The Cohesion vs Growth Tradeoff: Evidence from EU Regions (1980-2000)

Matthieu Crozet* Pamina Koenig†

May 12, 2005

Very preliminary draft

Abstract

This paper provides an empirical investigation of the cohesion versus growth tradeoff on European regions at a fine geographical disaggregation level. We use data on gdp per capita at the NUTS3 level for 1980-2000 to estimate the influence of income dispersion within NUTS1 on their economic growth. There is strong evidence that greater spatial disparities foster growth, at least for Northern regions. Finally, an increase in market potential, as expected, has an unambiguous positive impact on local growth.

Keywords: regional inequalities, agglomeration, growth, European regions.
JEL Classification: R11.

*TEAM University of Paris I, 106 bd de l'Hopital, 75647 Paris Cedex 13, France. Email: crozet@univ-paris1.fr
†CREST and University of Paris I, J360, 15 bd Gabriel Peri, 92245 Malakoff Cedex, France. Email: pks@ensae.fr

1 Introduction

A long tradition of development economics has shown that growth processes were closely associated with spatial agglomeration dynamics (Perroux, 1955; Myrdal, 1957; Hirschman, 1958). The recent theoretical literature integrating new growth theory and new economic geography (Walz, 1996; Martin and Ottaviano, 1999, 2001; Baldwin and Forslid, 2000; Baldwin and Martin, 2004; Baldwin, Martin and Ottaviano, 2001) provides a clear description of this tradeoff faced by policymakers between growth at the aggregate country level and convergence in the development of regions. On the one hand, policies favoring growth at the country level can also trigger agglomeration of industrial activities and hence an unequal development of regions. On the other hand, it can be shown that inequality can be source of more growth, when technological externalities are localized. Martin and Ottaviano (2001) show that the trade integration-driven agglomeration lowers the cost of innovation in one region and thus favors innovation and growth. However, in the presence of congestion costs, more inequality does not always foster more efficiency, hence this relation may not be monotone.

In this paper, we propose to shed light on the existence of a cohesion versus growth tradeoff at the level of European regions. We investigate the determinants of gdp per capita growth between 1980 and 2000 of large European regions pertaining to 15 countries. We analyze to what extent the degree of inequality inside these regions is an important determinant of that period's growth.

The existing literature on the relation between spatial inequality and growth encompasses different approaches to the issue, and the majority of them underline a positive relation between the two elements. At a broad geographical level, economic historians and development economists highlight a visible strong positive relationship at the country level between growth and the spatial distribution of economic activities (Bairoch, 1985). At a European scale, Quah (1996) provides evidence of a negative relation between country level growth and convergence of regional gdp per capita. Analyzing six European countries, Sbergami (2002), however, finds that dispersion of economic activities among regions favors growth at the national level. A related strand of literature analyses the determinants of local factor prices, growth and productivity, and estimates the relevance of different elements in explaining the level of factors' rewards, among which the influence of market forces, as originally exposed in the new economic geography literature. Audretsch and Feldman (1996, 1999), Combes (2000) and Gao (2004) show that the spatial structure of the economy influences local growth. Ciccone and Hall (1996), on US data, investigates the determinants of productivity at the State level. Results show a positive effect of employment density at the county level on productivity at the State level. Ciccone (2002) estimates the effect of agglomeration on productivity on European regional data, and finds a similar effect to the one found on US data. Hanson (1998) and Redding and Venables (2004) are two papers whose approach is closely linked to the *wage equation* defining factor price, and typical to the new economic geography models. Both paper estimate the effect of access to markets, also known as market potential, on factor prices.

This paper analyzes the existence of a "cohesion versus growth" tradeoff using Redding and Venables' (2004) approach. From a simple new economic geography model in which we add a technological externality in order to allow for local growth, we derive an estimable equation linking the level of factor prices in a region to the level of inequalities inside that region, as well as the region's access to markets. To avoid complications due to the existence of MAUP, we estimate the factor price equation in first difference. Our results show a positive relation between the gdp per capita growth rate of a region and the change in the level of inequalities inside the region. To our knowledge, this is the first paper to investigate the existence of the cohesion versus growth tradeoff at a fine regional disaggregated level.

The paper is structured as follows. Section (2) exposes the theoretical setting from which we obtain our estimable equation. In section (3), we provide some empirical facts illustrating the relation between the degree of internal inequality of European regions and their growth rate. Section (4) contains the estimations, and section (5) concludes.

2 Theory

The theoretical setting is built on two elements. First, we describe the economy using a standard trade and geography model in which R regions trade a manufactured and an agricultural good. This allows to define factor prices in a region as a function of the region's access to other markets. Second, we link the level of factor prices in a region to the intra-regional level of inequalities, by implicitly depicting each region as being divided into two locations. The marginal cost of production of region r is then described as a function of the level of internal inequalities. The rest of the section details the theoretical framework.

The economy consists of R regions. Each of them produces differentiated varieties of a manufactured good, under a Spence-Dixit-Stiglitz monopolistic competition market structure. Every consumer has the same utility function, that exhibits love for variety :

$$U = \left(\sum_{i=1}^{N} c_i^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}, \quad (1)$$

where c_i is consumption of variety i, N is the total number of available varieties in the economy, and $\sigma > 1$ the constant elasticity of substitution between varieties.

Each variety is produced by a single firm that operates under increasing returns to scale. In order to produce one variety of the manufactured good, a firm uses the composite factor of production L both in the fixed and variable cost. Noting w_r the factor remuneration in region r, the total cost of production for a firm i in region r is:

$$CT_{i(r)} = w_r \left[\beta_r x_{i(r)} + \alpha \right] \quad (2)$$

where $x_{i(r)}$ is the quantity produced by firm i in region r, α the fixed cost and β_r the marginal production cost.

