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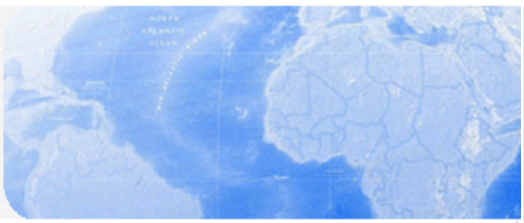

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INTERREGIONAL REDISTRIBUTION, GROWTH AND CONVERGENCE

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Abstract

Countries redistribute substantial amounts of wealth between regions through taxation and social security, even in the absence of an explicit regional policy. Economic theory suggests such redistribution might be distorting. This paper indeed finds that more redistribution leads to subsequent lower growth, but also slower interregional convergence.

This may explain the observed lack of within-country convergence in the EU, in contrast to faster convergence between countries where such redistributive schemes do not exist. In contrast, investment in infrastructure or human and physical capital is found to foster both growth and convergence.

Key words: income redistribution, inequality, regional convergence

JEL: O47; H3

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Introduction

There exist many systems through which income is redistributed between regions with different levels of wealth, both within countries and between countries, for example within supra-national organisations such as the EU. Many federal states have set up elaborate redistributive systems with the explicit aim to equalise wealth between regions. But even in a country without an explicit regional policy, the existence of a progressive tax system in combination with an equal provision of public goods across regions de facto implies interregional redistribution.

The size of both the interregional income differentials and the amount of redistributed wealth can be substantial. The question on the effect of interregional redistribution and especially the effect on regional growth and convergence therefore is an important one. Can redistribution help poorer regions to catch-up, or does it merely work redistributive without structurally changing the growth path of the poorer region? Or worse: does it distort incentives to an extent which prevents a potential catch-up from taking place?

Poorer European regions show higher average growth rates such that convergence might be reasonably expected. Convergence is slow, however, and seems to have slowed down even more in recent decades (Sala-i-Martin, 1996; de La Fuente and Vives, 1995). Clusters of regions (convergence clubs) seem to be emerging with different growth paths. Within many member states there is no sign of regional convergence. This observed lack of intra-country convergence is far from new. The European Commission (1999) reports that between 1986 and 1996 regional disparities decreased only in the UK and Portugal and more recent figures confirm this trend (see for example Armstrong and Vickerman, 1995; Canova and Marcet, 1995; Overman and Puga, 2002; Magrini, 2004).

There obviously exist many differences between regions within a single country on the one hand and regions in different countries on the other hand. Migration and trade, for example, are known to be more intensive within countries. Legislation such as labour market regulation is more homogeneous within countries. These facts, however, only add to the puzzle why within-country convergence rates are lower, rather than offering a possible explanation. The fact that regions within the same country are subject to substantial redistributive schemes by a central government is a distinctive property which has not received much attention in the growth and convergence literature and will be the focus of this paper.

Inter-state redistribution in the EU is necessarily limited since the EU budget is currently capped at 1.24 percent of GNI. Gordon (1991) estimates EU transfers lead to a 3 percent reduction of the initial difference in member state per capita income. Doménech et al. (2000) obtains 5 percent with more recent

data. These amounts are dwarfed by the estimated amount of within-country redistribution operating through taxation and social security. Mélitz and Zumer (2002), for example, estimate a 26 percent reduction of regional income inequality in the UK and a 38 percent reduction for France. The median EU member state in our sample compensates about 35 percent of interregional differences in primary income.[1]

The effect of fiscal policy has received considerable attention in the theoretical growth literature. Most contributions agree on the effects: income taxes (see for example Barro, 1990) and especially progressive income taxes (see Li and Sarte, 2004) distort investment incentives and long run growth. Kneller et al. (1999) find that income taxes and net social security payments are detrimental to growth. No negative effect is found for taxes on consumption.

Importantly, these models consider growth in a single country or region. The question on the effect of redistributive fiscal flows on interregional convergence has received far less attention in both the theoretical and empirical literature. Some models which explicitly consider the effects of interregional redistribution on convergence will be discussed in the next section. The main contribution of this paper, however, is empirical.

We will investigate the link between redistribution, growth and convergence by using two distinct datasets. Data from Eurostat from 1995 to 2005 on 173 regions in 10 EU member states is used to estimate the extend of within-country interregional redistribution and the speed of interregional convergence. This dataset contains observations on various regional characteristics, primary and secondary income, and information on the size of transfers by taxation, social security and other transfers. Arguably, a time-span of only 10 years is short to investigate phenomena such as growth and convergence. The main quality of this dataset is its rich cross-sectional dimension: there exist substantial interregional differences which can be exploited, in terms of the level and growth of regional income, and also with respect to the extend of within-country redistribution in the different member states and changes therein. Our results indicate that the lack of intra-country convergence in the EU can indeed be attributed to the existence of distorting within-country interregional redistribution.

Given the limited time-span of the European regional data, a second dataset was used with annual observations on primary and disposable income in 48 US states, for the years 1960-2006. Obviously, the main quality of this dataset is its long time-dimension, whereas it lacks a cross-sectional dimension. We

[1]See von Hagen (1998) for an overview of estimates of interregional redistribution in a variety of countries.

therefore estimate measures of redistribution and convergence for different time periods, and find that periods with more inter-state redistribution are characterised by lower subsequent convergence rates.

These results in line with Kessler and Lessmann (2008), who investigate the effect fiscal transfers to sub-national governments on regional disparities within a large set of developed countries. Our measure of interregional transfers differs significantly from theirs, however. Moreover, whereas Kessler and Lessmann (2008) estimate the effect on interregional disparity, we consider the effects on both regional growth and convergence. This allows to control for various regional characteristics and policies apart from interregional transfers.

The study which comes the closest to our approach is probably Checherita et al. (2009), who also consider both growth and convergence effects of redistribution. Again, however, our measure of redistribution differs significantly, and so do our interpretation and conclusions.

