Discussion Papers in Economics

IS THERE A TRADE-OFF BETWEEN REGIONAL GROWTH AND NATIONAL INCOME? THEORY AND EVIDENCE FROM THE EU

By

Young-Bae Kim

(University of Surrey)

DP 10/08

Department of Economics
University of Surrey
Guildford
Surrey GU2 7XH, UK
Telephone +44 (0)1483 689380
Facsimile +44 (0)1483 689548
Web www.econ.surrey.ac.uk
ISSN: 1749-5075

Is There A Trade-off Between Regional Growth and National Income? Theory and Evidence from the EU

Young-Bae Kim*

October 2008

Abstract

The paper theoretically and empirically investigates the effect of changes in national labour-market conditions on regional growth from the point of view of local economies. The mechanism of efficiency wage is introduced to a growth model and it is argued that local regions belonging to richer countries would experience slower economic growth than those in poorer countries, *ceteris paribus*. The model emphasises the process of interregional wage dependence in which national average wage or income plays an important role in determining regional wages and growth. The empirical findings from EU regional data also suggest that national income is significantly and negatively associated with regional growth. The adverse effect of national income on regional growth is also observed to be stronger among richer regions whose income is above the national average.

JEL Classification: J41, J64, O41.

Keywords: Efficiency wage; Unemployment; Regional growth.

* Department of economics, University of Surrey, Guildford, Surrey, GU2 7XH, UK; E-mail: y.b.kim@surrey.ac.uk; Tel: +44 (0)12 8942 6956; Fax: +44 (0)20 7631 6416. I am indebted to Gylfi Zoega, John Driffill, Ron Smith, Dennis Snower and Vasco Gabriel for helpful comments and suggestions. I gratefully acknowledge financial support from Birkbeck College, University of London. Any errors are solely my responsibility.

1. Introduction

Regional cohesion has recently been the subject of unremitting interest in the literature. The possibility cannot be ignored that without successful regional cohesion European economic integration would end up with undesirable consequences. A great deal of the growth literature has investigated, both theoretically and empirically, determinants of economic growth. In the context of determinants of growth examples include initial income, education, R&D investment, inflation, trade, government spending, fertility rates, democracy, and so forth (Stern, 1991; Barro and Sala-i-Martin, 1995; Sala-i-Martin, 1998). These determinants I have listed are mainly common macroeconomic and socio-political factors at the national level. It is obvious that these aggregate factors must play an important role through their interaction with sub-national regional factors in the process of regional growth.

However the growth literature has been restricted itself to analysing the effects of aggregate factors on aggregate growth or of regional factors on regional growth at the same level of economies. In particular the importance of macroeconomic factors tends to be given no heed in the context of sub-national regional growth analysis. For instance all the regional effects of macroeconomic factors have been at best implicitly captured by the inclusion of country dummies into estimation regressions (Barro and Sala-i-Martin, 1991, 1995). Such a trend in the empirical literature would be a matter of course in the absence of theoretical reasoning. In this paper hence I both theoretically and empirically investigate one of the potential channels through which macroeconomic conditions may influence economic growth at the regional level.

Alongside the evolution in the growth literature that investigates the explanations for growth, there has also been another expansion that analyses income convergence between countries or regions. For example in the light of both neo-classical theory (i.e. Solow, 1956) and new growth theory (Krugman, 1979; Segerstrom, 1991), poor economies should catch up with rich ones in terms of their income level although sources of income convergence are different: diminishing returns to capital and cheaper costs for technology imitation, respectively. A large number of empirical studies have also reported income convergence between countries (Martin et al., 2001;

Crespo-Cuaresma et al., 2002) as well as convergence between regions (Barro and Sala-i-Martin, 1991; Amstrong, 1995) in the EU.[1]

In contrast, another strand of the new growth theories claims income divergence under the assumption of increasing returns (Romer, 1986, Lucas, 1988), agglomeration/concentration effects (Krugman, 1991) and creative destruction (Aghion and Howitt, 1992). Several recent studies also report empirical evidence of non-convergence between EU regions (Canova and Marcet, 1995; Boldrin and Canova, 2001). Canova and Marcet (1995) find that income differences among EU NUTS2-level regions persist because those are reduced only by a small amount over time and claim that poorer regions stay poor.[2] Boldrin and Canova (2001), using updated EU regional data, also report a similar result that there is no evidence of either regional convergence or divergence between or within countries.[3]

Indeed, a new challenge to the growth literature would be to find out explanations for the presence of such contrasting findings: there is clear evidence for convergence between EU countries while non-convergence is reported for EU regions. However, the focus of the regional-growth literature has been to explain non-convergence between regions separately from convergence between countries. The failures of EU regional policies have mainly been blamed for non-convergence of EU regional income, such as EU structural funds (Canova and Marcet, 1995; Boldrin and Canova, 2001).[4] For the European Regional Development Fund that is a part of the EU structural funds, no distributional problem is found, but the fund has still appeared to be ineffective (Fattore, 2004). It is obviously important to improve the effectiveness of regional cohesion measures. Nevertheless, there must exist some systematic

[1] I would like to focus on the European context although there are a numerous number of studies on convergence between countries across the world and those for US states because I use EU regional data for the empirical analysis.

[2] Canova and Marcet (1995) use per capita GDP data for 144 NUTS2 regions within 14 EU countries from 1980 to 1992. Nevertheless, they also find supportive evidence for convergence when using labour productivity.

[3] Boldrin and Canova (2001) use data for a maximum of 185 NUTS2 regions within 15 EU countries from 1980 to 1996. Nevertheless, they also find supportive evidence for convergence when using labour productivity.

[4] The EU Growth and Stability Pact has hindered regional development (Eichengreen and Wyplosz, 1998; Driffill and Miller, 2003) and possibly affected convergence. For instance Driffill and Miller point out that the EU Growth and Stability Pact has had the undesirable consequences of putting restrictions on German fiscal policies such as high taxes to finance the transition costs and low government spending to control inflation, in turn leading to low investment in infrastructure and high unemployment.

reasons for non-convergence between regions and the mixed findings I have mentioned above.

Hence, I develop a model in which regional firms that operate in a given sub-national regional economy which is one of many regions belonging to a country and the firms are influenced by both regional and national labour-market conditions. In the light of the efficiency-wage theory, since workers are ready to shirk whenever their relative wages are perceived as unsatisfactory, an increase in other neighbouring firms' wages are systematically transferred to higher wages for a given firm and, as a result, the firm must cut jobs. My model applies such a mechanism of inter-firm or inter-sectoral wage dependence into the context of inter-regional wage dependence and thus incorporates an effort function (Solow, 1979) into an learning-by-doing growth model (Romer, 1986). I focus on sub-national regional behaviour although there exist labour-market shocks at the aggregate level. The incorporation of the above models enables me to investigate the effect of a change in national labour-market conditions on regional growth.

My approach to augmenting the growth model is comparable to that of Brecher et al. (2002) that introduce growth into an efficiency-wage model in an attempt to investigate causal links running from growth and unemployment. On the other hand, my idea is similar to that of Brauninger and Pannenberg (2002) that incorporate unemployment into a Solow growth model and predict negative effects of unemployment on growth. However, some theoretical studies predict the causal links running from unemployment to growth to be both positive and negative (Bean and Pissarides, 1993; Gorden**,** 1997). In contrast, the empirical literature has reported supportive evidence for the negative effect of unemployment on growth (Gorden 1997; Muscatelli and Tirelli, 2001; Brauninger and Pannenberg, 2002). Hence, another important contribution of this paper is that one of potential causal links from unemployment to growth is investigated both theoretically and empirically.

In the following section, I develop an augmented growth model that predicts that an increase in national (neighbouring regions') average wages raises regional wages and unemployment and thereby negatively influences regional growth through reduced learning activities. The undesirable consequences of higher wages relative to productivity for economic growth have been explored by, amongst others, Paldam

(1997) who investigates the effect of Danish income subsidies on wages and employment in Greenland.[5] My framework does not only formally model influences of such a windfall gain but also the model can generally be applied to any shocks that may alter aggregate average wages and income, such as subsidies, foreign aid, natural resource booms, and labour-market integration. The main argument of this paper is that regions in richer countries would on average grow slower than would those in poorer countries, *ceteris paribus*, which is a fresh result in the growth literature.

At this stage, I would also like to consider income convergence between countries. First, recall the criticism that the concept of β-convergence is meaningless under the assumption of heterogeneity in growth rates (Lee, Pesaran and Smith, 1998; Islam, 1998). For instance, Lee et al. show that the introduction of different steady-state levels and growth rates leads to a dramatic increase in the speed of convergence. On the other hand, Ben-David and Loewy (1998) argue that the knowledge spillovers, as long as the diffusion is not restrained, may cause income convergence as well as growth rate convergence in both the medium run and the long run. The main finding of my paper that country income is inversely associated with regional growth implies that higher income countries may on average grow slower. Hence, my paper also provides another explanation for income convergence between countries through investigating the interaction between aggregate and local economies.