As shown in equation (2), besides factor remuneration, marginal requirement in the composite factor may differ between regions. Let us implicitly characterize each region as containing several locations. We then make the assumption that urban agglomeration of factors and skills in one of the region's locations fosters aggregate regional productivity through technological spillovers. Hence, the marginal production cost in region r, β_r, is a decreasing function of spatial inequality within region r:

$$\beta_r = (ineq_r)^{-\theta} \qquad \theta > 0. \quad (3)$$

Profit maximisation leads to the well-known mark-up equation:

$$p_{i(r)} = p_r = \beta_r \frac{\sigma}{\sigma - 1}. \quad (4)$$

Moreover, free entry leads to zero profits in equilibrium, i.e., the quantity produced by each firm in region r is:

$$q_r^* = \frac{\alpha(\sigma - 1)}{\beta_r}. \quad (5)$$

We note τ_{rs} the bilateral iceberg trade cost between regions r and s, and we assume that trade costs increase with the geographic distance between two regions: $\tau_{rs} = d_{rs}^{\delta} \;\; \delta > 0$.

Using (1) and noting E_s expenditure in region s, we derive total demand for a variety i

produced in region r:

$$x_{i(r)} = p_r^{-\sigma} \sum_{s=1}^{R} \frac{E_s \tau_{rs}^{1-\sigma}}{\sum_k^R n_k (p_k \tau_{rk})^{1-\sigma}}. \tag{6}$$

Using (4) and (5), the market clearing condition for a variety produced in region r writes:

$$x_{i(r)} = q_r^* \;\Rightarrow\; w_r = \frac{\sigma - 1}{\sigma} \left(\sum_{s=1}^{R} \frac{E_s \tau_{rs}^{1-\sigma}}{\sum_k^R n_k (p_k \tau_{rk})^{1-\sigma}} \right)^{1/\sigma} \beta_r^{\frac{1-\sigma}{\sigma}}. \tag{7}$$

Equation (7) is referred to in Fujita et al. (1999) as the *wage equation*, and is typical to new economic geography models. It gives the equilibrium factor price in a region as a function of the region's access to other markets. This access to markets, given by the expression in brackets, is known in the literature (Fujita et al, 1999, Head and Mayer, 2004) as the *market potential* of a region. It represents the sum of expenditures in all markets weighted by the distance to each market and by the degree of competition in each market. Hanson (1998) and Redding and Venables (2004), using different methodology and data, provide evidence of the empirical relevance of this relation.

The difference here lies in the presence of the marginal cost term β_r. In equation (7), factor remuneration in region r is now a decreasing function of β_r. Knowing that β_r decreases with intra-regional agglomeration, we derive a tractable reduced form from equation (7), which relates factor prices in a region to the regional market potential and to the intra-regional level of inequalities. In the following, MP_r is the market potential of region r and $ineq_r$ the level of intra-regional spatial inequality.

$$\ln(y_r) = \gamma_0 + \gamma_1 \ln(MP_r) + \gamma_2 \ln(ineq_r). \tag{8}$$

Introducing time subscripts, we can obtain the following estimable equation, written in first differences:

$$\ln\left(\frac{y_{r,t}}{y_{r,t-1}}\right) = \gamma_0 + \gamma_1 \ln\left(\frac{MP_{r,t}}{MP_{r,t-1}}\right) + \gamma_2 \ln\left(\frac{ineq_{r,t}}{ineq_{r,t-1}}\right). \tag{9}$$

The growth of the gdp per capita in a region depends on the change of the region's access to markets and on the variation of the intra-regional level of inequalities. This equation represents the cohesion versus growth tradeoff: the widening of intra-regional spatial disparities should have a positive impact on the growth of gdp per capita at the regional level.

3 Data overview

We investigate the relation between gdp per capita growth and the degree of inequality within European regions, considered at the NUTS1 level[1]. The level of geographical disaggregation at which we are able to work imposes some restrictions on the number of regions kept in our empirical analysis. Indeed, intra-regional inequality is computed as the dispersion in gdp per capita between the NUTS3 composing a NUTS1. We thus restrict our analysis to NUTS1 regions that contain at least two NUTS3.

The market potential in equation (7) is approximated by the distance weighted sum of gdp proposed by Harris (1954). To avoid endogeneity problems, the market potential of region r is computed as the weighted sum of all EU-15 NUTS1 regions gdp, but itself:

$$MP_{r,t} = \sum_{s \neq r} \frac{GDP_{s,t}}{d_{rs}}.$$

Distances d_{rs} are the road distances between the two capital cities of regions r and s. They are computed from an electronic road atlas[2].

We consider two measures of spatial inequality, which are both widely used in the analysis of regional disparities: standard dispersion and the Theil inequality index. In the following, $z_{i(r)}$ is the gdp per capita of a NUTS3 i pertaining to NUTS1 r and $\overline{z}_r$ the average NUTS3 gdp per capita in NUTS1 r.

$$sdev_{r,t} = \sqrt{\sum (\ln z_{i(r),t} - \ln \overline{z}_{r,t})^2}, \tag{10}$$

$$Theil_{r,t} = \sum \frac{z_{i(r),t}}{\overline{z}_{r,t}} \ln \left(\frac{z_{i(r),t}}{\overline{z}_{r,t}} \right). \tag{11}$$

Regional data are available from Eurostat. The *Regio* database collects economic data at the regional level for all EU members. We use gdp and population data to compute gdp per capita for NUTS1 and NUTS3 regions. NUTS3 is a relatively low level of geographical disaggregation, thus statistical information is scarce, even for simple data such as gdp per capita. For the 1995-2000 period, we have 67 NUTS1 regions over 15 countries[3]. For the 1980-2000 period, data is

[1]NUTS (*nomenclature of territorial units for statistics*) is a nomenclature providing a hierarchical structure of sub-national regions covering all European territory. Eurostat first subdivides the EU-15 area into 78 NUTS1 (corresponding for instance to German Landers). Each NUTS1, if applicable, contains several NUTS 2, which are again divided into NUTS3.