Our results indicate redistribution is not only bad for convergence but also for growth. A regional redistributive scheme therefore is an expensive equity-efficiency trade-off: although redistribution reduces inequality in disposable income between regions, this comes at the double cost of both a lower country-level growth rate, but also even lower growth in primary income in the receiving backward regions.

The remainder of this paper consists of three sections. Section 2 gives a short overview of the existing literature on the theory and empirics of interregional transfers and convergence. Section 3**Error! Reference source not found.** introduces the datasets, derives a measure of redistribution and considers the effect of interregional redistribution on within-country disparity in a σ-convergence framework. Section 4 shows how transfers and other factors affect regional growth and convergence by means of a β-convergence analysis. A final section concludes.

Literature overview

Some theory on public policy and regional disparities

Obviously, regional policy may foster convergence in certain settings. In the neoclassical growth model of Doménech et al. (2000), for example, interregional transfers increase the capital stock of backward regions and as such lead to faster convergence. In the hybrid endogenous growth model of Puigcerver-Peñalver (2007) public policy affects the rate of technological progress and growth in backward regions. Given the mechanisms underlying growth in these models it is unsurprising that a government can

promote convergence through specific policy measures. What is worrying is that some policy measures which would intuitively foster growth in the poorer region may have the opposite effect. In the following paragraphs we briefly discuss four examples: interregional infrastructure investment, tax-breaks in the backward region, progressive income taxes and centralised wage setting with subsequent social transfers to the unemployed.

A significant part of European regional funds are invested in infrastructure. Models of economic geography, such as Martin and Rogers (1995); Puga (2002); Behrens (2003), however, show that infrastructure works in a country may increase regional inequality. Lower transport costs in presence of a sufficient asymmetry in market potential between the regions causes firms to relocate from the poorer to the richer region. If transport costs within the backward region decline more than the transport costs between regions, the backward region may benefit from infrastructure works. As argued by Ago et al. (2006) and Behrens (2004), however, a backward region may benefit from lower transport costs depending on its location (for example when the backward region is located in between two wealthier regions).

Dupont and Martin (2006) use a small general equilibrium model with two regions and mobile firms to show that various subsidy schemes in the poorer region, such as tax-breaks or production subsidies which are financed on the national level, may actually increase interregional inequality and even decrease welfare in the poorer region. Dupont and Martin (2006) show that when capital is mobile, these subsidies eventually only benefit capital owners, irrespective of their location. When more capital owners live in the richer region this policy will increase regional inequality.

In a very different setting with constant returns to scale and perfectly mobile labour and capital Padovano (2007) derives similar results. In his model productive factors relocate to the region with the highest return which leads to income convergence. Progressive taxation of factor income reduces interregional factor return differentials. This slows the relocation of factors of production and leads to slower convergence. Appendix 6 shows the derivation of the effect of redistribution on mobility and convergence in a model based on Blanchard (1991) and Padovano (2007). This model will serve as the basis of the empirical analysis in section 4. Kessler and Lessmann (2008) consider the effect of regional transfers in a model with mobile labour, and find that such transfers prevent convergence. Padovano (2007) and Hansen and Kessler (2004) develop a model of political economy where such a system which promotes regional disparities emerges endogenously.

An alternative channel which might explain a link between interregional social security payments and convergence and growth can be found in Faini (1999). His model considers the effects of central wage setting in the presence of regional productivity differences. The effects are lower growth on the country level, and even lower growth in the more backward region. As unemployment increases more in the low-productivity region, interregional flows related to social security are higher when wages are equalised between both regions. In this case interregional redistribution through the social security system is a symptom of the labour market rigidities which are the cause of lower growth and slower convergence.[2]

The predicted effects of interregional transfers on convergence therefore appear to depend on the nature of the transfers. Transfers which are purely redistributive are mostly predicted to distort incentives, growth and convergence. Transfers which are able to increase the capital stock and R&D investment in the backward region are predicted to foster growth and convergence. The predictions on the effect of infrastructure investment are very different when comparing models of economic geography and neoclassical models of economic growth.

Regional disparities and regional policy in the EU

European regions show large differences in various measures of economic performance and welfare such as regional measures of income per capita or unemployment rates. As noted by Puga (1999); Puga (2002), nearly one in four EU citizens live in regions which receive money from the EU's structural funds, as they have a gross domestic product per capita below 75 percent of the EU average. If a similar system would exist in the US only 2 States, Missisipi and West Virginia would be eligible, containing only 2 percent of the US population. The question whether the EU regional policy is helping poor regions has been the topic of a broad empirical literature.

Boldrin and Canova (2001) take a critical stance on the effectiveness of European regional policies. They note that income disparities in the EU15 are large and do not seem to be disappearing. Similarly Midelfart-Knarvik and Overman (2002) find that the EU structural funds have been unsuccessful in fostering growth in lagging regions. Midelfart-Knarvik and Overman (2002) suggest policy should focus on activities which are in line with existing comparative advantages of the target region. They believe regional comparative advantages (as opposed to comparative advantages on the national level) are severely restricted by centralised wage setting and this prevents regions within countries to converge.

[2]The balanced growth path is different in the two regions in this model, absolute convergence therefore does not normally occur even in the absence of central wage setting. Nevertheless, observed unconditional and conditional convergence rates will be lower as a consequence of centralised wage setting.

Using a spatial econometric model which explicitly takes into account potential regional spillover effects Dall'erba and Le Gallo (2003) find no impact of structural funds and no interregional spillover effects.

Fagerberg and Verspagen (1996) find proof of regional divergence with the emergence of different growth clubs, after an initial post-war period of convergence. They do not find a significant effect of structural funds on regional growth. Cappellen et al. (1999) and Cappelen et al. (2003) find a positive impact on regional growth, but note that the effect is conditional on the presence of a favourable institutional environment in the receiving region. In other words, the policy is most effective where it is less needed. These contributions emphasise the role of R&D, which acts as a major determinant of growth but tends to be highly spatially concentrated. European regional policy insufficiently targets such drivers of growth, and Cappellen et al. (1999) suggest that any positive effect these policies might have are counteracted by other policies at the EU or national level. Ederveen et al. (2006) find a similar conditional effect of structural funds on convergence between member states. Falk and Sinabell (2008) find that although objective 1 NUTS 3 regions grow faster, this is almost completely explained by the characteristics of these regions, such as their lower initial level of income.

