journal of Regional Science, 44(1), 43-73.

LUCAS, R.E. (1988) On the mechanics of economic development. Journal of Monetary Economics, 22(1), 3-42.

MADRIAGA, N. & PONCET, S. (2007) FDI in Chinese Cities : Spillovers and Impact on Growth. The World Economy, 30, 837-862.

MARTIN, P. (1998) Can regional policies affect growth and geography in Europe ?

World Economy, 21(6), 757-774.

MARTIN, P. (1999) Public policies, regional inequalities and growth. Journal of Public Economics, 73(1), 85-105.

MOHL, P. & HAGEN, T. (2010) Do EU structural funds promote regional growth ? New evidence from various panel data approaches. Regional Science and Urban Economics, forthcoming. OECD (2006) The new rural paradigm : policies and governance, Paris, OECD Publishing.

OKUI, R. (2009) The optimal choice of moments in dynamic panel data models. Journal of Econometrics, 151, 1-16.

PIRAS, G. & ARBIA, G. (2007) Convergence in per-capita GDP across EU NUTS2 regions using panel data models extended to spatial autocorrelation effects. Statistica, forthcoming.

RODRIGUEZ-POSE, A. & FRATESI, U. (2004) Between development and social policies : the impact of European structural funds in Objective 1 regions. Regional Studies, 38(1), 97-113.

ROMER, P. (1986) Increasing returns and long run growth. Journal of Political Economy, 95(5), 1002-1037.

ROODMAN, D. (2009) A note on the theme of too many instruments. Oxford Bulletin of Economic and Statistics, 71(1), 135-158.

SALA-I-MARTIN, X. (1997) I just ran two million regressions. American Economic Review, 87(2), 178-183.

SOLOW, R. M. (1956) A contribution to the theory of economic. The Quarterly Journal of Econometrics, 70, 65-94.

SWAN, T. W. (1956) ECONOMIC GROWTH and CAPITAL ACCUMULATION. The Economic Record, 32, 334-361.

YU, J., DE JONG, R. & LEE, L.F. (2008) Quasi-maximum likelihood estimators for spatial dynamic panel data with fixed effects when both n and T are large. Journal of

Econometrics, 146, 118-134.

YU, J. & LEE, L.F. (2009) Convergence : A spatial Dynamic Panel Data Approach, Working Paper.