[2]These data are available from the authors on request.

[3]These 67 NUTS1 regions represent 1075 NUTS3 regions. Hence, there are, within each NUTS1, about 16

available only 34 NUTS1 regions belonging to 6 countries (Belgium, Germany, Spain, France, Greece, Italy and the Netherlands - Cf. data appendix). NUTS3 data is unavailable for Italy for 1980-1995. We thus use Italian NUTS2 data to compute regional inequality indexes during this period[4].

Working with spatial inequality indices such as *sdev* and *Theil* and comparing them among a large set of regions raises the standard problem known in the literature as MAUP (Modifiable Areal Unit Problem). Indeed, regional inequality indices are sensitive to the number of regional subdivisions and to their relative size. The partition of the NUTS1 regions results from an exogenously political and historical process. Hence, the inequality indices do not provide an optimal comparison tool to be used in empirical analysis. To bypass this difficulty, we estimate equation (9), which is written in first differences. Regional characteristics as thus eliminated from the estimation, which should smooth the MAUP.

Figure (1) displays the mean values of our two measures of intra-regional inequality. They are computed on the sample of 34 NUTS1 regions for which data is available for the period 1980-2000 (comparable values of average inequality for the whole sample of 67 regions and the 1995-2000 period can be found in appendix, Table 6). The standard deviations and the Theil indexes are obviously highly correlated. Both measures show a similar pattern of evolution between 1980 and 2000: the global trend appears to be slightly increasing. The mean level of gdp per capita dispersion first decreases until 1987. From 1987 to 1996, we observe a steady increase of inequalities within EU NUTS1 regions, but since 1996 the increase in disparities has slow down. Our measures of spatial inequality confirm the well documented literature on EU regional cohesion[5].

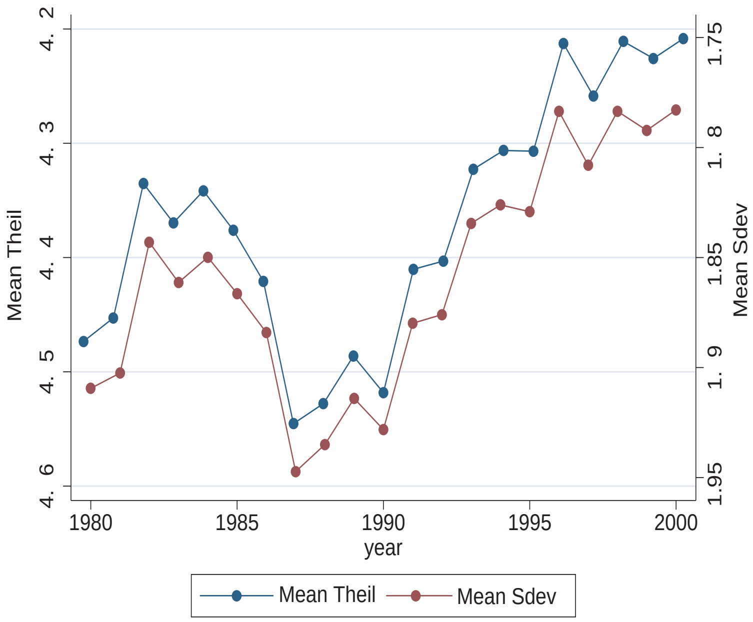
The two following figures illustrate the relation between the growth in gdp per capita among the NUTS1 regions and the level of intra-regional disparities. Figure (2) reports data for 34 NUTS1 from 1980 to 2000, while Figure (3) displays 1995 and 2000 data for 67 NUTS1 regions. Overall, the relation appears positive: more inequalities inside a region is correlated with a larger gdp per capita. However, for some Italian regions as well as for all Spanish, Portuguese and Greek regions, the level of gdp per capita for a given level of inequality is lower than for the rest of the sample. More, the figures show for these peripheral regions an inverted relationship:

NUTS3 from which we compute our measures of spatial income inequality. There are merely two NUTS1 that are subdivided into only two NUTS3: de5 (Bremen) and Fr3 (Nord Pas-de-Calais). In contrast, we have information on 96 NUTS3 that belong to Bayern.

[4] In the end, we use data for 581 NUTS3, that is an average of 18.7 NUTS3 regions for each NUTS1.

[5] See for instance European Commission's *Third report on economic and social cohesion*, 2004: "*Disparities in income and employment in the European Union have narrowed over the past decade*", p.2.

Figure 1: Mean intra-regional inequalities 1980-2000



the relation between intra-regional inequalities and regional income appears downwards sloping. From this stylized fact, we can infer that these regions follow a different path with respect to their internal level of disparities either because they are poorer, or because these are all southern regions. Empirical analysis will help disentangle both explanations.

4 Empirical results

We study two time periods. As growth and agglomeration are processes that evolve relatively slowly, we consider sufficiently long periods of time to avoid short term disturbances. On the one side, the period 1995-2000, on which we provide cross-sectional estimations results. On the other side, the period 1980-2000, on which we use panel estimations methods. 1980-2000 is subdivided into four four-year non-overlapping periods: 1980-1984, 1985-1989, 1990-1994, 1995-1999.