Some studies are more optimistic on the effect of regional funds. The study of Beugelsdijk and Eijffinger (2005) finds that structural funds are significantly contributing to economic convergence between entire member states over a time-span of only seven years, despite the relatively limited size of the EU budget for regional policy.

Summarising the large and heterogeneous literature evaluating the EU regional policy is hazardous. Despite the mixed results, it nevertheless appears that regional policy is not delivering as much as hoped for. The best results are obtained from policies stimulating R&D and training and education. These positive effects, however, depend on the presence of certain conditions in the targeted regions.

The effectiveness of interregional redistribution on the country-level

Reducing income inequality is an important goal for many national governments. Governments redistribute wealth between regions in various ways. For obvious reasons, the empirical literature's attention has been drawn to cases where there exist both large interregional differences in income and substantial redistribution, and to cases where the effectiveness of the policy in reducing interregional inequality has been questioned. Rather worrying with respect to the effectiveness of regional redistribution are the examples of Italy, Germany and Belgium. These countries are characterised by large regional differentials in terms of both income and unemployment rates, and have large explicit and implicit interregional flows.

The average yearly transfer from former West-Germany to former East-Germany amounts to about 80 billion Euro. This exceeds the combined official development assistance by OECD countries. In spite of these efforts, fast regional convergence did not result (see for example Boltho et al., 1997; Rummel, 1997; Snower and Merkl, 2006). Rather telling is the fact that the Czech Republic is expected to converge with West-Germany in terms of GDP per capita before East-Germany does (Hunt, 2008).

Padovano (2007) finds for Italy that periods with higher rates of interregional redistribution are associated with lower interregional convergence rates. Faini (1999) sees the abolition of regional wage differentials in Italy at the end of the 60's as a possible cause of the halt of the convergence process in the 70's and the observed divergence in the 80's at the end of last century. Cerisola and Ramakrishnan (2004) draw a similar conclusion regarding the link between central wage agreements and convergence between Australian states.

Similarly for Canada, Dunaway et al. (2003) note that the national unemployment insurance system had a significant negative impact on convergence, but less distorting lump-sum payments from the central government to less well-off provinces did not impede interregional convergence. Coulombe and Day (1999) point out the more generous Canadian unemployment benefit system may explain the different evolution of interregional disparities, comparing groups of Canadian states with groups of neighbouring US states.

One of the few studies which investigate the link between transfers and convergence by comparing multiple countries is Kessler and Lessmann (2008). These authors develop a theory explaining how interregional redistribution may prevent convergence promoting migration. Using a panel of 23 OECD countries, they estimate the share of sub-national government revenue which is received to grants by other levels of government and the share of sub-national government which is determined autonomously. It is found that countries which have large or increasing interregional fiscal flows according to these measures face increasing regional disparities, whereas countries with low or decreasing interregional fiscal flows exhibit steady or decreasing interregional disparities.

Checherita et al. (2009) is another study which compares fiscal transfers in multiple countries to derive conclusions on its effects on convergence. Controlling for various growth determinants, it is found that transfers may lead to convergence by lowering growth in richer, heavily taxed regions, more than by promoting growth in the backward regions.

Interregional redistribution and income disparities

Whereas investment in say transport infrastructure is relatively easy to measure, the large interregional flows via the tax system, direct personal state transfers or through the social security system are more difficult to quantify. As the return to factors of production is key to migration, relocation and investment decisions, it is the extend to which transfers affect the relative regional factor prices which matters for convergence, rather than the absolute amount transferred. This focus is an important difference between our model and other studies investigating the link between transfers and convergence in a multi-country setting such as Kessler and Lessmann (2008) and Checherita et al. (2009). As in Bayoumi and Masson (1995) and Mélitz and Zumer (2002) we fit following conditional mean specification by ordinary least squares:[3]

$$\mathrm{E}\left[\frac{Y_{i,disp}}{Y_{disp}}\right] = \beta_0 + (1-\rho)\frac{Y_i}{Y}, \tag{1}$$

where Y_i is the primary household income in some region i, $Y_{i,disp}$ the secondary or disposable income, which is obtained after subtracting contributions and adding transfers through the social security system, taxation, and direct transfers to households. Variables without indices denote country averages. $1-\rho$ expresses how much, on average, of a relative difference in primary income is translated in a relative differences in secondary income. ρ is the share of the primary income differential which is removed through redistribution and will be referred to as the 'rate of interregional redistribution'. Appendix A shows how this measure of redistribution is relevant for the analysis of regional growth and convergence.

The first column of table 1 shows the estimated rate of redistribution obtained from estimating equation(1) for each EU member state in our sample[4], in 1995. The reported rates of redistribution for Germany and France in table 1 are slightly larger than those of Mélitz and Zumer (2002). This might be due to small changes in accounting rules. Figures 5 and 6 in the appendix illustrate the evolution of the

[3]The index of geographical redistribution of Padovano (2007) is the coefficient γ from the regression $\frac{Y_{i,disp}}{Y_i} - \gamma_0 = \gamma \log(Y_i)$. It can be easily shown that if the average of $Y_i/Y_{i,disp}$ is not too different from Y_i/Y_{disp}, then γ will be close to ρ (for geometric averages $\rho = \gamma$). In our dataset the correlation between γ and ρ is 0.96, and the difference between both measures in the estimation results is minimal.

[4]Finland, Ireland, Denmark and Luxemburg contain to few NUTS 2 regions to reliably calculate the amount of interregional redistribution. Greece had to be dropped from the analysis on grounds of data availability. Our results are nevertheless robust to the inclusion of these member states in the analysis (where possible).

rate of redistribution in these different countries over time. Whereas most countries show a clear trend, the behaviour is more erratic in others (most notably the Netherlands and Sweden). To cancel out the effect of temporary shocks to the rate of convergence, we will use a four year moving average of the rate of redistribution rather than the original series in the formal analysis, but using the original non-smoothed values hardly changes the results.