This theoretical prediction is tested with EU regional data. After setting up the theoretical model, in the rest of the paper, I briefly describe the data and introduce estimation methods for the cross-regional growth analysis. Then I report empirical findings supporting the main hypothesis that the rate of regional growth varies inversely with national average income and wages, *ceteris paribus.* I also split the sample into two groups of poor and rich regions for the robustness test. Finally, I summarise the main findings.

2. A Growth Model with Worker's Effort

[5] A higher ratio of wages to productivity induced by external subsidies resulted in higher unit labour costs which harm international competitiveness and economic growth.

This section develops a theoretical framework to illustrate how changes in labour-market conditions of neighbouring regions affect regional growth of a given region. In this analysis, changes in national average wages play an important role regardless of whatever the causes are. My model show how increased national average wages following a labour market shock can retard growth from the point of view of regional economies. A learning-based growth model (Romer, 1986) is augmented with an endogenous effort function. The wage-dependence property of efficiency wage theory enables the model to show that increased national average wages impede regional growth. In this augmented growth model, workers' learning activities are set to be the main source of knowledge accumulation and economic growth is propelled by learning activities.

In my model, I restrict myself to the effect on regional growth of a change of labour-market conditions at the national level such as national average wages by leaving aside other aspects of economies such as aggregate product-market conditions and monetary economics. Zoega (2000) reveals that no structural changes in labour markets are detected and differences in labour-market performance are likely to be caused by either national or common macroeconomic shocks across the countries belonging to the EMS group. Thus it would be plausible to investigate the effect of labour-market changes independently without explicitly considering aspects of EU integration, although my theoretical prediction will be tested with EU regional data.

2.1 Labour Markets and Production

The framework set up is based on the model of Romer (1986). However, there are three major differences between his model and my model. First, there is only one goods-producing sector in which labour is the only factor of production. Second, workers in this sector spend their time in two activities: production activity and learning activity. Finally, workers' effort is endogenous to the model and depends on the employer's wage policies.

I assume that a national economy consists of many small regional economies. In each region, many identical competitive firms carry out production and employment. Labour is the only input of production. Workers cannot move from one region to another, but they compare their wages to what is paid in other regions and their perception of whether their current wages are fair or not fair affects their work effort. The reasoning for assuming the low or zero labour mobility is to simplify the modelling exercise. One could justify the assumption by appealing to imperfect information about alternative employment opportunities, the unwillingness of workers to risk unemployment, the uncertain period of job searching, moving costs, or cultural differences between regions. It is plausible that workers cannot have full information about wage rates in all other individual regions, but they have a fair assessment about national average wages. It is supposed that atomic firms in every region take national labour-market conditions as given.

To simplify the model solved here, the labour force L in each region is taken as given. As in efficiency wage theory there is a benefit as well as a cost of paying a higher wage. In the literature the benefits stem from several sources. First, a higher relative wage can increase workers' effort with imperfect monitoring (Shapiro and Stiglitz (1984). Second, higher wages may attract better workers (Weiss, 1982). Third, higher wages may reduce turnover (Hoon and Phelps, 1992). In my model, effort is made to depend on the ratio of own wages to wages in other regions. Note that it is not monopsony that is the cause of the wage-setting power of firms but, instead, market failures such as moral hazard and adverse selection that make firms use their wage policies to motivate workers. Hence, wages no longer adjust to equilibrate the labour market.

A fraction u of total labour force L is unemployed and a fraction $1-u$ is employed. There is only one goods-producing sector that uses labour to produce output and provide opportunities for learning. The number of workers employed N equals the total labour force less the unemployed: $N(t)=(1-u)\cdot L$. Workers in a given region decide how much effort to exert given their relative wages. Although firms have full bargaining power, they are unable to monitor workers' effort and behaviour perfectly because perfect monitoring is too costly. This creates a moral hazard problem: workers tend to shirk when their wages are low in comparison to national wages.[6] Thus workers' effort depends on relative wages rather than absolute

[6] Layard (2003) recently argues that people are happy with less income, as long as they are better off than others. As general living standards get improved, in other words, people who make more money may not get much happier because others get wealthier too.

wages. Even when absolute wages in a given region remain unchanged, higher average wages in other regions make workers in the region reduce their effort.

To capture workers' behaviour, the model adopts a simple effort function, which was used in Solow (1979).[7] Workers' effort is denoted by the strictly concave function, $e\left(w/\overline{w}\right)$, by assumption:

$$e\left(w/\overline{w}\right) \geq 0, \quad e'\left(w/\overline{w}\right) > 0, \quad e''\left(w/\overline{w}\right) < 0 \tag{2.1}$$

where w are real wages for the representative firm in a region and $\overline{w}$ denotes average real wages for the respective country (hereafter, all wages are in real terms). In this representative-agent framework, all firms in a given region are identical and wages set by a representative firm for a region are in fact identical to regional wages. The representative firm takes the prevailing national average wages paid in other regions in the country as given.

Shirkers face a probability of getting caught and face the penalty of being fired. On the other hand, firms have to pay sufficiently high wages to provide workers with incentives not to shirk. Therefore firms cannot offer jobs to unemployed workers who are willing to work at lower wage rates because firms know that these new workers will shirk at the lower wages. The representative firm wants to maintain relative wages $w/\overline{w}$ at the optimal level in order to provide sufficient incentives for workers not to shirk.

Workers are assumed to be involved in two activities: production activity and learning and innovation activity and to be able to do both at the same time. It is also assumed that the firm uses no capital but only labour in production and hires new workers to generate a flow of ideas that raises productivity. The quantity of output produced by a representative firm in a given region at time t is:

$$Y(t) = \left[e\left(\frac{w}{\overline{w}}\right) \cdot A(t) \cdot N(t) \right]^{\gamma} \cdot A(t)^{1-\gamma} \tag{2.2}$$

[7] The microeconomic foundation for the effort functions based on a shirking model are given in Solow (1979) and Shapiro and Stiglitz (1984) while those based on a quitting model can be found in Salop (1979), Calvo (1979), and Hoon and Phelps (1992). It is beyond the scope of this study to derive these because they are already well established in the unemployment literature.

where $0<\gamma<1$, $e(w/\bar{w})$ denotes workers' effort, and A is the accumulated stock of knowledge at time t. The production function exhibits labour-augmenting technological progress. There are diminishing returns to labour but constant returns to knowledge. Increased knowledge raises the productivity of workers in a labour-augmenting fashion but it also greases the wheels of the company as captured by the term $A^{1-\gamma}$. Furthermore, the effective labour $A\cdot N$ is augmented by the level of workers' effort $e(w/\bar{w})$ which is defined above, and this enables firms to employ efficiency units of labour $e\cdot A\cdot N$ in their production activities.

Similarly, the process of learning or discovering know-how depends on the stock of knowledge, the level of workers' effort and learning:

$$\dot{A}(t)=B\cdot\left[e\left(\frac{w}{\bar{w}}\right)\cdot aN(t)\right]^{\alpha}\cdot A(t)^{\beta} \qquad (2.3)$$

where B is a shift parameter, $B>0$, $\alpha\geq 0$, and $\beta>0$. The parameter, a, measures the effectiveness of workers' learning and discovering better ways of doing things and $a>0$. The higher the intensity of learning, a, the higher the likelihood of discovering new ways of producing output. Finally, β represents the elasticity of new knowledge production $\dot{A}$ with respect to the level of knowledge A and $\beta>0$ so that there are only positive intertemporal knowledge transfers. If $\beta=1$, $\dot{A}$ is proportional to A. The effect of A on $\dot{A}$ is stronger if $\beta>1$ while weaker if $0<\beta<1$.

2.2 Profit Maximisation and Efficiency Wages

The firm's profit maximisation problem describes how firms decide the optimal levels of employment and wages. Profits for a representative firm in a given sub-region are defined as follows:

$$\Pi=\left[e(w/\bar{w})\cdot A(t)\cdot N(t)\right]^{\gamma}\cdot A(t)^{1-\gamma}-w\cdot A(t)\cdot N(t) \qquad (2.4)$$

Define $w \cdot A$ as the effective wage $\hat{w}$: $\hat{w}(t) = w \cdot A(t)$. This is the wage received per worker. The first-order condition for profit maximisation with respect to labour employed N should be satisfied:

$$\hat{w}(t) = \frac{\gamma \cdot Y(t)}{N(t)} \tag{2.5}$$

According to this equation, the optimal quantity of labour employed to produce goods is implicitly determined for a given effective wage $\hat{w}$. The left hand side of the equation measures the marginal cost of labour, that is, the effective wage and the right hand side represents the marginal product of labour. The equation implies that the quantity of labour engaged in the production activities, N, is a decreasing function of the effective wage.[8]

Second, the optimal level of sub-regional wages must satisfy the first-order condition with respect to regional wages w:

$$\varepsilon^{e}_{w/\overline{w}} \equiv \frac{e'(w/\overline{w}) \cdot (w/\overline{w})}{e(w/\overline{w})} = 1 \tag{2.6}$$

This equation is Solow's elasticity condition: the elasticity of effort with respect to the ratio of regional wages to the national wages is equal to unity. The level of regional wages w satisfying this condition minimises the firm's labour costs.