Working with intra-NUTS1 rather than intra-national inequality provides enough observations to perform cross-sectional estimations. However, the number of observations remains small. The empirical results are very sensitive to influential outliers. Consequently, we perform robust regressions rather than OLS.

Table (1) shows the basic regressions for the two samples separately. Following equation (9),

Figure 2: Regional GDP per capita and intra-regional inequality 1980-2000

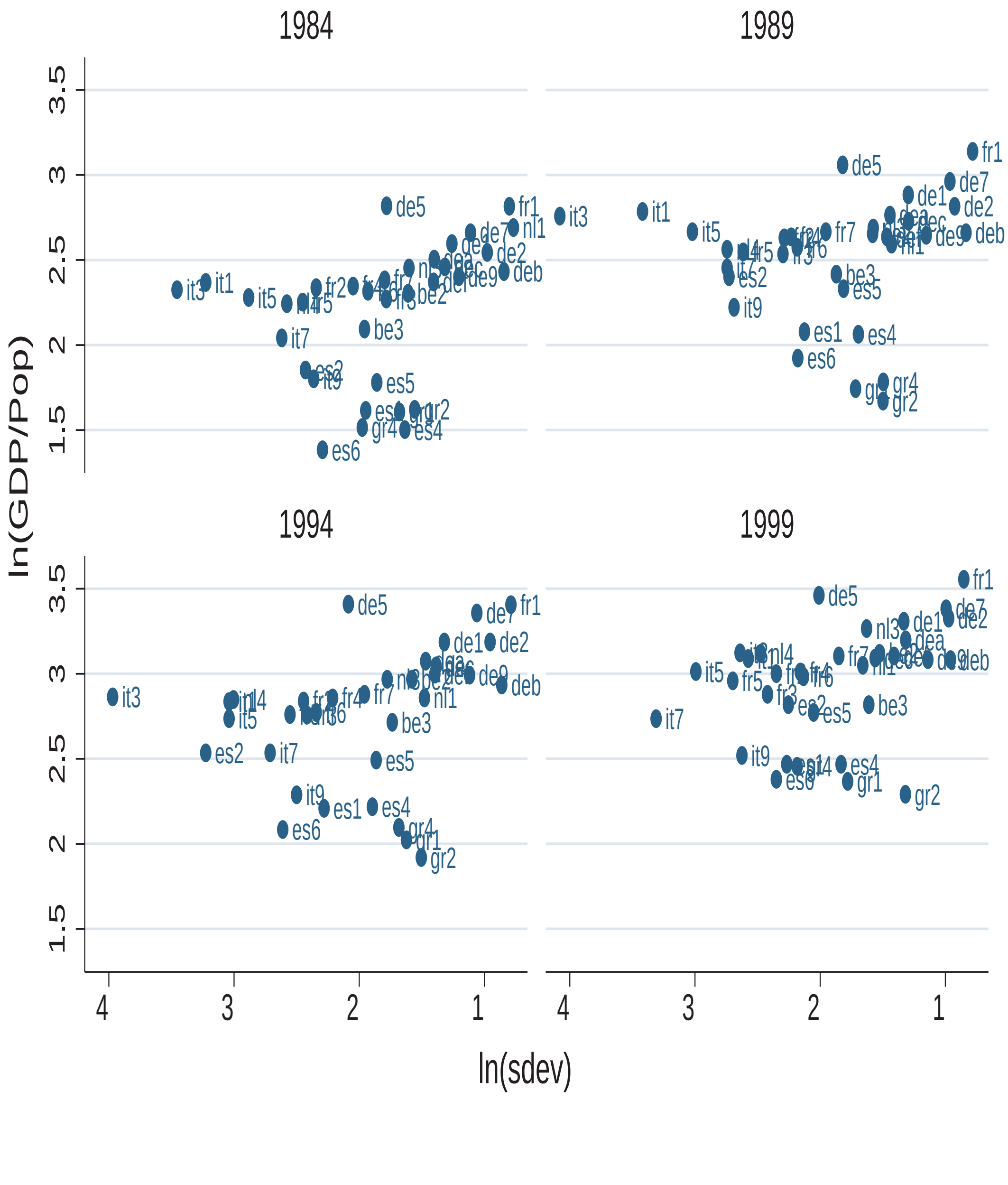
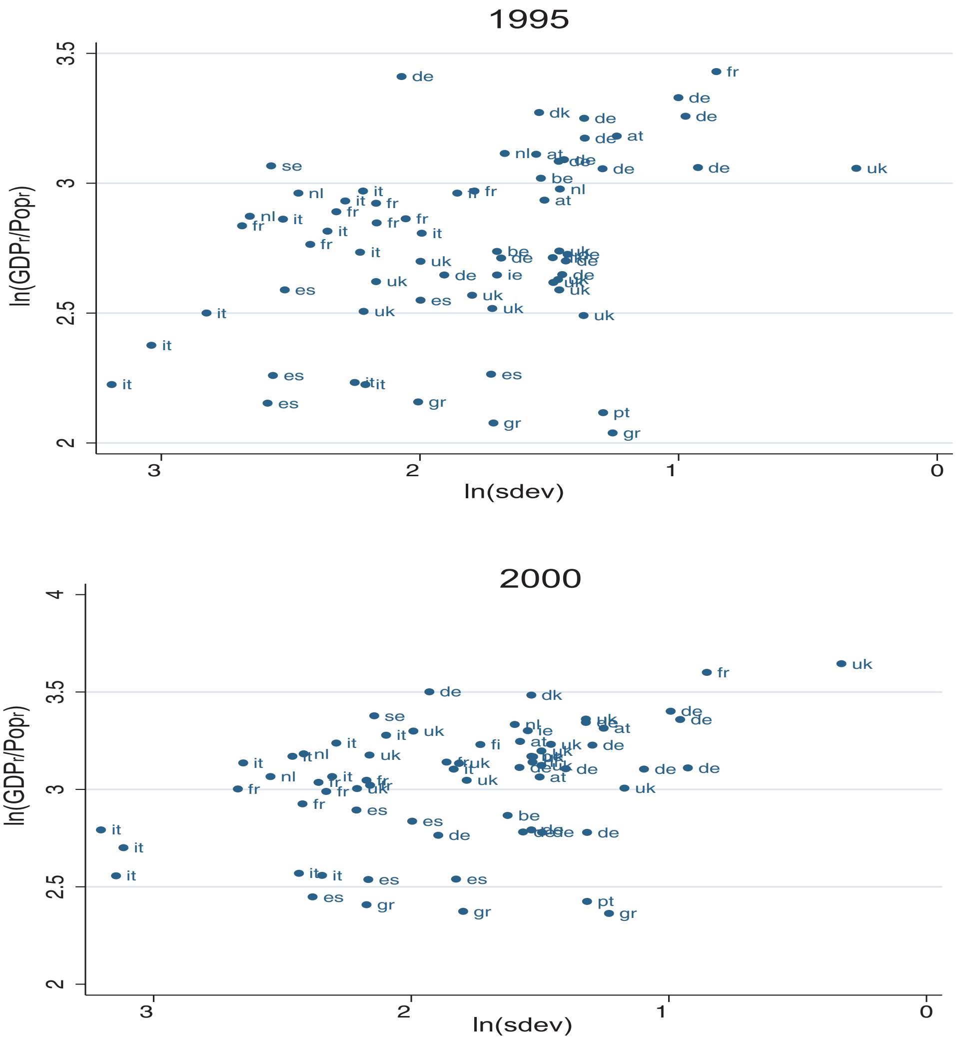