	ρ_{1995}	$\rho_{2005} - \rho_{1995}$	cv_{1995}	$cv_{2005} - cv_{1995}$	β	conv. rate
AT	0.481	−0.046	0.088	−0.023	−0.034	0.041
FR	0.425	−0.030	0.135	−0.009	−0.013	0.014
NL	0.425	0.030	0.085	0.021	0.029	−0.026
UK	0.399	−0.013	0.140	0.015	0.012	−0.012
SE	0.381	0.036	0.125	0.014	0.015	−0.014
BE	0.361	−0.036	0.155	0.013	0.010	−0.009
DE	0.322	0.078	0.174	0.002	−0.002	0.002
ES	0.282	−0.069	0.209	−0.010	−0.013	0.014
PT	0.250	0.005	0.229	−0.027	−0.026	0.030
IT	0.179	0.021	0.285	−0.058	−0.029	0.034

Table 1: The measured rate of interregional redistribution ρ, the coefficient of variation in regional primary income cv and β-convergence rates in different EU member states.

The third column of table 1 reports the level of regional disparity in primary income in 1995, as expressed by the coefficient of variation in all the EU member states which will be used in the empirical section. The *level* of the rate of redistribution in a country is clearly inversely related to the amount of regional income disparity. It appears that countries with large interregional differences have lower rates of redistribution (which need not imply smaller interregional flows), whereas countries with a more uniform income distribution can afford a higher rate of redistribution (which need not imply larger flows between regions). Figure 1 illustrates this link, by plotting the average regional disparities within a country against the average rate of interregional redistribution.

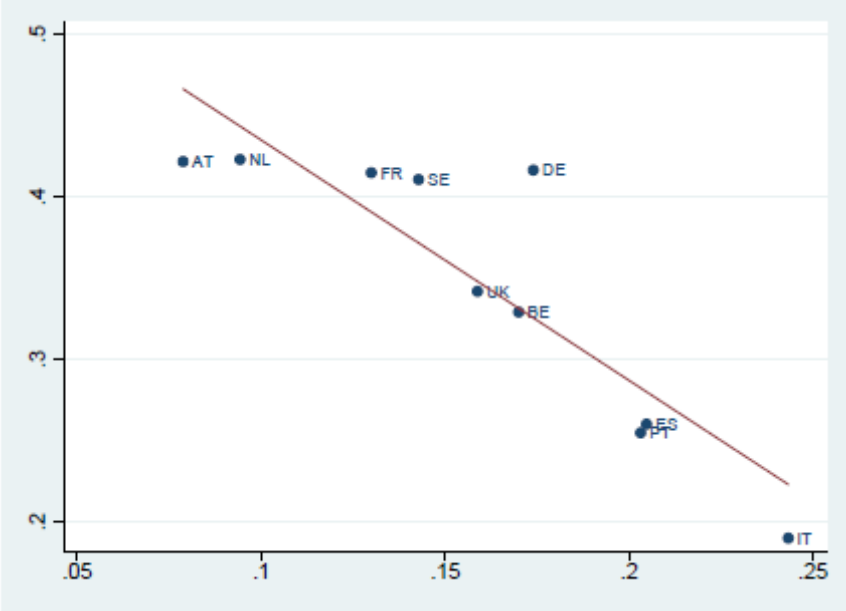

Figure 1: Within-country regional disparities as measured by the average coefficient of variation in the regional primary income (horizontal axis) and the average rate of within-country interregional redistribution (vertical axis).

Noteworthy is also the fact that countries which redistribute more than predicted given their level of regional disparity and the average behaviour of the other EU member states in the sample, such as Germany and Sweden, appear to be countries which exhibited only small decreases or even increases in interregional disparity as measured by the change in the coefficient of variation. Countries which redistribute significantly less (Austria, Italy) experienced relatively fast interregional convergence. Also, when considering the *change* in the rate of redistribution over time and the *change* in within-country regional disparity shown in the second and fourth column of table 1, the positive relationship which was apparent in the levels is reversed: countries which increased the rate of redistribution on average show an increase in disparity as measured by the change in the coefficient of variation. This relationship is not significant, however.

Following regression allows a more formal analysis of the growth of regional disparities $\Delta \log(cv_{nt})$ in a country n and its determinants

$$\Delta \log(cv_{nt}) = \rho_{nt-1} + \gamma X_{nt-1} + \eta_n + \xi_t + \epsilon_{nt}. \qquad (2)$$

This specification is essentially a type of conditional σ-convergence analysis. It allows to determine how the rate of redistribution ρ and a vector of other determinants X in a country n affect the subsequent change in the level of regional income disparities as measured by the percentage growth of the coefficient of variation cv_{nt}. The change in variation is considered with respect to the average change in each country by including country fixed-effects, thus controlling for trends in the evolution of regional inequality which might differ between countries in a non-random fashion. Similarly, the specification includes year dummies to control for unobserved common shocks to both dependent and independent variables which might affect the results. Table 2 reports the results.

Dependent variable: $\Delta \log(cv_{nt})$		
ρ_{nt-1}	0.288^{a}	0.420^{b}
	(0.0822)	(0.142)
covunemp_{nt-1}		−0.0628
		(0.0730)
covold_{nt-1}		−0.000915
		(0.0106)
covdeath_{nt-1}		0.0603^{c}
		(0.0282)
$\text{covagrishare}_{nt-1}$		0.178
		(0.274)
constant	-0.138^{a}	−0.213
	(0.0284)	(0.142)
N	100	90
R^2	0.20	0.285

Robust standard errors in parentheses.
^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$

Table 2: The effect of redistribution and other variables on the subsequent evolution of within-country regional income disparity in EU member states.