In addition, the Solow condition also provides three important implications:

$$\frac{dw}{d\overline{w}} = \frac{w}{\overline{w}} > 0 \qquad \text{or} \qquad \frac{dw}{d\overline{w}} \cdot \frac{\overline{w}}{w} = 1 . \tag{2.7}$$

The first equation of (2.7) suggests that increases in national wages are systematically transferred to regional wages and thus any changes in national wages lead to changes in the regional wages in the same direction. Thus it is plausible to

[8] By substituting for Y from Eq. (2.2) into N of Eq. (2.5) and rearranging the results for N, the level of employment N is found to be an increasing function of workers' effort and the stock of knowledge and a decreasing function of the effective wage.

specify a function capturing such a positive association of the regional wages with national wages as follows: $w = W(\overline{w})$, $W'(\overline{w}) = dw/d\overline{w} = w/\overline{w} > 0$. The second equation of (2.7) implies that the elasticity of regional wages with respect to national wages equals unity at the optimum. In other words, the growth rate of regional wages π_w is the same as that of the national wages $\pi_{\overline{w}}$ so that the relative wages $w/\overline{w}$ do not change: $\pi_w = \pi_{\overline{w}}$ and $d(w/\overline{w})/dt = 0$. Finally, combining this property with the Solow condition suggests that there is no change over time in workers' effort at the optimum: $\dot{e}(w/\overline{w}) = 0$. The reason for this is that according to the Solow condition, workers' effort changes at the same rate as does the relative wages that do not change.

2.4 Growth and Employment

The two first-order conditions and the properties of Solow condition derived above can be used to investigate the determinants of the growth rate of output per worker, employment, and unemployment. From Eq. (2.2), the level of output per worker is determined by A and N:

$$y(t) = Y(t)/N(t) = e(w/\overline{w})^{\gamma} \cdot A(t) \cdot N(t)^{\gamma-1} \tag{2.8}$$

where $e(w/\overline{w})$ is a constant as shown in Eq. (2.7).[9] The time derivative of Eq. (2.8) yields:

$$\begin{aligned}\dot{y}(t) &= y(t)\cdot\frac{\dot{A}}{A} + (\gamma-1)\cdot y(t)\cdot\frac{\dot{N}}{N} \\ &= \left[g_A(t) - (1-\gamma)\cdot g_N(t)\right]\cdot y(t)\end{aligned}$$

where $g_A = \dot{A}/A$, the growth rate of knowledge, $g_N = \dot{N}/N$, the growth rate of employment, and $0 < \gamma < 1$. From this, the growth rate of output per worker g_y is obtained:

$$g_y(t) = \dot{y}(t)/y(t) = g_A(t) - (1-\gamma)\cdot g_N(t) \tag{2.9}$$

[9] Define output per worker by a lower-case letter, y.

According to Eq. (2.9), the growth rate of output per worker equals the growth rate of knowledge less a fraction of the growth rate of employment.

Considering the growth rate of employment, $g_N = \dot{N}/N$, The substitution of the production function Y of Eq. (2.2) into the optimal employment function N of Eq. (2.5) and rearranging the results for N suggests that employment is a function of technology A and effective wages $\widehat{w}$:

$$N(t) = \gamma^{\frac{1}{1-\gamma}} \cdot e(w/\overline{w})^{\frac{\gamma}{1-\gamma}} \cdot A(t)^{\left(\frac{1}{1-\gamma}\right)} \cdot \widehat{w}(t)^{-\left(\frac{1}{1-\gamma}\right)} \tag{2.10}$$

since γ and $e(w/\overline{w})$ are constants. Taking the time derivative of this equation and dividing the result by N yields the growth rate of employment as follows:

$$g_N(t) = \frac{\dot{N}(t)}{N(t)} = \frac{g_A(t) - \pi_{\widehat{w}}(t)}{1-\gamma} = \frac{g_A(t) - g_A(t)}{1-\gamma} = 0 \tag{2.11}$$

where $g_A = \dot{A}/A$ and $\pi_{\widehat{w}} = \dot{\widehat{w}}/\widehat{w}$. Since $\widehat{w}(t) = w \cdot A(t)$ where w is a constant, $\dot{\widehat{w}} = w \cdot \dot{A}$ and $g_A = \pi_{\widehat{w}}$. This equation indicates that the number of workers employed does not change over time: $\dot{N} = 0$ and thus the growth rate of employment equals zero: $g_N = \dot{N}/N = 0$. The first term on the right hand side of this equation $g_A/(1-\gamma)$ shows that technological progress $\dot{A}$ leads to an increase in productivity and then an increase in labour demand and employment N. In contrast, the second term $g_A/(1-\gamma)$ shows that knowledge accumulation $\dot{A}$ leads to an increase in regional effective wages $\widehat{w}$ because $\widehat{w} = w \cdot A$, which reduces employment N. Since these two opposite effects of knowledge accumulation on labour demand are exactly offset by each other, employment does not tend to grow over time.

By definition, the unemployment rate appears to be a decreasing function of employment N:

$$u(t) = 1 - N(t)/L \tag{2.12}$$

where L is a positive constant. The result of Eq. (2.11), $g_N = \dot{N}/N = 0$, indicates that the unemployment rate is also trendless: $g_u = \dot{u}/u = 0$.

Turning back to the growth rate of output per worker g_y, since $g_N = 0$, then g_y from Eq. (2.9) is simply equal to the growth rate of knowledge g_A which is given by $\dot{A}$ of Eq. (2.3) divided by A:

$$\begin{aligned} g_y(t) &= g_A(t) = \dot{A}(t)/A(t) \\ &= a^{\alpha} \cdot B \cdot e\left(w/\overline{w}\right)^{\alpha} \cdot N(t)^{\alpha} \cdot A(t)^{\beta-1}. \end{aligned} \tag{2.13}$$

This equation implies that the growth rate of output per worker g_y is totally determined by the speed of knowledge accumulation g_A and thus by determinants of g_A. In other words, assuming that the relative wage $w/\overline{w}$ is initially at the optimal level, the initial value of either g_y or g_A depends on optimal levels of effort e and employment N, the initial level of knowledge A, and parameters.

Similarly, the time path of g_y also depends totally on the behaviour of g_A over time. Since $\dot{e} = 0$ and $\dot{N} = 0$, the time derivative of g_y in Eq. (2.13) is equal to the derivative of g_A with respect to A times the time derivative of A:

$$\begin{aligned} \dot{g}_y(t) = \dot{g}_A(t) &= (\beta-1) \cdot g_A(t) \cdot A(t)^{-1} \cdot \dot{A}(t) \\ &= (\beta-1) \cdot g_A(t)^2 = (\beta-1) \cdot g_y(t)^2 \end{aligned} \tag{2.14}$$

The growth rate of output per worker is constant at the rate of g_y^* satisfying the condition that $\dot{g}_y = \dot{g}_A = 0$. This means that regional economies would experience their steady-state regional growth rates of output per worker where $g_y = g_y^*$, or when the elasticity of new knowledge production with respect to the level of knowledge, $\beta = 1$. If $\beta = 1$, the dynamics of the growth rate of knowledge A disappear and thus the regional economy is on its balanced growth path. On the other hand, if $\beta > 1$, the trajectory of $\dot{g}_A$ is a strictly convex curve starting at the origin in the space of $\dot{g}_A$ and g_A. In this case, since $\dot{g}_A$ is increasing in g_A, the regional economy will exhibit an ever increasing growth path without convergence to the balanced growth rate. In contrast, if $\beta < 1$, the path of $\dot{g}_A$ goes in the completely opposite direction and $\dot{g}_A$ is decreasing in g_A.

2.5 Adverse Effects of National Wages on Regional Growth

Using this framework, now I demonstrate negative effects of an increase in national wages on unemployment and long-run growth rates of technology and output per worker at the regional level. Clearly, higher wages induced by a labour-market shock can raise welfare in a given region, in spite of the adverse growth effect. Without specifying a formal welfare function, it is likely that current welfare increases at the cost of future welfare. Which one is more important will then depend on the pure rate of time preference as well as on how much future generations' utility is discounted.