CODE	NAME	O1	CODE	NAME	O1	CODE	NAME	O1
AT11	Burgenland	1995-2006	FI13	Itä-Suomi		ITE2	Umbria	
AT12	Niederösterreich		FI18	Etelä-Suomi		ITE3	Marche	
AT13	Wien		FI19	Länsi-Suomi		ITE4	Lazio	
AT21	Kärnten		FI1A	Pohjois-Suomi	1995-2006	ITF1	Abruzzo	1989-96
AT22	Steiermark		FR10	Île de France		ITF2	Molise	1989-2006
AT31	Oberösterreich		FR21	Champagne-Ardenne		ITF3	Campania	1989-2006
AT32	Salzburg		FR22	Picardie		ITF4	Puglia	1989-2006
AT33	Tirol		FR23	Haute-Normandie		ITF5	Basilicata	1989-2006
AT34	Vorarlberg		FR24	Centre		ITF6	Calabria	1989-2006
BE10	Région de Bruxelles-Capitale		FR25	Basse-Normandie		ITG1	Sicilia	1989-2006
BE21	Prov. Antwerpen		FR26	Bourgogne		ITG2	Sardegna	1989-2006
BE22	Prov. Limburg (B)		FR30	Nord - Pas-de-Calais	1994-2004	NL11	Groningen	
BE23	Prov. Oost-Vlaanderen		FR41	Lorraine		NL12	Friesland	
BE24	Prov. Vlaams Brabant		FR42	Alsace		NL13	Drenthe	
BE25	Prov. West-Vlaanderen		FR43	Franche-Comté		NL21	Overijssel	
BE31	Prov. Brabant Wallon		FR51	Pays de la Loire		NL22	Gelderland	
BE32	Prov. Hainaut	1989-2006	FR52	Bretagne		NL31	Utrecht	
BE33	Prov. Liège		FR53	Poitou-Charentes		NL32	Noord-Holland	
BE34	Prov. Luxembourg (B)		FR61	Aquitaine		NL33	Zuid-Holland	
BE35	Prov. Namur		FR62	Midi-Pyrénées		NL34	Zeeland	
DE1	Baden-Württemberg		FR63	Limousin		NL41	Noord-Brabant	
DE2	Bayern		FR71	Rhône-Alpes		NL42	Limburg (NL)	
DE5	Bremen		FR72	Auvergne		PT11	Norte	1989-2006
DE6	Hamburg		FR81	Languedoc-Roussillon		PT15	Algarve	1989-2006
DE7	Hessen		FR82	Provence-Alpes-Côte d'Azur		PT16	Centro (PT)	1989-2006
DE9	Niedersachsen		FR83	Corse	1989-2004	PT17	Lisboa	1989-2004
DEA	Nordrhein-Westfalen		GR11	Anatoliki Makedonia, Thraki	1989-2006	PT18	Alentejo	1989-2006
DEB	Rheinland-Pfalz		GR12	Kentriki Makedonia	1989-2006	SE01	Stockholm	
DEC	Saarland		GR13	Dytiki Makedonia	1989-2006	SE02	Östra Mellansverige	
DEF	Schleswig-Holstein		GR14	Thessalia	1989-2006	SE04	Sydsverige	
DK00	DENMARK		GR21	Ipeiros	1989-2006	SE06	Norra Mellansverige	
ES11	Galicia		GR22	Ionia Nisia	1989-2006	SE07	Mellersta Norrland	1995-2006
ES12	Principado de Asturias	1989-2006	GR23	Dytiki Ellada	1989-2006	SE08	Övre Norrland	1995-2006
ES13	Cantabria	1989-2006	GR24	Sterea Ellada	1989-2006	SE09	Småland med öarna	
ES21	País Vasco		GR25	Peloponnisos	1989-2006	SE0A	Västsverige	
ES22	Comunidad Foral de Navarra		GR30	Attiki	1989-2006	UKC	North East	
ES23	La Rioja		GR41	Voreio Aigaio	1989-2006	UKD	North West	1994-2006
ES24	Aragón		GR42	Notio Aigaio	1989-2006	UKE	Yorkshire and The Humber	2000-06
ES30	Comunidad de Madrid		GR43	Kriti	1989-2006	UKF	East Midlands	
ES41	Castilla y León	1989-2006	IE	Ireland	1989-2006	UKG	West Midlands	
ES42	Castilla-la Mancha	1989-2006	ITC1	Piemonte		UKH	Eastern	
ES43	Extremadura	1989-2006	ITC2	Valle d'Aosta/Vallée d'Aoste		UKI	London	
ES51	Cataluña		ITC3	Liguria		UKJ	South East	
ES52	Comunidad Valenciana	1989-2006	ITC4	Lombardia		UKK	South West	2000-06
ES53	Illes Balears		ITD3	Veneto		UKL	Wales	2000-06
ES61	Andalucía	1989-2006	ITD4	Friuli-Venezia Giulia		UKM	Scotland	1994-2006
ES62	Región de Murcia	1989-2006	ITD5	Emilia-Romagna		UKN	Northern Ireland	1989-2006
ES70	Canarias (ES)	1989-2006	ITE1	Toscana				