Figure 3: Regional GDP per capita and intra-regional inequality 1995-2000



explanatory variables are the growth rate of the region's market potential and the growth of intra-regional inequality. For the 1980-1999 sample, we use fixed effects by four-year sub-period. As suggested by Figures (2) and (3), three dummy variables are added to the regression: one for Greek regions, one for Spanish and Portuguese regions, and one for Southern Italy[6]. All estimations perform well in terms of their explicative power.

Market potential has a large impact on gdp per capita growth rate in both samples. Coefficients are highly significant and comprised between 2.3 and 2.8, thus much larger than corresponding coefficients found by Redding and Venables (2004) on country-level gdp. While Redding and Venables' access to markets variable is more sophisticated and thus can not directly be compared to ours, this difference in the value of coefficients suggests that access to markets is more influential at a small geographical scale than at a worldwide level.

Overall, Table (1) shows that growth in intra-regional spatial inequality influences positively regional economic performances. Coefficients on the two inequality indices $\ln(sdev_t/sdev_{t-1})$ and $\ln(Theil_t/Theil_{t-1})$ are positive and significant for both time periods.

The estimated coefficients are significantly larger for the restricted sample (1995-2000) than for the 1980-1999 period. For the 34 regions in the first sample, a 10% increase in the standard deviation index of gdp per capita within a NUTS1 leads on average to an increase in regional income of 0.5%. For the 1995-2000 sample, a 10% increase in the standard deviation index leads to a 1.6% increase in regional gdp per capita.

Figures (2) and (3) have highlighted the existence of a different behavior of some regions with respect to the cohesion versus growth tradeoff. Graphically, the diverging regions are all Southern and significantly poorer than the average European region. Tables (2) and (3) present separated estimates of the influence of intra-regional inequality on growth for Northern and Southern regions[7]. In both tables, the impact is non significative for Southern regions and positive and significant for Northern regions. Moreover, coefficients estimated for Northern regions are higher than those displayed in Table (1).

To investigate whether the different behavior of some regions is restricted to the remoteness of Mediterranean regions or due to a lower regional income, we estimate separated coefficients γ_2 for regions that differ by their initial income. Specifically, we distinguish between regions which initial gdp per capita is lower or higher than the median gdp per capita of the sample. As

[6] Lazio, Abruzzo-Molise, Campania, Sud, Sicilia, and Sardegna.

[7] The dummy *South* in Tables (2) and (3) takes the value 1 for Greek, Spanish, Portuguese and Southern Italian regions.

expected, the tradeoff is stronger for advanced regions. However, this income-based partition is less relevant than the spatial North-South division.

Finally, we consider the question whether the relation between spatial disparities and regional growth is non linear. Martin and Ottaviano (2001) emphasized that in the presence of congestion costs, more inequalities does not always foster more growth. Tables (4) and (5) display estimations of equation (9) in which we introduced the squared inequality variable. For 1995-2000, the coefficients on $\ln(sdev_t/sdev_{t-1})$ and $\ln(Theil_t/Theil_{t-1})$ remain positive, while the squared terms are negative, as expected. This comforts the intuition according to which there is an inverted-U relationship between spatial inequalities and growth. Then, as in Tables (2) and (3), we consider separately Northern and Southern regions. Results confirm the absence of significant influence of inequality for Southern regions. However, for Northern regions, results appear to show evidence of the existence of congestion costs. Alternatively, conclusions are different for 1980-1999. Both coefficients are non ambiguously non significant.