More interestingly, when an increase in national wages occurs, the unemployment rate will rise because the number of workers employed falls for a given level of the total labour force L. This is shown using Eq. (2.12) as follows:[10]

$$\frac{du(t)}{d\overline{w}} = -\frac{1}{L}\cdot\left(\frac{-N(t)}{(1-\gamma)\cdot w}\right)\cdot\frac{dw}{d\overline{w}} = \frac{N(t)}{(1-\gamma)\cdot\overline{w}\cdot L} > 0. \qquad (2.15)$$

At first, a rise of national wages increases regional wages because $dw/d\overline{w} = w/\overline{w} > 0$ (Eq. 2.7). The increased regional wages will then lower employment and raise the rate of unemployment according to Eq. (2.10) and (2.12) where $\widehat{w} = w \cdot A$.

Finally, in order to illustrate how the growth rate of technology and that of output per worker responds to any changes in regional wages, we need to take the derivative of the growth rate of output per worker with respect to regional wages. Before taking this derivative, we need to substitute for N from Eq. (2.10) into g_y of Eq. (2.14) and in turn substitute for $\widehat{w} = w \cdot A$. Then, using $dw/d\overline{w} = w/\overline{w} > 0$ from Eq. (2.9), a negative value for the derivative of the growth rate with respect to national wages is obtained:

$$\frac{\partial g_y(t)}{\partial \overline{w}} = -\left(\frac{\alpha}{1-\gamma}\right)\cdot\frac{g_y(t)}{\overline{w}} < 0 \tag{2.16}$$

When national wages $\overline{w}$ rise, regional wages w also jump, leading to a reduction in labour demand and employment N. This decreased employment leads to reduced learning activities and a consequent fall in the growth rate of knowledge g_A and that of output per worker g_y, that are both identical to each other according to Eq. (2.13) and thus depend on determinants of g_A. Lower employment reduces the probability of discovering new ideas and know-how and hence regional growth.

The model's main results about the effect of an increase in the neighbours' or national wage on the regional level of effort, output and growth are robust to changes in the model's assumptions. When workers find themselves to be treated unfairly, they work less hard and research less hard and hence there are fewer discoveries and a lower rate of growth. This result follows from plausible functional relationships – the effort function and the production function – and these can be supported by the microeconomic foundations cited earlier.

Finally, it would be worth considering the case where some labour mobility is allowed. In my model, an increase in national wages leaves relative wages – that is the ratio of regional wages to national wages – unchanged and thus workers do not have any incentive to relocate to other regions even if labour mobility is allowed for. The rate of unemployment is another factor which workers might consider when they consider moving to other regions or countries. Workers in regions with higher unemployment might be more likely to move to other regions. If it is the case that poorer countries have higher unemployment and there is labour mobility between two countries, workers may move from regions in the poor country to regions in the rich country. However, there is no obvious reason for adding this effect to the model.

In sum, this simple endogenous growth model shows that higher national wages have an adverse effect on regional growth. In the context of local regional labour markets, workers' effort is assumed to depend on the ratio of regional to national

---

[10] Before taking the derivative, we need to substitute for N from Eq. (2.10) into Eq. (2.12) and then to substitute for $\widehat{w} = w \cdot A$.

wages. Higher national average wages appear to be systematically transferred to higher regional wages. Workers' effort and employment are found to be constant over time and the growth rate of output per worker appears to equal the growth rate of knowledge. According to the results of the theoretical model, an increase in national wages results in a fall in employment and a rise in unemployment at the regional level. This is because increased unit labour costs for a given level of productivity in those regions cause firms to reduce their use of labour. Reduced employment in turn reduces the rate of learning and the growth rate of technology and of output per worker at the regional level. Hence, the model I developed shows a clear link running from unemployment to growth.

Indeed, it is predicted that regions belonging to richer countries experience slower economic growth, *ceteris paribus*, than those in poorer countries. If this is the case, then I can argue that the growth rate of poor countries is on average higher than that of rich counties, leading to income convergence between countries. However, the prediction for convergence between regions seems ambiguous. Consider three regions with the same level of income and each of these regions belongs to a different country with a different level of income. The region in the middle income country grows slower than the region in the low income country while it grows faster than the region in the high income country. In this case, these three regions with the same income level are more likely to exhibit different growth rates. Therefore income convergence between regions across countries would depend on the combination between regional income and national income.

3. Data and Empirical Methodology

The rest of the paper endeavours to test for the theoretical prediction of the negative effects of national income on regional growth using EU regional data. In this section, I briefly describe the EU regional data and estimation methods used for the analysis.

3.1. Data

A set of cross-sectional data for 136 (sub-national) regions at NUTS2 (Nomenclature of Statistical Territorial Units level 2) in nine EU member countries for the period of 1982-1998 is constructed from Regional Statistics (*REGIO*) in *Eurostat New Cronos*.[11] Regions at NUTS2 are used because the European Commission defines NUTS2 as the basic administrative units and the geographical target level at which the disappearance or persistence of unacceptable regional inequality should be measured.[12] Data on the main variables of interest such as real per capita GDP (hereafter, income), wages and unemployment are constructed from *Eurostat*.[13] Regional data that are usable for this analysis are available from the year 1982 onwards in *REGIO*. The nine EU countries are chosen to get the best coverage for some limited data such as wage and unemployment rates.[14] See Appendix B for the definition of the variables and sources of the data.

Education attainment data are constructed from Barro and Lee (2000). The country rate (rather than the regional rate) of education attainments is used because education data are not available at the sub-national level for the EU. EU structural fund data are collected from the annual reports on structural funds published by the European Committee since 1989. However, the reports do not provide figures for structural funds at the regional level in every year and even those figures are not available for Greece and Portugal. At the regional level, as a result, dummies for EU Structural Funds 1989-93 are used: 1 for 102 regions (out of 136 sample regions) which have been granted the funds (including Objectives 1, 2 and 5b) between 1989 and 1993 and 0 for the rest of the sample regions.[15] On the other hand, at the country level, I use the

[11] Nine EU countries in the sample are Belgium, Germany, Spain, Greece, France, Italy, the Netherlands, Portugal, and the United Kingdom. See Appendix A for the full list of regions and countries included in the sample.

[12] Moreover, NUTS2 is the appropriate size of territory that is comparable with the U.S. counties. Although Boldrin and Canova (2001) point out several reasons why NUTS2 would not be the appropriate size, the NUTS2 is used because there are no alternatives as in Boldrin and Canova. According to NUTS, the EU before EU enlargement in 2004 is divided into the 15 member countries at NUTS0, 77 regions at NUTS1, 211 regions at NUTS2, and 1031 regions at NUTS3. Some NUTS1 regions and NUTS3 regions are used when there is no data available for NUTS2 regions.

[13] It should be noted at the outset that the lack of appropriate price indices for individual regions causes potential measurement errors in both the growth rates and the levels of real per capita GDP for the EU regions. Barro and Sala-i-Martin (1992) point out a similar problem.

[14] For instance wage data are not available for two of nine sample countries, Greece and Portugal and year 1988 is the only year that covers all the sample regions for regional unemployment data.

[15] The period of 1989-1993 is used in order to capture the long-term effect of structural funds.

country rate of EU Structural Funds 1989-93, that is, the country ratio of EU Structural Funds (including all Objectives) between 1989 and 1993 to GDP in 1989.

3.2. Regression Models for Regional Growth

The basic estimation strategy I employ is to run Barro-type regressions (1991) of regional growth on initial regional income as well as initial country income to test the hypothesis that the rate of regional growth varies inversely with country average income and wages and also with the rate of regional unemployment, *ceteris paribus*. Although the theoretical model has no transitional dynamics, I employ Barro-type regression models due to the limited availability of regional wage and unemployment data.[16]

The regression model I use is more like a typical two-dimensional equation for unbalanced panel data although the model is for cross-sectional regressions. This is because data are available for individual regions, $i = 1, 2, ..., n_j$ within countries $j = 1, 2, ..., m$ (9 EU countries) and the total number of observations is $N = \sum_j n_j$ (136 EU regions). As a result, I can adopt panel data techniques by replacing time t of the standard panel model with region i of my model.

I apply three approaches to see if estimated coefficients of interest are robust to various alternative specifications. Those are the pooled ordinary least square (POLS) model, a two-stage method based on the FE model, and the RE model. As the benchmark regression, I estimate pooled OLS estimators as in the standard cross-section (regional) regression model on the basis of the assumption of a common intercept for all regions or no country specific effects. I use heteroskedasticity robust estimators.[17]

I adopt a two-stage process as the second method. The panel regression employed has the following form:

---

[16] For instance, data on regional unemployment rates which cover all the sample regions are available only for the year 1988. As a result, it is also possible to test for convergence among regions.