The positive coefficient on the past level of redistribution is indicative of a perverse effect of redistribution: periods with a high level of redistribution, relative to the country average, are characterised by subsequent interregional divergence in primary income, above the country-specific trend. This

relationship holds while controlling for year dummies and other factors which might influence both the level of redistribution and subsequent changes in inequality, such as the regional variation in unemployment, the disparity in the share of elderly people in the regional population, the disparity of the mortality rate, and interregional differences in the share of agriculture in total employment.

The results of this section showed increases in interregional redistribution lead to subsequent increases in regional dispersion of primary income in the EU. Appendix B reaches the same conclusion regarding the effect of redistribution on the evolution of regional disparities in the US. As a country-level summary statistic the coefficient of variation in regional primary income is hardly suited for an analysis of the differences in regional growth rates which are underlying the observed changes in regional income disparity. It is impossible to determine whether redistribution increases disparities by decreasing growth in poorer regions, or rather by increasing growth in richer regions, for example. The next section therefore explicitly considers regional growth and its determinants. By investigating how the growth rates of regions depend on their initial level of income it can be determined whether convergence in primary income can reasonably be expected. We will investigate how redistribution and other policy measures affect convergence by evaluating the effect of these variables on growth at different levels of initial regional income.

Redistribution as a determinant of regional growth and β-convergence

β-convergence between EU-regions

Standard neoclassical growth models predict that regions with similar characteristics apart from a different initial level of wealth should convergence towards the same balanced growth path. Poorer regions are predicted to grow faster, and within this framework the rate of convergence can be derived from estimating the relationship between the average growth rate of regional primary income in time t over some period of length τ, and the log of the initial level of primary income $y_{int-\tau}$ of a region i in country n as in

$$\frac{Y_{int} - Y_{int-\tau}}{\tau Y_{int-\tau}} = \beta_0 + \beta y_{int-\tau} + \epsilon_{int}. \qquad (3)$$

There is proof for β-convergence if the coefficient β is negative and significant, and the rate of convergence can be calculated as $r = -\frac{\ln(1+\beta)}{\tau}$. A possible issue with this approach is the fact that the initial level of income $y_{it-\tau}$ might be correlated with regional characteristics affecting growth. We will attempt to control for this by including regional characteristics, and adding country-level (and later regional) fixed effects. Under certain conditions a negative coefficient on initial income may not imply a decrease in interregional income disparity, for example in a situation where poorer regions grow sufficiently fast to overtake the richer regions. We believe such cases are not highly relevant for the case of European regional growth. Table 1 shows the estimated coefficients β when estimating equation (3) for each member state separately over the ten years in the sample. Germany is the only country which shows β convergence, but not σ convergence. The β coefficient remains of interest as a measure of the tendency of poorer regions to grow faster, even if this does not imply a decrease in dispersion. As noted by de La Fuente (2002), this holds even if the underlying production function is not neoclassical or even abstracting completely from an underlying structural model.

Figure 2 shows a scatterplot of the log of primary income per capita in 1995 versus the average growth rate of this variable over the years 1995-2005, for all NUTS2 regions in the EU15 member states for which this data is available.[5] There is clear evidence of β-convergence: initially poorer regions are growing faster than richer regions. The bold negatively sloped line shows the estimated relationship between the initial level of wealth and subsequent growth as estimated by least squares. The highly significant slope parameter (β) is about -0.0315, which corresponds to a convergence rate of about 3.7% annually. There is much less evidence of convergence between regions within individual member states, however. Many member states experience slow convergence or even divergence. The thinner lines show the least squares estimation of equation (3) for individual member states and the fifth and sixth column of table 1 show the estimated β coefficients and the corresponding convergence rates for each country which will be used in the subsequent analysis. With the exception of Greece, all member states are characterised by substantially slower within-country regional convergence rates compared to the EU-wide sample. Five of these member states (Belgium, Finland, the Netherlands, Sweden and the UK) even experienced further widening of primary regional income disparity over this time period.

[5]This leaves out Denmark, Ireland and Luxembourg.

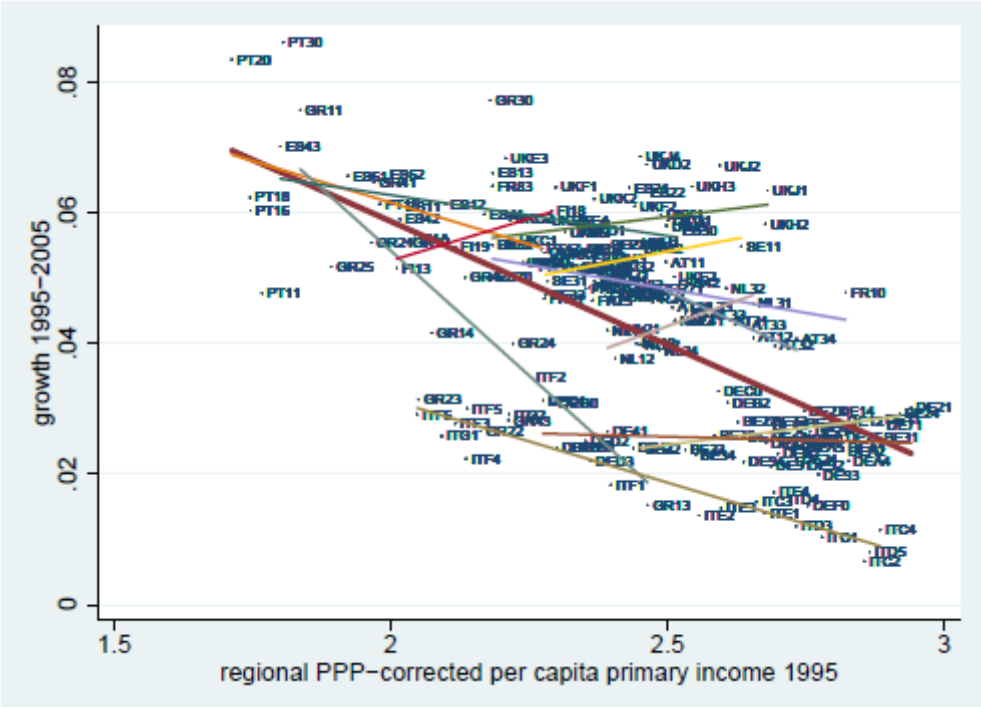

Figure 2: Regional β-convergence in per capita primary income in the EU15 (excluding Denmark, Luxembourg and Ireland). There is clear evidence for convergence in that poorer regions are growing faster than richer regions (bold line). There is less evidence of convergence within countries. Many member states experience slow convergence or even divergence (thin lines).