Table 1: Spatial inequality and growth

	Robust regressions Dependent Variable: NUTS1 GDPpc growth			
Model :	1980-1999 /4 years growth		1995-2000 / 5 years growth	
$\ln(MP_t/MP_{t-1})$	2.783***	2.775***	2.738***	2.749***
	(0.241)	(0.242)	(0.150)	(0.148)
$\ln(sdev_t/sdev_{t-1})$	0.051**		0.165**	
	(0.024)		(0.070)	
$\ln(theil_t/theil_{t-1})$		0.025**		0.076**
		(0.012)		(0.033)
intercept	-0.406***	-0.405***	-0.431***	-0.434***
	(0.048)	(0.048)	(0.039)	(0.038)
Greece	0.081***	0.080***	0.056	0.054
	(0.020)	(0.020)	(0.042)	(0.041)
Spain & Portugal	0.027*	0.027*	-0.013	-0.010
	(0.016)	(0.016)	(0.034)	(0.033)
South Italy	0.037	0.037	0.071**	0.068**
	(0.024)	(0.024)	(0.031)	(0.031)
Fixed Effects	years	years		
Nb. obs.	136	136	67	67
R^2	0.728	0.726	0.848	0.851
RMSE	0.065	0.065	0.07	0 .069

Note: Standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% level.

Table 2: Spatial inequality and growth - Who is concerned?

Model :	Robust regressions Dependent Variable: NUTS1 GDPpc growth 1980-1999 /4 years growth		1995-2000 / 5 years growth	
$\ln(MP_t/MP_{t-1})$	2.817***	2.810***	2.756***	2.730***
	(0.243)	(0.244)	(0.144)	(0.147)
$\ln(sdev_t/sdev_{t-1})$	0.005		0.023	
$*South$	(0.045)		(0.105)	
$\ln(sdev_t/sdev_{t-1})$	0.068**		0.302***	
$*North$	(0.029)		(0.086)	
$\ln(sdev_t/sdev_{t-1})$		0.026		0.098
$*(y_{t-1} < \overline{y}_{t-1})$		(0.035)		(0.087)
$\ln(sdev_t/sdev_{t-1})$		0.069**		0.288***
$*(y_{t-1} > \overline{y}_{t-1})$		(0.033)		(0.108)
intercept	-0.414***	-0.413***	-0.440***	-0.432***
	(0.049)	(0.049)	(0.037)	(0.038)
Greece	0.083***	0.082***	0.050	0.054
	(0.020)	(0.020)	(0.041)	(0.041)
Spain & Portugal	0.026	0.027	0.018	0.007
	(0.016)	(0.016)	(0.032)	(0.032)
South Italy	0.035	0.035	0.061**	0.067**
	(0.024)	(0.024)	(0.031)	(0.031)
Fixed Effects	years	years		
N	136	136	67	67
R^2	0.731	0.729	0.862	0.855
RMSE	0.065	0.066	0.067	0.068

Note: Standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% level.

5 Conclusion

While the relation between growth and spatial inequalities has been well documented by historian and development economics, the chapter on agglomeration and regional growth in the forthcoming Handbook of Urban and Regional Economics by Baldwin and Martin (2004) underline that *"There are however few direct empirical tests of the relation between agglomeration and growth"*. Following Redding and Venables (2004), in this paper we develop a simple trade and geography model in which regional income is impacted by access to markets. More, we introduce a tradeoff between growth and inequalities through an externality; intra-regional spatial inequalities affect local gdp per capita. We provide an empirical estimation of this tradeoff at

Table 3: Spatial inequality and growth - Who is concerned?

	Robust regressions Dependent Variable: NUTS1 GDPpc growth			
Model :	1980-1999 /4 years growth		1995-2000 / 5 years growth	
$\ln(MP_t/MP_{t-1})$	2.820***	2.814***	2.750***	2.725***
	(0.244)	(0.245)	(0.148)	(0.150)
$\ln(theil_t/theil_{t-1})$	0.003		0.008	
$*South$	(0.022)		(0.056)	
$\ln(theil_t/theil_{t-1})$	0.033**		0.131***	
$*North$	(0.014)		(0.040)	
$\ln(theil_t/theil_{t-1})$		0.012		0.045
$*(y_{t-1} < \overline{y}_{t-1})$		(0.017)		(0.043)
$\ln(theil_t/theil_{t-1})$		0.034**		0.122**
$*(y_{t-1} > \overline{y}_{t-1})$		(0.017)		(0.050)
intercept	-0.415***	-0.413***	-0.439***	-0.431***
	(0.049)	(0.049)	(0.038)	(0.039)
Greece	0.083***	0.081***	0.050	0.053
	(0.020)	(0.020)	(0.042)	(0.042)
Spain & Portugal	0.026	0.026	0.020	0.008
	(0.016)	(0.016)	(0.033)	(0.032)
South Italy	0.035	0.036	0.061**	0.066**
	(0.024)	(0.024)	(0.031)	(0.031)
Fixed Effects	years	years		
N	136	136	67	67
R^2	0.73	0.728	0.855	0.851
RMSE	0.065	0.066	0.069	0.07

Note: Standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% level.

a very fine geographical disaggregation level for 14 EU countries. We assess the positive influence of widening intra-regional disparities on local economic growth. More, we emphasized that Northern and Southern regions behave differently. Economic development in NUTS1 regions belonging to core EU members is much more influenced by an increase in spatial inequalities. Finally, there is mixed evidence on the linearity of the relation.

Table 4: Spatial inequality and growth - Is the relation non-linear?