[17] I apply White heteroskedasticity test of which the likelihood ratio statistics reject the null hypothesis of homoskedasticity at the 5 percent level. This implies that the OLS estimators are no longer efficient although they are still unbiased and consistent.

$$y_{ij} = \beta' x_{ij} + u_j + \varepsilon_{ij}, \qquad i = 1, 2, ..., n_j \quad j = 1, 2, ..., m \tag{3.1}$$

where x_{ij} is a vector of region-varying observable variables; β is a parameter vector for x_{ij}; u_j is an country specific intercept term. This is the fixed effects (FE) model. At the first stage, I estimate the country specific intercepts u_j.[18] However, a major drawback of the FE model is the dummy variables to capture all country specific effects and thus the coefficients γ on the observed country variables, z_j cannot be directly estimated. In the second stage, thus, I use information hidden behind those estimated coefficients of country dummies, u_j. The country specific intercept term u_j can be defined as:

$$u_j = \gamma' z_j + v_j \tag{3.2}$$

where $z_j = \left(1, z_j^1\right)$ is a vector that contains unity and a set of region-invariant observable variables; $\gamma = \left(\alpha, \gamma^1\right)$ is a vector that consists of a constant term and a set of parameters for z_j^1; v_j is a region-invariant unobserved random variable, distributed independently across countries; and ε_{ij} is the disturbance assumed to be uncorrelated with x_{ij}, z_j and v_j, and have typical assumptions. I regress those estimated coefficients of country dummies, u_j, on country observed variables, z_j, in order to extract the share of country variables, z_j, from the country specific effects estimated in the FE model at the first stage.[19]

As the final alternative approach I use the random effects (RE) panel data model by substituting Eq. (3.2) into Eq. (3.1) and run

---

[18] It is more likely that regions within different countries have their own different country specific characteristics rather than that all regions share a common effect. In other words, regional variables are very likely correlated with the country effects. In this case, it is appropriate to use the fixed effects (FE) model or the least squares dummy variables (LSDV).

[19] This requires that the unobserved country effects, v_j, are uncorrelated with the observed country variables, z_j.

$$y_{ij} = \beta' x_{ij} + \gamma' z_j + \left(v_j + \varepsilon_{ij}\right) \tag{3.3}$$

only if the unobserved country effects, v_j, are uncorrelated with x_{ij} and z_j. The fixed effects (FE) model discards other possible country effects causing the omitted-variable problem and a loss of degrees of freedom. The FE estimator, β^{FE}, is consistent if regional variables, x_{ij}, are not exogenous. In contrast, when x_{ij} are exogenous, it is appropriate to use the RE estimator, β^{RE}.[20] As mentioned earlier, since all regional variables are measured in the initial year, these regional variables are predetermined and exogenous. In this sense, the RE estimator, β^{RE}, would be correct. I also test for exogeneity by applying Hausman's (1978) specification test for the null hypothesis of β^{RE} against the alternative of β^{FE}.[21]

Following the usual manner in growth regression models, the dependent variable, y_{ij}, is the average of the regional growth rate of real per capita GDP (hereafter, income) over the period between 1982 and 1998. The main specifications to test are as follows. The coefficients on three key variables such as initial country income, country wages and regional unemployment rates all are hypothesized to be negative, implying their inverse association with regional growth in the light of the theoretical prediction.[22] The country rate of education attainment is included to reflect the effect of the stock of human capital and two variables of EU structural funds are added to test if the EU regional policy has contributed to regional growth in addition to the purpose of the robustness test.

Finally, I divide the sample into two groups and test the hypotheses for the robustness check: one for poor regions and the other for rich regions, relative to their

[20] This is because if the regional observed variables, x_{ij}, are not correlated with country effects, v_j, the FE estimator, β^{FE}, is inefficient. The RE model assumes the unobserved country effects, v_j, to be random and thus uncorrelated with x_{ij} and z_j. The RE model allows us to estimate the γ directly and does not lose the degrees of freedom unlike the FE model.

[21] The Hausman test helps choose which of these two models is more appropriate. Following Greene's (2000) suggestion, the individual specific effects should be treated as random as long as unobserved country effects, v_j, are found to be uncorrelated with x_{ij} and z_j.

[22] These initial variables are predetermined, fixed before ε_{ij} is realised and thus can be treated as weakly exogenous as long as ε_{ij} is not serially correlated.

respective country average income. I use linear equations with actual values of variables in this analysis because the purpose of the paper is not to estimate the precise speed of regional convergence that may be obtained from a Barro-type log-linear equation.[23]

4. Findings from EU Regional Growth Regressions

In this section, I report the results of regional growth regressions for EU regional data. This estimation analysis focuses on the effects of country variables on regional growth. From the theoretical framework, an increase in country average income or wages forces regional firms to pay higher wages to maintain workers' effort at the profit optimum and to cut jobs and this increased unemployment impedes regional growth through reduced learning activities.

In Table 1, I report the regression results estimated for the whole sample. Sub-table 1A presents the results of the cross-regional pulled OLS growth estimation.[24] Sub-table 1B presents the results of the fixed effects model in the first two columns and the results of cross-country OLS regressions of country fixed effect coefficients on country variables respectively in the second half. Sub-table 1C displays the results of random effects regressions.[25]

Country income is hypothesised to have a negative association with regional growth for a given level of regional income. As predicted, estimated coefficients of country income all appear with negative signs in the second row of Table 1 regardless of estimation methods. These coefficients are statistically significant with only one exception that is from regression B2F, a cross-country regression of fixed effects coefficients obtained from a fixed effects regression B2. I also obtain similar results for another main country variable, country average wages for which regression results are reported on the forth row.

---

[23] Lee, Pesaran and Smith (1998) and Islam (1998) point out that the concept of β-convergence is meaningless under the assumption of heterogeneity in growth rates.

[24] The estimated coefficients for the country dummies are not reported. The number of observations drops from 136 to 118 when country wage is added due to lack of wage data for two countries, Greece and Portugal.

[25] For the cross-regional regressions, the *t*-statistics are obtained from White heteroskedasticity-consistent standard errors & covariance estimation and reported within parentheses beneath the

<Insert Table 1 here>

Regression A1 suggests that if other things equal, an increase of ECU 10,000 in initial country income from one country to another one causes a fall in regional growth by about 3 percent points per year. In other words, an increase in country income from the poorest country to the richest one by ECU 7,600 reduces regional growth by about 2.4 percent points. The estimated adverse impact of country wages on regional growth tends to be weaker than this effect from country income.

Another variable of interest is the rate of regional unemployment that is theoretically identified as one of the main channels through which changes in labour-market conditions at the country level influence economic growth at the regional level. A negative association is found between regional unemployment and regional growth which is statistically significant.[26] As found from random effects regression C1, the Hausman tests for exogeneity favour the random effects model for regional variables, implying that the unobserved country effects are uncorrelated with the observed regional variables and the observed country variables. The results from random effects regressions suggest that a 1% increase of regional unemployment rate would reduce the regional growth rate by approximately 0.03%.

The results for three variables of interest such as country income, country wages, and regional unemployment confirm that they all have significant and negative association with regional growth. Such results confirm the theoretical prediction that regions in richer countries would growth slower than regions in poorer countries if other things equal.

I also add the country rate of EU structural funds and regional dummies for the funds. European countries and regions have received EU Structural Funds of ECU 42,707 million (1989 prices) from 1989 to 1993 and ECU 120,280 million (1994 prices) from 1994 to 1999. EU structural funds are distributed as measures to improve regional and national welfare and regional cohesion. However, failures of EU regional policies are mainly blamed for persistent income differences within EU regions (Canova and Marcet, 1995; Boldrin and Canova, 2001). Since it is not convenient to

---

coefficients. Ordinary *t*-statistics cannot be used because the likelihood ratio statistics reject the null hypothesis of homoskedasticity at the 5 percent level.

measure the welfare effect of EU subsidies in this analysis, I briefly discuss the effect of such subsidies on regional growth. The results for EU structural funds I obtain suggest that EU structural funds have failed to enhance long-term growth of EU regions so far. Such findings for EU regional funds provide further supportive evidence for the claim of the studies I cited. The adverse effect of country income and wages I obtain is robust to the inclusion of these two variables for EU subsidies.

Finally, I also add a proxy for the stock of human capital that is the ratio of population at least completing secondary education to total population of 25 year old and over at the national level. Educational data are not available at the regional level for the EU. As expected, coefficients on education attainment are significantly positive in all cases.

I divide the whole sample into two sets of regions; one for rich regions whose income is above country average income and the other for poor regions whose income is below country income. The poor group comprises 94 regions and the rich group 42 regions.[27] The same tests made in the preceding section are replicated for the robustness test. Table 2 reports results for rich regions and Table 3 for poor regions.[28]

<Insert Table 2 and Table 3 here>

Even after dividing the sample, I still obtain negative coefficients of country income remain unchanged even for all specifications and methods I used. Estimated coefficients are all significant for the rich group. These coefficients for the poor group are also significant in all regressions with full specification. The overall results for country average wages for both groups are similar to those obtained for all sample regions. Negative coefficients on country wages are overall statistically significant for both groups while those that I obtained from fixed effects regressions for poor regions appear insignificant. Similarly, the rate of regional unemployment is found to have a

[26] Estimated coefficients on regional unemployment rates are all statistically significant with only one exception that is from pulled OLS regression A1.