As argued in the previous sections, there is reason to believe that the lack of regional convergence within a country (as opposed to convergence between member states) may be related to distorting redistributive schemes on the the country level (as opposed to the lack thereof between countries). The results reported in tables 1, 2, 6 and 7 and also figure 1 indeed provide some evidence that countries with a strong tendency to redistribute wealth exhibit slower within-country interregional convergence in primary income, or even divergence.

In the remainder of this section, we will attempt to identify the effect on convergence and growth of interregional redistribution through taxation and social transfers in a 'β-convergence' framework. This will allow to estimate the impact of redistribution on both regional growth and convergence, while controlling for other determinants of convergence and growth which have been suggested in the literature.

Redistribution and β-convergence in the EU without controlling for regional characteristics

In appendix A we set up a simple model of regional growth and convergence with mobile factors. It is shown how redistribution affects the secondary income distribution, which influences the location decision of workers (or capital) and thereby regional growth and convergence. Following estimation equation derives directly from equation (8) in the appendix:

$$\frac{Y_{int} - Y_{int-\tau}}{\tau Y_{int-\tau}} = \beta_0 + \beta y_{int-\tau} + \beta' \rho_n y_{int-\tau} + \rho_n + \epsilon_{it} \qquad (4)$$

The above equation relates the initial level of wealth of all EU regions in the sample to subsequent growth and considers the effect of redistribution on the growth level and the tendency of regional income to converge.[6]

Table 3 shows the result of estimating equation (4) on the sample of 173 regions from the 10 EU member states reported in table 1. For the first four columns the dependent variable defined as growth in primary income between 1995 and 2005 and the independent variables are evaluated at their levels in 1995. The coefficients are therefore estimated using cross-sectional information only (including cross-sectional differences in growth rates). The specification without controlling for redistribution in column (I) suggests that, on average, EU regions converge at a rate of about $1 - (1 - 10 \times 0.03315)^{1/10} \approx 3.7\%$.

[6]This specification is quite different from Martin (1998), who simply adds control variables such as investment in transport infrastructure to a standard growth equation and derives the effect of infrastructure investment on convergence simply from the change in the coefficient on initial income after adding the variable. We do not follow this line of thought. The coefficient on initial income shows the convergence rage controlling for the level of infrastructure, rather than a convergence rate given a particular level of infrastructure. The latter would be obtained from interacting the initial level of GDP/capita in his regression with a measure of transport infrastructure endowment and evaluating at different levels of infrastructure endowments.

Dependent variable: the average regional growth rate $(Y_{it} - Y_{it-\tau})/(\tau Y_{it-\tau})$					
	(I)	(II)	(III)	(IV)	(V)
$y_{t-\tau}$	-0.0315^a	-0.0558^a	-0.017^a	-0.0611^a	
	(0.00567)	(0.0124)	(0.004)	(0.0128)	
$y_{t-\tau} \times \rho_{t-\tau}$		0.112^a		0.143^a	0.259^a
		(0.0342)		(0.0310)	(0.0793)
$\rho_{t-\tau}$		-0.180^b			-0.638^a
		(0.0821)			(0.198)
constant	0.110^a	0.150^a	0.101^a	0.0396^a	0.376^a
	(0.0186)	(0.0298)	(0.010)	(0.0134)	(0.0846)
$y_{t-\tau} \times$ I(AT)					-0.134^a
$y_{t-\tau} \times$ I(BE)					-0.0918^a
$y_{t-\tau} \times$ I(DE)					-0.105^a
$y_{t-\tau} \times$ I(ES)					-0.0851^a
$y_{t-\tau} \times$ I(FR)					-0.129^a
$y_{t-\tau} \times$ I(IT)					-0.0833^a
$y_{t-\tau} \times$ I(NL)					-0.153^a
$y_{t-\tau} \times$ I(PT)					-0.0962^a
$y_{t-\tau} \times$ I(SE)					-0.138^a
$y_{t-\tau} \times$ I(UK)					-0.0933^a
τ	10	10	10	10	5
N	173	173	173	173	361
Country dummies	No	No	Yes	Yes	Yes
Country specific effect of y	No	No	No	No	Yes
Year dummies	No	No	No	No	Yes

Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$

Table 3: The effect of redistribution on regional growth and convergence in the EU. Column (I) shows the overall convergence between European regions. Column (II) considers how redistribution affects this overall convergence rate. Column (III) considers growth and convergence within member states, controlling for a country specific time-invariant growth rate. Column (IV) considers the effect of redistribution on within-country convergence. Column (V) additionally controls for time invariant country specific convergence rates by splitting the sample in two 5-year periods.

As the interaction between the initial level of primary income and the rate of redistribution is positive in column (II), regions in countries with a high rate of redistribution have a lower tendency to converge towards the imposed common EU-wide balanced growth path, or more precisely: either backward regions in such countries have relatively lower growth rates, or richer regions in such countries have relatively higher growth rates. Evaluating the coefficient on the initial level of primary income in column (II) at $\rho = 0$ indicates regions would converge at 7.8% annually in the extreme case without any interregional redistribution.