TAB. 5: Sample selection

	GMM-DIFF			GMM-DIFF		
	Full lag instruments	Second lag instruments only	Collapsed instruments	Full lag instruments	Second lag instruments only	Collapsed instruments
$ln(\frac{Y_{i,t-1}}{pop_{i,t-1}})$	0.789***	0.816***	0.815***	0.790***	0.820***	0.819***
	(0.11)	(0.11)	(0.11)	(0.10)	(0.10)	(0.10)
$ln(\frac{I_{i,t}}{pop_{i,t}})$	0.339***	0.318***	0.318***	0.277***	0.233***	0.233***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
$ln(\frac{pop_{i,t}}{pop_{i,t-1}})$	-0.000	-0.001	-0.001	-0.003	-0.004	-0.004
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
$ln(\frac{SF_{i,t}}{pop_{i,t}})$	-0.026***	-0.025***	-0.025***	-0.019**	-0.016*	-0.016*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$OBJ1$	0.144***	0.136***	0.136***	-0.149	-0.213	-0.215
	(0.04)	(0.04)	(0.04)	(0.12)	(0.12)	(0.12)
$OBJ1.ln(\frac{SF_{i,t}}{pop_{i,t}})$				0.046**	0.054**	0.054**
				(0.02)	(0.02)	(0.02)
Observations nb.	429	429	429	429	429	429
AR(2)	-1.796	-1.684	-1.685	-0.032	0.308	0.320
(AR(2) p.value)	(0.073)	(0.092)	(0.092)	(0.974)	(0.758)	(0.749)
Hansen J	5.649	3.417	3.530	4.470	0.143	0.157
(Hansen J p.value)	(0.059)	(0.065)	(0.060)	(0.107)	(0.705)	(0.692)
Hansen-Diff J	35.32	42.93	20.14	35.95	41.80	36.09
(Hansen-Diff J p.value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Instruments nb.	7	6	6	8	7	7

TAB. 6: Estimation of Structural Funds direct effect with a standard dynamic panel

	S-GMM-DIFF		
	Full lag instruments	Second lag instruments only	Collapsed instruments
$ln(\frac{Y_{i,t-1}}{pop_{i,t-1}})$	0.156	0.249**	0.265*
	(0.11)	(0.13)	(0.15)
$\sum_{i\neq j} w_{ij}.ln(\frac{Y_{i,t}}{pop_{i,t}})$	0.840***	0.759***	0.739***
	(0.10)	(0.10)	(0.12)
$ln(\frac{pop_{i,t}}{pop_{i,t-1}})$	-0.002	-0.003	-0.003
	(0.00)	(0.00)	(0.00)
$ln(\frac{SF_{i,t}}{pop_{i,t}})$	-0.001	-0.001	-0.001
	(0.00)	(0.00)	(0.00)
$OBJ1$	-0.145*	-0.153*	-0.168**
	(0.01)	(0.01)	(0.01)
$OBJ1.ln(\frac{SF_{i,t}}{pop_{i,t}})$	0.027*	0.029**	0.032**
	(0.01)	(0.01)	(0.01)
Observations nb.	429	429	429
AR(2)	0.444	0.244	0.206
(AR(2) p.value)	(0.657)	(0.808)	(0.837)
Hansen J	7.015	4.330	3.385
(Hansen J p.value)	(0.535)	(0.363)	(0.496)
Hansen-Diff J	12.05	14.15	5.65
(Hansen-Diff J p.value)	(0.210)	(0.117)	(0.227)
Instruments nb.	14	10	10

TAB. 7: Estimation of equation (4) without investment p.c.

TEPP Working Papers

10-1. Are young French jobseekers of ethnic immigrant origin discriminated against? A controlled experiment in the Paris area

Emmanuel Duguet, Noam Leandri, Yannick L'Horty, Pascale Petit

10-2. Couple's Work Hours, Satisfaction and reconciling Work and family Life

Nathalie Georges, Dominique Méda, Danièle Trancart

10-3. Housing ownership, social housing and unemployment: an econometric analysis of the Paris area

Emmanuel Duguet, Yannick L'Horty, Florent Sari

10-4. Do Public Subsidies Have an Impact on New Firm Survival? An Empirical Study with French Data

Lionel Désiage, Richard Duhautois, Dominique Redor

10-5. The effect of social security payroll tax reductions on employment and wages: an evaluation of the 2003 French reform

Matthieu Bunel, Fabrice Gilles, Yannick L'Horty

10-6. What are Entrepreneurs' Objectives When Starting a New Business?