[27] This number of observations drops when country wages added to regressions because wage data are not available for Greece and Portugal. The number of observations drops to 80 regions in seven countries for the poor group and to 38 regions in six countries for the rich group. For the rich group, there is no region for the UK.

[28] It should be noted that according to the results of Wald coefficient tests for both groups, the estimated coefficients for all variables do not significantly differ from those for the whole sample. This is not reported here.

significantly negative association with regional growth among rich regions. For the country rate of education attainments and EU structural funds, the split of the sample does not alter the overall results obtained from the full sample. These findings indicate that there clearly exist adverse effects of higher country income and wages on regional growth for rich regions while the message for poor regions is ambiguous.

5. Conclusions

My main findings provide supportive evidence of a significant and substantial trade-off between national income and regional growth. These findings threw light on the link between aggregate economic conditions and long-term growth of regional economies.

From the theoretical model, it was found that an increase in national wages leads to a rise in regional unemployment due to increased unit labour costs for a given level of productivity at the regional level. The increased level of regional unemployment in turn reduces the regional growth rate of technology and of output per worker through lowering the rate of learning. Hence, the augmented endogenous growth model I developed shows both an adverse effect of higher national wages on regional growth and a clear link between labour-market frictions and growth.

In the EU regional data, it was found that the rate of regional growth varies inversely with national average income and wages and also with the rate of regional unemployment, *ceteris paribus*. The empirical findings support my theoretical prediction. I interpret the findings as evidence that compared with regions in higher income countries, those in lower income countries experienced an above-normal rate of economic performance for a given level of regional income. In so far as that is the case, regions belonging to a rich country experience slower economic growth, *ceteris paribus*, than those in a poor country, suggesting income convergence between countries on average. This interpretation is subject to the usual caveats about inferences drawn from a cross-section, although I applied several panel data analysis techniques. Although I have been able to control for other determinants of economic growth as suggested by previous studies, it remains possible that there are other factors that might affect regional growth which are not controlled due to lack of data at the regional level.

Findings about the relationship between national income and regional growth have a potential bearing on policy-making in the field of regional development and cohesion. If there is a trade-off between national income and regional growth, this would imply that, on average, national governments were failing in choosing optimal policies for regional development and cohesion. The ultimate source of this trade-off was found to be the gap between national average income and regional income. If one or a few regions lead economic performance at the aggregate level, then this inter-regional income gap would be high and hinder regional growth. As far as discerned from the theoretical model, this does not necessarily obviate the need for any national subsidies to relatively poor regions, as is well known, but rather it would be appropriate to enhance balanced regional development and thereby reduce labour-market frictions.

References

Aghion, Philippe and P. Howitt, 1992, A model of growth through creative destruction, Econometrica 60 (2), 323-351.

Baldwin, R. E., 1989, The growth effects of 1992, Economic Policy, October, 247-281.

Barro, R. J., 1991, Economic growth in a cross section of countries, Quarterly Journal of Economics 106, 407-443.

Barro, R. J. and J. W. Lee, 2000, International data on educational attainment: updates and implications, CID Working Paper 42, Harvard University.

Barro, R. J. and X. Sala-i-Martin, 1991, Convergence across states and regions, Brookings Papers on Economic Activity 1:1991, 107-182.

Barro, R. J. and X. Sala-i-Martin, 1992, Convergence, Journal of Political Economy 100 (2), 223-251.

Bean, C. and C. Pissarides, 1993, Unemployment, consumption and growth, European Economic Review 37, 837-859.

Boldrin, M. and F. Canova, 2001, Inequality and convergence in Europe's regions reconsidering European regional policies, Economic Policy 32, 207-253.

Burda, M. C. and C. M. Schmidt, 1997, Getting behind the east-west [Germany] wage differential: Theory and evidence, The Davidson Institute Working Paper No. 105, William Davidson Institute, Michigan Business School.

Canova, F. and A. Marcet, 1995, The poor stay poor: non-convergence across countries and regions," CEPR discussion paper no. 1265, November.

Crespo-Cuaresma, J., M. A. Dimitz and D. Ritzberger-Grünwald, 2002, Growth, convergence and EU membership, Oesterreichische Nationalbank (Austrian National Bank) working papers no. 62.

Driffill, J. and M. Miller, 2003, No credit for transition: European institutions and German unemployment, Scottish Journal of Political Economy 50 (1), 41-60.

Eichengreen, B. and C. Wyplosz, 1998, The stability pact: more than a minor nuisance?, Economic Policy 26.

Ezcurra, Roberto, 2007, "Is Income Inequality Harmful for Regional Growth? Evidence from the European Union." Urban Studies, 44(10), 1953-1971

Fattore, Christina, 2004, "A New Kind of Regionalism: The European Regional Development Fund and Its Impact on the Economically Lagging Regions of the

European Union." Paper presented at the annual meeting of the International Studies Association, Le Centre Sheraton Hotel, Montreal, Quebec, Canada

Hallett, A. H., Y. Ma and J. Melitz, 1994, Unification and the policy predicament in Germany, CEPR discussion paper no. 956.

Hausman, J. A., 1978, Specification tests in econometrics," Econometrica 46, 1251-1271.

Henrekson, M., J. Torstensson and R. Torstensson, 1997, Growth effects of European integration, European Economic Review 41, 1537-1557.

Hunt, J., 1998, Post-unification wage growth in East Germany, CEPR discussion paper no. 2106.

Islam, N., 1998, Growth empirics: a panel data approach – A reply, Quarterly Journal of Economics 113 (1), 325-329.

Jones, C. I., 1995, Time series tests of endogenous growth models, Quarterly Journal of Economics 110, May, 495-525.

Kim, Y. B., 2004, Labour market integration and economic growth: Theory, Presented in IXth Spring Meeting of Young Economists (SMYE), Warsaw, Poland.

Krugman, P. R., 1991, Increasing returns and economic geography, Journal of Political Economy 99 (3), 484-499.

Landau, D., 1995, The contribution of the European common market to the growth of its member countries: An empirical test, Weltwirtschaftliches Archiv 4, 774-782.

Lee, K., M. H. Pesaran and R. Smith, 1998, Growth empirics: a panel data approach – A comment, Quarterly Journal of Economics 113 (1), 319-323.

Overman, H. G. and D. Puga, 2002, Unemployment clusters across Europe's regions and countries, Economic Policy, 117-147.

Paldam, M., 1997, Dutch disease and rent seeking: the Greenland model, European Journal of Political Economy 13, 591-614.

Rivera-Batiz, L. A. and P. M. Romer, 1991, Economic integration and endogenous growth, Quarterly Journal of Economics 106 (2), May, 531-555.

Romer, P. M., 1986, Increasing returns and long-run growth, Journal of Political Economy 94 (5), October, 1002-1037.

Sala-i-Martin, X., 1998, Determinants of Economic Growth: A Cross-Country Empirical Study, the MIT Press.

Shapiro, C. and J. E. Stiglitz, 1984, Equilibrium unemployment as a worker discipline device, American Economic Review 74 (3), June, 433-444.

Sibert, A. and A. Sutherland, 2000, Monetary union and labour market reform, Journal of International Economics 51, August, 421-436.

Solow, R. E, 1956, A contribution to the theory of economic growth, Quarterly Journal of Economics 70, 65-94.

Solow, R. E., 1979, Another possible source of wage stickiness, Journal of Macroeconomics 1, 79-82.

Stern, Nicholas, 1991, The Determinants of Growth, The Economic Journal, 101(401), 122-133.

Vanhoudt, P., 1999, Did the European unification induce economic growth? In search of scale effects and persistent changes, Review of World Economics 135 (2), 193-220.

Zoega, G., 2000, The implications of EMU for European labour markets, in: T. Boeri, ed., Product market competition and the labour market, (MIT Press) 368-221.