Evaluating the effect of the rate of redistribution at the lowest regional initial log income level of about 2 gives $-0.180 \quad 2 \times 0.112 - 0.044$: increasing redistribution by 10 percentage points (which is about the standard deviation of the redistribution rate of 0.085) increases the average annual growth rate of the poorest region by about 0.5 percent. Redistribution is bad for convergence in this estimation, as richer regions benefit substantially more from redistribution: a 10 percentage point increase in redistribution increases the average annual growth rate of the richest region with a log primary income of about 3 by about 1.5 percent. The overall positive effect of redistribution on growth might be due to the fact redistribution fosters growths, or alternatively, it might be the case that regions in countries with more elaborate redistributive schemes have unobserved characteristics which are associated with both higher redistribution rates and higher growth rates.

The above remarks illustrate that it is difficult to interpret the estimated effect of redistribution on growth and convergence as estimated from equation (4) and reported in the second column of table 3. It is also important to bear in mind that this regression answers questions on the relationship between redistribution and convergence on the EU-level, and does not regard convergence and divergence within member states. To control for time-invariant country characteristics which affect both the level of redistribution and subsequent growth country-specific fixed effects can be added to equation (4) to obtain

$$\frac{Y_{int} - Y_{int-\tau}}{\tau Y_{int-\tau}} = \beta_0 + \beta y_{int-\tau} + \beta' \rho_n y_{int-\tau} + \rho_n + \nu_n + \epsilon_{it}. \qquad (5)$$

This specification has the advantage that it is able to measure the causal effect of redistribution even when the redistribution scheme in a country is endogenous to all time-invariant characteristics of the country. The results on the effect of redistribution from this regression also answers another question altogether, namely whether redistribution affects growth of a region *relative to other regions in the same country* and

on how redistribution affects the convergence of regions in a country *towards the country specific balanced growth path*. As a benchmark, column (III) shows the results of estimating the basic growth regression with the addition of country fixed effects, without allowing for an effect of redistribution. As such, this specification estimates the unconditional within country β convergence rate. Comparing column (I) and (III) illustrates the characteristically slower within country convergence as compared to the case considering overall convergence between EU regions of column (I).

The result of estimating equation (5) is shown in column (IV) of table 3. Controlling for country-fixed effects, it is again found that redistribution increases growth rates more in initially richer regions, or alternatively, that redistribution lowers growth rates by more in initially poorer regions. It is impossible to distinguish between both scenarios in this specification as it is impossible to estimate the level effect of the initial rate of redistribution on growth: redistribution is evaluated in 1995, is time-invariant and thus collinear with the country-level fixed effect.

If we split up our sample in two time periods 1995-2000 and 2000-2005, however, the measured rate of redistribution is allowed to change over time, and both the level effect of redistribution and its effect on convergence can be estimated. A further potential form of endogeneity bias can be controlled using this setup, when countries with different redistribution rates do not only have different levels of growth (which was captured by including country fixed effects), but also some different level of convergence due to factors not included in the model. If these factors are time-invariant they can appropriately be taken into account by including country-specific effects of the log initial level of primary income. This leads to following estimation equation:

$$\frac{Y_{int} - Y_{int-\tau}}{\tau Y_{int-\tau}} = \beta_0 + \beta_n y_{int-\tau} + \beta' \rho_{nt} y_{int-\tau} + \rho_{nt} + \nu_n + \epsilon_{it}. \qquad (6)$$

Column (V) in table 3 shows the results of this specification.

Since the coefficient on the interaction term between redistribution and the log initial level of primary income is positive and significant, a higher rate of redistribution counteracts convergence. Contrary to our previous findings, by evaluating the effect of the rate of redistribution at different levels of initial log income now suggest that not all regions growth faster because of redistribution. More specifically, the poorest region would suffer a decline of 1.2 percent in its average annual growth rate after a 10 percentage point increase in the rate of redistribution. Growth in the richest region would in contrast increase by 1.4 percent. More than half of the regions in our sample are initially richer than the level of

income at which the effect of redistribution becomes positive (2.47), and one could therefore conclude that the effect on growth is positive for the average region. Drawing this conclusion is risky, however, as the precise income level at which the growth effect becomes positive is imprecisely estimated. Including redistribution without any interaction term reveals an overall positive but non significant effect of 0.025(0.019). A 10 percentage point increase in redistribution would thus lead to an increase in the growth rate of about a 0.25 percent.

Importantly, the large and significant difference between relatively fast overall convergence and slow within-country convergence almost disappears after evaluating controlling for the rate of redistribution. Controlling for the redistribution rate and evaluating at a redistribution rate $\rho = 0$, there is no significant difference between the overall and within-country convergence rates (columns (II) and (IV)), whereas the overall convergence rate without controlling for within-country redistributive schemes is almost double the within-country rate (columns (I) and (III)), and this difference is significant on the 1 percent level. This strongly suggests that the large redistributive schemes through taxation and social security are a key factor in explaining the observed lack of within-country regional convergence in the EU. In fact, at $\rho = 0$, the estimated within-country convergence rate is higher than the overall convergence rate. This is as expected when factor mobility is higher within countries as compared to between countries, which is likely, considering for example labour mobility in EU. As may be expected, within-country redistribution slows convergence, but more so for within-country convergence as compared to EU-wide convergence: evaluating the convergence rates at the average level of redistribution $\rho = 0.35$ gives an overall convergence rate of 1.8 percent, and a within-country convergence rate of 1.16 percent.

The Eurostat data used in this analysis contains information on three types of redistribution which make up the difference between primary and secondary income. Net social security benefits make up the largest share of the redistributive flows: out of the 35 percent of regional differences in primary income which is compensated by the average EU member state, 26 percent is compensated through the social security system, 7 percent through income taxes and only 1 percent through direct transfers. It is not obvious that these transfers should have similar effects. Separately estimating the effects of these flows in a specification with country fixed effects such as (5) which is reported in column (V) of table 3 gives coefficients on the interaction of the initial level of primary income and social security transfers, income taxes and transfers of respectively 0.136 (0.047), 0.283 (0.111) and 0.380 (0.164) respectively, indicating that each of these flows impedes convergence.