Lionel Désiage

10-7. Health and Early Retirement: Evidence from French Data for individuals

Thomas Barnay, Karine Briard

10-8. Ageing, chronic conditions and the evolution of future drugs expenditures

Thomas Barnay, Sophie Thiébaut, Bruno Ventelou

10-9. Entrepreneurial motives and performance: Why might better educated entrepreneurs be less successful?

Arnab Bhattacharjee, Jean Bonnet, Nicolas Le Pape, Régis Renault

10-10. Returns to firm-provided training in France: Evidence on mobility and wages

Arnaud Chéron, Bénédicte Rouland, François-Charles Wolff

10-11. Taxation of early retirement windows and delaying retirement: the French experience

Pierre-Jean Messe

10-12. Pre Entry Motives into Entrepreneurship and Post Entry Entrepreneurial Orientation

Jean Bonnet, Nicolas Le Pape

10-13. Hiring Practices, Employment Protection and Temporary Jobs

Anne Bucher

10-14. Young-in Old-out: a new evaluation

Michela Bia, Pierre-Jean Messe, Roberto Leombruni

10-15. On the impact of the TFP growth on the employment rate: does training on-the-job matter?

Eva Moreno-Galbis

10-16. The dynamics of youth labor market integration

Anne Bucher

10-17. Fostering the potential endogenous development of European regions: a spatial dynamic panel data analysis of the Cohesion Policy on regional convergence over the period 1980-2005

Salima Bouayad-Agha, Nadine Turpin, Lionel Védrine

10-18. Cost-saving or Cost-enhancing Mergers: the Impact of the Distribution of Roles in Oligopoly

Nicolas Le Pape, Kai Zhao

10-19. Bankruptcy Risk, Product Market Competition and Horizontal Mergers

Bernard Franck, Nicolas Le Pape

10-20. Endogenous Job Destructions and the Distribution of Wages

Arnaud Chéron, Bénédicte Rouland

10-21. Employment Protection Legislation and Adverse Selection at the Labor Market Entry

Anne Bucher, Sébastien Ménard

The TEPP Institute

The CNRS **Institute for Labor Studies and Public Policies** (the TEPP Institute, FR n°3126 CNRS) gathers together research centres specializing in economics and sociology:

- the **Centre d'Etudes de l'Emploi** (Centre for Employment Studies), **CEE**, Public Administrative Organization, under the leadership of the Ministers of Work and Research

- l'**Equipe de Recherche sur les Marchés, l'Emploi et la Simulation** (Research Team on Markets, Employment and Simulation), **ERMES**, University of Paris II Panthéon-Assas

- the **Centre d'Etudes des Politiques Economiques de l'université d'Evry** (Research Centre focused on the analysis of economic policy and its foundations and implications), **EPEE**, University of Evry Val d'Essonne

- the **Centre Pierre Naville** (Research on Work and Urban Policies), **CPN**, University of Evry Val d'Essonne

- l'**Equipe de Recherche sur l'Utilisation des Données Temporelles en Economie** (Research Team on Use of Time Data in Economics), **ERUDITE**, University of Paris-Est Créteil and University of Paris-Est Marne-la-Vallée

- the **Groupe d'Analyse des Itinéraires et des Niveaux Salariaux** (The Group on Analysis of Wage Levels and Trajectories), **GAINS**, University of the Maine

The TEPP Institute brings together 115 researchers and research professors, 140 PhD students and 40 associate researchers who study changes in work and employment in relation to the choices made by firms and analyse public policies using new evaluation methods.

www.tepp.eu