Model :	Robust regressions Dependent Variable: NUTS1 GDPpc growth 1980-1999 /4 years growth		1995-2000 / 5 years growth	
$\ln(MP_t/MP_{t-1})$	2.779***	2.770***	2.752***	2.776***
	(0.243)	(0.251)	(0.149)	(0.147)
$\ln(sdev_t/sdev_{t-1})$	-0.006		0.277*	
	(0.068)		(0.159)	
$\ln \frac{sdev_t}{sdev_{t-1}} . \left\vert \ln \frac{sdev_t}{sdev_{t-1}} \right\vert$	0.096		-0.434	
	(0.123)		(0.531)	
$\ln(sdev_t/sdev_{t-1})$		0.065		0.002
$*South$		(0.132)		(0.310)
$\ln \frac{sdev_t}{sdev_{t-1}} . \left\vert \ln \frac{sdev_t}{sdev_{t-1}} \right\vert$		-0.128		0.068
$*South$		(0.274)		(0.964)
$\ln(sdev_t/sdev_{t-1})$		-0.011		0.708***
$*North$		(0.084)		(0.258)
$\ln \frac{sdev_t}{sdev_{t-1}} . \left\vert \ln \frac{sdev_t}{sdev_{t-1}} \right\vert$		0.140		-2.639*
$*North$		(0.143)		(1.373)
intercept	-0.407***	-0.408***	-0.434***	-0.444***
	(0.049)	(0.050)	(0.039)	(0.038)
Greece	0.086***	0.084***	0.059	0.048
	(0.020)	(0.021)	(0.042)	(0.043)
Spain & Portugal	0.025	0.030*	0.001	0.016
	(0.016)	(0.017)	(0.032)	(0.034)
South Italy	0.039	0.034	0.068**	0.060*
	(0.025)	(0.025)	(0.031)	(0.031)
Fixed Effects	years	years		
N	136	136	67	67
R^2	0.731	0.729	0.852	0.864
RMSE	0.066	0.066	0.069	0.068

Note: Standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% level.

Table 5: Spatial inequality and growth - Is the relation non-linear?

Model :	Robust regressions. Dependent Variable: NUTS1 GDPpc growth: 1980-1999 /4 years growth		1995-2000 / 5 years growth	
$\ln(MP_t/MP_{t-1})$	2.779***	2.763***	2.752***	2.747***
	(0.244)	(0.252)	(0.150)	(0.148)
$\ln(theil_t/theil_{t-1})$	-0.005		0.118	
	(0.032)		(0.075)	
$\ln \frac{theil_t}{theil_{t-1}} . \left\lvert \ln \frac{theil_t}{theil_{t-1}} \right\rvert$	0.026		-0.076	
	(0.028)		(0.116)	
$\ln(theil_t/theil_{t-1})$		0.034		-0.008
$*South$		(0.064)		(0.163)
$\ln \frac{theil_t}{theil_{t-1}} . \left\lvert \ln \frac{theil_t}{theil_{t-1}} \right\rvert$		-0.034		0.026
$*South$		(0.068)		(0.252)
$\ln(theil_t/theil_{t-1})$		-0.010		0.351***
$*North$		(0.040)		(0.118)
$\ln \frac{theil_t}{theil_{t-1}} . \left\lvert \ln \frac{theil_t}{theil_{t-1}} \right\rvert$		0.039		-0.635**
$*North$		(0.032)		(0.282)
intercept	-0.407***	-0.407***	-0.435***	-0.437***
	(0.049)	(0.050)	(0.039)	(0.039)
Greece	0.086***	0.086***	0.059	0.047
	(0.020)	(0.021)	(0.042)	(0.044)
Spain & Portugal	0.025	0.030*	0.000	0.018
	(0.016)	(0.017)	(0.031)	(0.034)
South Italy	0.039	0.035	0.068**	0.060*
	(0.025)	(0.025)	(0.031)	(0.031)
Fixed Effects	years	years		
N	136	136	67	67
R^2	0.73	0.73	0.851	0.861
RMSE	0.066	0.066	0.07	0.069

Note: Standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% level.

6 Data appendix

NUTS1 regions in the 1980-2000 sample:

Belgium: be2 (Flanders), be3 (Wallonie), **Germany:** de1 (Baden-wuerttenberg), de2 (Bayern), de5 (Bremen), de7 (Hessen), de9 (niedersachen), dea (nordrhein-westfalen), deb (Rheinland-pfalz), dec (saarland), def (schleswig-holstein), **Spain:** es1 (Nordoeste), es2 (Noreste), es4 (Centro), es5 (Este), **France:** fr1 (Ile-de-France), fr2 (Bassin Parisien), fr3 (Nord Pas-de-Calais), fr4 (Est), fr5 (Ouest), fr6 (Sud-Ouest), fr7 (Centre-Est), **Greece:** gr1 (Voreia Ellada), gr2 (Kentriki Ellada), gr4 (Nisia Aigaiou, Kriti), **Italy:** it1 (Nord Ovest), it3 (Nord Este), it5 (Centro), it7 (Abruzzo-Molise) , it9 (Sud), **The Netherlands:** nl1 (Noord-Nederland), nl3 (West-Nederland), nl4 (Zuid-Nederland).

NUTS1 regions in the 1995-2000 sample:

Austria: at1 (Ostterreich), at2 (Sorterreich), at3 (Westterreich), **Belgium:** be2 (Flanders), be3 (Wallonnie), **Germany:** de1 (Baden-wuerttenberg), de2 (Bayern), de4 (Brandenbourg), de5 (Bremen), de7 (Hessen), de8 (Mecklenburg-vorpommern), de9 (niedersachen), dea (nordrhein-westfalen), deb (Rheinland-pfalz), dec (saarland), ded (sachen), dee (sachen-anhalt), def (schleswig - holstein), deg (thueringen), **Danemark:** dk0 (Danemark), **Spain:** es1 (Nordoeste), es2 (Noreste), es4 (Centro), es5 (Este), es6 (Sur), **Finland:** fi1 (Manner-Suomi), **France:** fr1 (Ile-de-France), fr2 (Bassin Parisien), fr3 (Nord Pas-de-Calais), fr4 (Est), fr5 (Ouest), fr6 (Sud-Ouest), fr7 (Centre-Est), fr8 (Sud), **Greece:** gr1 (Voreia Ellada), gr2 (Kentriki Ellada), gr4 (Nisia Aigaiou, Kriti), **Ireland:** ie0 (Ireland), **Italy:** it1 (Nord Ovest), it2 (Lombardia), it3 (Nord Este), it4 (Emilia-Romagna), it5 (Centro), it6 (Lazio), it7 (Abruzzo-Molise), it8 (Campania), it9 (Sud), ita (Sicilia), itb (Sardegna), **The Netherlands:** nl1 (Noord-Nederland), nl2 (Oost-Nederland), nl3 (West-Nederland), nl4 (Zuid-Nederland), **Portugal:** pt1 (Continente), **Sweden:** se0 (Sweden), **United Kingdom:** ukc (North East), ukd (North West), uke (Yorkshire & Humber), ukf (East Midlands), ukg (West Midlands), ukh (Eastern), uki (London), ukj (South East), ukk (South West), ukl (Wales), ukm (Scotland), ukn (Northern Ireland).

7 References

Audretsch D. B. and M. P. Feldman, 1996, "R&D Spillovers and the Geography of Innovation and Production", *American Economic Review*, 86(): 630-640.

Audretsch D. B. and M. P. Feldman, 1999, "Innovation in Cities: Science-based Diversity, Specialization and Localized Competition", *European Economic Review*, 43: 409-429.

Table 6: Evolution of intra-regional inequality

	1980-2000 sample (32 NUTS1 regions)		1995-2000 sample (67 NUTS1 regions)	
Year	Standard dev.	Theil index	Standard dev.	Theil index
2000	0.1829	0.0258	0.1877	0.0264
1999	0.1796	0.0246	0.1847	0.0255
1998	0.1812	0.0248	0.1856	0.0259
1997	0.1794	0.0245	0.1835	0.0253
1996	0.1828	0.0253	0.1839	0.0255
1995	0.1798	0.0261	0.1842	0.0253
1994	0.1794	0.0250		
1993	0.1804	0.0253		
1992	0.1826	0.0257		
1991	0.1840	0.0260		
1990	0.1862	0.0262		
1989	0.1881	0.0269		
1988	0.1888	0.0275		
1987	0.1900	0.0278		
1986	0.1941	0.0292		
1985	0.1962	0.0302		
1984	0.1943	0.0297		
1983	0.1928	0.0289		
1982	0.1946	0.0289		
1981	0.1870	0.0276		
1980	0.1857	0.0271		

Bairoch P., 1985, *De Jerico Mexico, Villes et Economie dans l'histoire*, Gallimard, Collection Arcades, Paris.

Baldwin R. E. and R. Forslid, 2000, "The Core-Periphery Model and Endogenous Growth: Stabilizing and Destabilizing Integration", *Economica*, 67: 307-324.

Baldwin R. E. and P. Martin, 2004, "Agglomeration and Regional Growth", Handbook of Urban and Regional Economics, J. V Henderson and J-F Thisse (eds).

Baldwin R. E., P. Martin and G. I. P. Ottaviano, 2001, "Global Income Divergence, Trade, and Industrialisation: a Geography of Growth Take-offs", *Journal of Economic Growth*, 6: 5-37.

Ciccone A. and R. E. Hall, 1996, "Productivity and the Density of Economic Activity", *American Economic Review*, 86(1): 57-70.

Ciccone A., 2002, "Agglomeration Effects in Europe", *European Economic Review*, 46: 213-227.

Combes P-P., 2000, Economic Structure and Local Growth: France, 1984-1993", *Journal of Urban Economics*, 47: 329-355.

European Commission, 2004, "Third Report on Economic and Social Cohesion", Luxembourg.

Fujita M., P. Krugman and A. J. Venables, 1999, *The Spatial Economy: Cities, Regions, and International Trade*, MIT Press, Cambridge, MA.

Gao T., 2004, "Regional Industrial Growth: Evidence from Chinese Industries", *Regional Science and Urban Economics*, 34: 101-124.

Hanson G., 1998, "Market Potential, Increasing Returns, and geographic Concentration", NBER Working Paper # 6429.

Harris C. D., 1954, "The Market as a Factor in The Localization of Industry in the United States", *Annals of the Association of American Geographer*, 44: 315-348.

Head K. and T. Mayer, 2004, "The Empirics of Agglomeration and Trade", Handbook of Urban and Regional Economics, J. V Henderson and J-F Thisse (eds).

Hirschman A. O., 1958, *The Strategy of Economic Development*, Yale University Press, Newhaven, CT.

Martin P. and G. I. P. Ottaviano, 2001, "Growth and Agglomeration", *International Economic Review*, 42: 947-968.

Martin P. and G. I. P. Ottaviano, 1999, "Growing Locations: Industry Location in a Model of endogenous Growth", *European Economic Review*, 43: 281-302.

Myrdal G., 1957, *Economic Theory and Under-Developed Regions*, Duckworth, London.

Perroux F., 1955, "Notes sur la notion de Pôle de Croissance", *Economie Appliquée*, 1-2:320.

Quah, D. T., 1996, "Regional Cohesion from Local Isolated Actions: I. Historical Outcomes", *mimeo.*

Redding S. and A. J. Venables, 2004, "Economic Geography and International Inequality", *Journal of Internal Economics*, 62: 53-82.

Sbergami F., 2002, "Agglomeration and Economic Growth: Some Puzzles", HEI Working Paper N. 02/2002.

Walz U., 1996, "Transport Costs, Intermediate Goods, and Localized Growth", *Regional Science and Urban Economics*, 26: 671-695.