Appendix A. List of 136 Regions in 9 EU Countries

NUTS	Title of Regions	NUTS	Title of Regions	NUTS	Title of Regions
BE	**1. Belgium (11)**	GR14	Thessalia	FR81	Languedoc-Roussillon
BE1	Région Bruxelles-	GR21	Ipeiros	FR82	Provence-Alpes-Côte d'Azur
	/Brussels hoofdstad	GR22	Ionia Nisia	FR83	Corse
BE21	Antwerpen	GR23	Dytiki Ellada	**IT**	**6. Italy (20)**
BE22	Limburg (B)	GR24	Sterea Ellada	IT11	Piemonte
BE23	Oost-Vlaanderen	GR25	Peloponnisos	IT12	Valle d'Aosta
BE24	Vlaams Brabant	GR3	Attiki	IT13	Liguria
BE25	West-Vlaanderen	GR41	Voreio Aigaio	IT2	Lombardia
BE31	Brabant Wallon	GR42	Notio Aigaio	IT31	Trentino-Alto Adige
BE32	Hainaut	GR43	Kriti	IT32	Veneto
BE33	Liège	**ES**	**4. Spain (18)**	IT33	Friuli-Venezia Giulia
BE34	Luxembourg (B)	ES11	Galicia	IT4	Emilia-Romagna
BE35	Namur	ES12	Principado de Asturias	IT51	Toscana
	2. Germany (30),	ES13	Cantabria	IT52	Umbria
DE	**include exGDR from 1991**	ES21	Pais Vasco	IT53	Marche
DE11	Stuttgart	ES22	Comunidad Foral de	IT6	Lazio
DE12	Karlsruhe	ES23	La Rioja	IT71	Abruzzo
DE13	Freiburg	ES24	Aragón	IT72	Molise
DE14	Tübingen	ES3	Comunidad de Madrid	IT8	Campania
DE21	Oberbayern	ES41	Castilla y León	IT91	Puglia
DE22	Niederbayern	ES42	Castilla-la Mancha	IT92	Basilicata
DE23	Oberpfalz	ES43	Extremadura	IT93	Calabria
DE24	Oberfranken	ES51	Cataluña	ITA	Sicilia
DE25	Mittelfranken	ES52	Comunidad Valenciana	ITB	Sardegna
DE26	Unterfranken	ES53	Baleares	**NL**	**7. Netherlands (9)**
DE27	Schwaben	ES61	Andalucia	NL11	Groningen
DE5	Bremen	ES62	Murcia	NL12	Friesland
DE6	Hamburg	ES63	Ceuta y Melilla (ES)	NL13	Drenthe
DE71	Darmstadt	ES7	Canarias (ES)	NL31	Utrecht
DE72	Gießen	**FR**	**5. France (22)**	NL32	Noord-Holland
DE73	Kassel	FR1	Île de France	NL33	Zuid-Holland
DE91	Braunschweig	FR21	Champagne-Ardenne	NL34	Zeeland
DE92	Hannover	FR22	Picardie	NL41	Noord-Brabant
DE93	Lüneburg	FR23	Haute-Normandie	NL42	Limburg (NL)
DE94	Weser-Ems	FR24	Centre	**PT**	**8. Portugal (5)**
DEA1	Düsseldorf	FR25	Basse-Normandie	PT11	Norte
DEA2	Köln	FR26	Bourgogne	PT12	Centro (P)
DEA3	Münster	FR3	Nord - Pas-de-Calais	PT13	Lisboa e Vale do Tejo
DEA4	Detmold	FR41	Lorraine	PT14	Alentejo
DEA5	Arnsberg	FR42	Alsace	PT15	Algarve
DEB1	Koblenz	FR43	Franche-Comté	**UK**	**9. United Kingdom (8)**
DEB2	Trier	FR51	Pays de la Loire	UKE	Yorkshire and The Humber
DEB3	Rheinhessen-Pfalz	FR52	Bretagne	UKF	East Midlands
DEC	Saarland	FR53	Poitou-Charentes	UKG	West Midlands
DEF	Schleswig-Holstein	FR61	Aquitaine	UKH1	East Anglia
GR	**3. Greece (13)**	FR62	Midi-Pyrénées	UKK	South West
GR11	Anatoliki Makedonia,	FR63	Limousin	UKL	Wales
GR12	Kentriki Makedonia	FR71	Rhône-Alpes	UKM	Scotland
GR13	Dytiki Makedonia	FR72	Auvergne	UKN	Northern Ireland

Note: The numbers within parentheses besides of the country title indicate the number of regions used for the country. The codes in the NUTS columns indicate the NUTS level for the regions used. The EU member states are at NUTS0 coded with two letters (for instance, BE for Belgium), NUTS1 with three letters (i.e. BE2), and NUTS2 with four letters (i.e. BE21).

Appendix B. Definition of the variables and sources of the Data

Variable	Definition	Sources
Regional Growth Rate of Real Per Capita GDP (or Income)	Average Growth Rates of Real GDP Per Inhabitant (RGDPPH) of EU Regions at NUTS2 between 1982 and 1998 at its appropriate EU Country's CPI (1985 = 100). This variable is calculated using Gross Domestic Product Per Inhabitant (GDPPH) at NUTS3 in both ESA79 and ESA95, which is taken from Economic Accounts in REGIO, Eurostat. As series of GDPPH in ESA79 covers the period 1977-1996 and that in ESA95 the period 1995-1998, I reconstructed the series covering the 1977-1998 by transforming ESA95 to ESA79 with taking the year 1996 as the base year. Then I filtered NUTS2 from NUTS3. The regional GDPPH was deflated by CPI of each corresponding EU country (1985 =100).	REGIO, Eurostat
Initial Regional Income (in ECU 1,000)	Initial Regional Real GDP Per Inhabitant in 1982 (ECU, European Currency Unit), as defined above.	REGIO, Eurostat
Initial Country Income (in ECU 1,000)	Initial Country Real GDP Per Inhabitant 1982 (ECU.) at NUTS0, as defined above.	REGIO, Eurostat
Initial Country Average Wages, 1982 (in ECU 1,000)	Country Real Compensation Per Employee 1982 (ECU.). Total compensation of employees (TCE) at NUTS2 covering the period 1970-1996 is taken from Branch Accounts in Economic Accounts, Regional Statistics and deflated by CPI of its appropriate EU country (1985 =100). Then the TCE is divided by total employees at NUTS2 covering the period 1975-1997 taken from the Branch Account. This variable covers 7 member states corresponding to 118 regions, compared with the total sample of136 regions in 9 EU countries.	REGIO, Eurostat
Regional Unemployment Rate, 1988	Local Unemployment/Working Population Rate, 1988 that is the earliest year that cover the whole sample.	Eurostat
Country Rate of Schooling, 1980	Rate of "Secondary School Complete" or "Higher School Attained" in the Total Population of 25 Years or More, 1980.	Barro & Lee (2000)
Regional Dummies for EU Structural Funds 1989-93	1 for 102 regions (out of 136 sample regions) which have been granted EU structural funds (including Objectives 1, 2 and 5b) between 1989 and 1993 and 0 for the rest of the sample regions.	Annual Reports on Structural Funds, EC
Country Rate of EU Structural Funds 1989-93	Country Ratio of EU Structural Funds (including all Objectives) between 1989 and 1993 to GDP in 1989.	Annual Reports on Structural Funds, EC
CPI (1985 = 100)	Consumer Price Indices (Annual): various consumption goods and services of each of 9 EU member countries used (1985 = 100). The CPIs at country level is taken from Theme2 Economics and Finance, Eurostat.	PRICE, Eurostat

Appendix C. Summary Statistics

	All Regions				
	Mean	Max	Min	Std. Dev.	Obs.
Regional Growth 1982-98	0.007315	0.0478	-0.095407	0.033339	136
Regional Income 1982	9781.517	22746.83	4130.65	2902.24	136
Country Income 1982	10185.23	12893.08	5278.22	2191.89	136
Country Real Wages 1982	17144.53	21472.72	6045.93	4183.19	118
Regional Unemp. Rate 1988	0.102	0.353	0.032	0.056	136
Country Educ. Attain. 1980	0.213	0.331	0.081	0.073	136
Country EU Struct. Funds Rate 1989-93	0.022335	0.144363	0.000671	0.039545	136
	Poor Regions				
	Mean	Max	Min	Std. Dev.	Obs.
Regional Growth 1982-98	0.00839	0.043085	-0.092981	0.034441	94
Regional Income 1982	8923.03	12642.37	4130.65	2135.90	94
Country Income 1982	10410.82	12893.08	5278.22	2190.08	94
Country Real Wages 1982	17068.13	21472.72	6045.93	4541.65	80
Regional Unemp. Rate 1988	0.104	0.353	0.034	0.059	94
Country Educ. Attain. 1980	0.220	0.331	0.081	0.071	94
Country EU Struct. Funds Rate 1989-93	0.022839	0.144363	0.000671	0.041935	94
	Rich Regions				
	Mean	Max	Min	Std. Dev.	Obs.
Regional Growth 1982-98	0.004908	0.0478	-0.095407	0.030991	42
Regional Income 1982	11702.90	22746.83	6965.96	3451.77	42
Country Income 1982	9680.33	12893.08	5278.22	2135.84	42
Country Real Wages 1982	17305.37	21472.72	6045.93	3354.90	38
Regional Unemp. Rate 1988	0.098	0.218	0.032	0.049	42
Country Educ. Attain. 1980	0.198	0.331	0.081	0.075	42
Country EU Struct. Funds Rate 1989-93	0.021207	0.144363	0.000671	0.034034	42

Table 1. EU Regional Growth Regressions

Sub-Table	1A		1B				1C	
Estimation Method	Robust Pulled OLS		Robust Fixed Effects		FE Coefficient OLS		Random Effects	
	A1	A2	B1	B2	B1F	B2F	C1	C2
Initial Regional Income 1982 (in ECU 1,000)	-0.00547** (-3.04)	-0.00971** (-3.98)	-0.00735** (-2.86)	-0.00714** (-2.89)			-0.00690** (-4.18)	-0.00971** (-4.28)
Initial Country Income 1982 (in ECU 1,000)	-0.00318** (-2.36)	-0.00921** (-2.99)			-0.00423** (-1.72)	-0.00669 (-1.32)		-0.00921** (-3.62)
Country*Regional Income 1982 (in ECU Mil.)	0.00043** (2.75)	0.00081** (3.83)	0.00057** (2.68)	0.00055** (2.67)			0.00054** (3.6)	0.00081** (3.99)
Initial Country Wages 1982 (in ECU 1,000)	-0.00119** (-6.25)	-0.00089** (-3.50)			-0.00107* (-1.50)	-0.00080 (-0.92)		-0.00089** (-4.84)
Regional Unemployment Rate 1988	-0.0240 (-1.08)	-0.02892* (-1.27)	-0.04* (-1.61)	-0.03696* (-1.52)			-0.03113** (-2.33)	-0.02892* (-1.62)
Country Rate of Schooling 1980	0.1827** (19.98)	0.15211** (10.36)			0.185** (2.50)	0.00159* (1.83)		0.15211** (10.75)
Regional Dummy for EU Funds 1989-93		-0.00302** (-1.79)		-0.00188* (-1.43)				-0.00302** (-1.91)
Country Rate of EU Funds 1989-93 to GDP 1989		-0.70367** (-1.94)				-0.60422 (-0.62)		-0.70368** (-2.88)
Constant	0.0427 (2.45)	0.11766 (3.22)			0.058 (2.80)	0.08964 (1.58)	0.0195 (1.70)	0.1177 (3.90)
Adjusted R^2 (R^2 overall)	0.792	0.813	0.877	0.878	0.451	0.311	(0.2139)	(0.8256)
S.E. of regression (Wald χ^2)	0.007	0.0065	0.0052	0.0052	0.0088	0.0096	(18.27)	(447.91)
Durbin-Watson (Hausman χ^2)	0.914	1.08	1.66	1.64	1.74	1.46	(2.83)	
Included Obs	118	118	118	118	7	7	136	118

Note: *t*-values appear within parentheses below the coefficients and are obtained with White heteroskedasticity-consistent standard errors & covariance whenever necessary. **Significant at 5%; *Significant at 10%. The dependent variable is average of growth rates of regional income from 1982 to 1998 except B1F and B2F for which coefficients on country fixed effects are used. The loss of observations from 136 to 118 is due to the exclusion of 13 regions of Greece and 5 regions of Portugal for which there are no wage data available. Critical values for χ^2 at 5% are $\chi^2(3) = 7.81$, and $\chi^2(6) = 12.59$.

Table 2. Rich EU Regional Growth Regressions

Sub-Tables	2A		2B				2C	
Estimation Method	Robust Pulled OLS		Robust Fixed Effects		FE Coefficient OLS		Random Effects	
Regressors	A1	A2	B1	B2	B1F	B2F	C1	C2
Initial Regional Income	-0.00751**	-0.01470**	-0.01310**	-0.01130**			-0.01330**	-0.01470**
1982	(-3.52)	(-3.97)	(-3.45)	(-3.03)			(-3.41)	(-3.61)
Initial Country Income	-0.00493**	-0.01620**			-0.00964**	-0.01170**		-0.01620**
1982	(-2.36)	(-2.89)			(-4.77)	(-5.30)		(-2.85)
Country*Regional Income	0.00059**	0.00122**	0.00108**	0.00091**			0.00109**	0.00122**
1982	(3.09)	(3.67)	(3.33)	(2.73)			(3.11)	(3.33)
Initial Country Wages	-0.00145**	-0.00131**			-0.00175**	-0.00134**		-0.00131**
1982	(-4.48)	(-5.91)			(-2.96)	(-3.78)		(-4.45)
Regional Unemployment Rate	-0.03730*	-0.05938**	-0.0786**	-0.07295**			-0.05984**	-0.05938**
1988	(-1.43)	(-1.94)	(-2.52)	(-2.28)			(-1.73)	(-1.88)
Country Rate of Schooling	0.2044**	0.16965**			0.2053**	0.00173**		0.16965**
1980	(13.22)	(7.70)			(3.37)	(4.92)		(7.83)
Regional Dummy for EU Funds		-0.00353*		-0.00370*				-0.00353*
1989-93		(-1.61)		(-1.64)				(-1.56)
Country Rate of EU Funds		-1.14527**				-0.81859*		-1.14528**
1989-93 to GDP 1989		(-2.07)				(-1.91)		(-2.21)
Constant	0.0667	0.20861			0.130	0.16076	0.0303	0.2086
	(2.48)	(3.15)			(7.63)	(6.34)	(2.10)	(3.07)
Adjusted R^2 (R^2 overall)	0.864	0.892	0.888	0.894	0.867	0.949	(0.2328)	(0.9153)
S.E. of regression (Wald χ^2)	0.0059	0.0053	0.0054	0.0053	0.0072	0.0038	(13.26)	(236.62)
Durbin-Watson (Hausman χ^2)	0.506	0.90	0.94	0.89	1.43	3.26	(0.48)	
Included Obs	38	38	38	38	6	6	42	38

Note: *t*-values appear within parentheses below the coefficients and are obtained with White heteroskedasticity-consistent standard errors & covariance whenever necessary. **Significant at 5%; *Significant at 10%. The dependent variable is average of growth rates of regional income from 1982 to 1998 except B1F and B2F for which coefficients on country fixed effects are used. The loss of observations is due to the exclusion of regions of Greece and Portugal for which there are no wage data available. For the rich group, there is no region for the UK. Critical values for χ^2 at 5% are $\chi^2(3) = 7.81$, and $\chi^2(6) = 12.59$.

Table 3. Poor EU Regional Growth Regressions

Sub-Table	3A		3B				3C	
Estimation Method	Robust Pulled OLS		Robust Fixed Effects		FE Coefficient OLS		Random Effects	
	A1	A2	B1	B2	B1F	B2F	C1	C2
Initial Regional Income 1982 (in ECU 1,000)	-0.00435 (-0.92)	-0.02900** (-3.82)	-0.00941** (-2.23)	-0.00956** (-2.23)			-0.00321 (-0.88)	-0.02900** (-5.13)
Initial Country Income 1982 (in ECU 1,000)	-0.00174 (-0.70)	-0.02560** (-3.65)			-0.00403 (-1.15)	-0.00987* (-1.52)		-0.02560** (-5.11)
Country*Regional Income 1982 (in ECU Mil.)	0.0003 (0.79)	0.00241** (3.78)	0.00070** (1.90)	0.00072** (1.92)			0.000213 (0.67)	0.00241** (5.10)
Initial Country Wages 1982 (in ECU 1,000)	-0.0011** (-3.31)	-0.00057** (-1.88)			-0.00101 (-0.99)	-0.00047 (-0.42)		-0.00057** (-2.63)
Regional Unemployment Rate 1988	-0.026 (-0.69)	-0.05069** (-1.75)	-0.0009 (-0.33)	-0.00787 (-0.28)			0.01131 (0.71)	-0.05069** (-2.06)
Country Rate of Schooling 1980	0.172** (9.14)	0.11619** (5.55)			0.2084** (1.98)	0.00160* (1.44)		0.11619** (6.33)
Regional Dummy for EU Funds 1989-93		-0.00309* (-1.50)		-0.00108 (-0.89)				-0.00309* (-1.61)
Country Rate of EU Funds 1989-93 to GDP 1989		-2.26849** (-3.44)				-1.29718 (-1.05)		-2.26851** (-5.08)
Constant	0.0309 (0.97)	0.32196 (3.87)			0.052 (1.76)	0.12349 (1.70)	0.0117 (0.86)	0.3220 (5.28)
Adjusted R^2 (R^2 overall)	0.720	0.798	0.905	0.904	0.196	0.218	(0.2687)	(0.8186)
S.E. of regression (Wald χ^2)	0.007	0.0062	0.0043	0.0043	0.0126	0.0122	(2.13)	(273.02)
Durbin-Watson (Hausman χ^2)	0.564	0.82	1.40	1.41	2.13	2.07	(3.69)	
Included Obs	80	80	80	80	7	7	94	80

Note: *t*-values appear within parentheses below the coefficients and are obtained with White heteroskedasticity-consistent standard errors & covariance whenever necessary. **Significant at 5%; *Significant at 10%. The dependent variable is average of growth rates of regional income from 1982 to 1998 except B1F and B2F for which coefficients on country fixed effects are used. The loss of observations is due to the exclusion of regions of Greece and Portugal for which there are no wage data available. Critical values for χ^2 at 5% are $\chi^2(3) = 7.81$, and $\chi^2(6) = 12.59$.