The effect of the initial income level on subsequent growth is assumed to be linear. This assumptions is rarely tested in empirical work. Table 9 in the appendix shows the result of repeating the estimation

using dummies four categories (quartiles) of regions depending on their initial level of primary income. The results suggest that a more efficient linear approximation is reasonable. Here as well, comparing the first and third column, we see that without controlling for the effect of redistribution, overall convergence between EU regions is faster than within-country convergence. Controlling for redistribution, the difference disappears.

Summarising the results obtained so far, it was found in all specifications that redistribution leads to *relatively* lower growth rates in initially poorer regions. Redistribution thus hampers convergence. In specifications without country-fixed effects and without allowing for country-specific differences in convergence rates, redistribution increases the growth rate of the average region, and the effect on convergence worked through a larger increase in growth rates in initially richer regions because of redistribution. In the more robust specification which includes country fixed effects and country specific convergence rates, redistribution lowers growth in poorer regions, and increases the growth rates of initially richer regions. The overall effect on growth is positive, but insignificant.

Redistribution and β-convergence in the EU, controlling for regional characteristics

The inclusion of country-level fixed effects may not suffice to control for regional specific factors which affect both growth and convergence. As a further robustness check, we therefore included several variables which have been suggested in the growth literature. Moreover, by interacting with the initial level of income, we allow some important variables to affect convergence rate (or put alternatively, we allow the effect of these variables to depend on the initial income level of the region). The estimates are obtained while allowing for year effects, country fixed-effects and country-specific convergence rates (interactions of country dummies with the initial level of income as in column (V) of table 3). Table 4 shows the results.

Dependent variable: the average regional growth rate $(Y_{it} - Y_{it-\tau})/(\tau Y_{it-\tau})$				
$y_{t-\tau} \times \rho_{t-\tau}$		0.27^{a} (0.083)		
$y_{t-\tau} \times \rho_{t-\tau}^{soc}$				0.19 (0.12)
$y_{t-\tau} \times \rho_{t-\tau}^{tax}$				0.41^{a} (0.14)
$y_{t-\tau} \times \rho_{t-\tau}^{trans}$				2.60^{a} (0.99)
$y_{t-\tau} \times \text{logmotor}_{t-\tau}$	-0.0049 (0.0033)	-0.0069^{b} (0.0031)	-0.0054^{c} (0.0032)	-0.0085^{a} (0.0031)
$y_{t-\tau} \times \text{gfixpop}_{t-\tau}$	-0.10 (0.068)	-0.11 (0.064)	-0.12^{c} (0.070)	-0.10^{c} (0.060)
$y_{t-\tau} \times \text{high}_{t-\tau}$	-0.067 (0.048)	-0.066 (0.048)	-0.063 (0.048)	-0.086^{c} (0.051)
$\rho_{t-\tau}$	-0.053^{a} (0.018)	-0.75^{a} (0.21)		
$\rho_{t-\tau}^{soc}$			-0.11 (0.079)	-0.60^{b} (0.29)
$\rho_{t-\tau}^{tax}$			-0.039 (0.050)	-1.04^{a} (0.34)
$\rho_{t-\tau}^{trans}$			-0.33 (0.27)	-6.63^{a} (2.46)
popgrowth_{t}	-0.091^{a} (0.021)	-0.096^{a} (0.021)	-0.091^{a} (0.022)	-0.096^{a} (0.021)
$\text{logmotor}_{t-\tau}$	0.014^{c} (0.0084)	0.019^{b} (0.0078)	0.016^{c} (0.0082)	0.023^{a} (0.0081)
$\text{highereduc}_{t-\tau}$	0.22^{c} (0.13)	0.21^{c} (0.13)	0.21 (0.13)	0.26^{c} (0.14)
$\text{gfixpop}_{t-\tau}$	0.33^{c} (0.20)	0.34^{c} (0.19)	0.38^{c} (0.20)	0.32^{c} (0.18)
$\text{logold}_{t-\tau}$	-0.0025^{a} (0.00073)	-0.0026^{a} (0.00072)	-0.0024^{a} (0.00071)	-0.0024^{a} (0.00070)
$\text{logyoung}_{t-\tau}$	0.015^{a} (0.0031)	0.014^{a} (0.0031)	0.015^{a} (0.0030)	0.014^{a} (0.0027)
$\text{covunemp}_{t-\tau}$	-0.056^{a} (0.015)	-0.052^{a} (0.015)	-0.082^{c} (0.042)	-0.091^{b} (0.042)
constant	-0.051 (0.056)	0.23^{b} (0.11)	-0.035 (0.059)	0.22^{b} (0.11)
N	327	327	327	327

Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$

Table 4: Regressions of regional growth rates on various determinants.

Typical variables which are thought to affect growth are population growth *popgrowth*, road infrastructure per capita *logmotor*, the share of higher educated in the population *highereduc*, gross fixed capital formation per capita *gfixpop*, the share of elderly (65+) in the population *logold*, the share of youth (25-) in the population *logyoung* and the local unemployment rate *logunemp*. We also included the country-specific interregional coefficient of variation in unemployment *covunemp* as it may influence both the rate of redistribution and the convergence rate. Controls which were considered, but turned out to be highly insignificant and did not affect the results apart from decreasing the estimation efficiency were the regional mortality rate (included as a control for environmental and other regional qualities), the local unemployment rate and the within-country regional variation in both primary income and the share of elderly in the population.

As we are interested in convergence, all specifications contain the log of initial primary income as an explanatory variable, which has been interacted with country dummies to allow for a time-constant country-specific convergence rate. Unlike in column (V) of table 3 we do not report these, as they do not have a natural interpretation in these regressions.[7] Several factors are investigated as possible determinants of the speed of convergence: redistribution, as before, but also the level of transport infrastructure, the share of higher educated people and the level of gross fixed capital formation. These variables are therefore interacted with the initial level of log primary income.

Column (I) investigates the growth effect of redistribution, without considering convergence, by including the rate of redistribution without an interaction term with the initial income level. The highly significant coefficient of -0.055 on ρ_{t-1} implies that an increase of 10 percentage points in the rate of redistribution is estimated to lower the average regional growth rate by about 0.5 percent. Column (III) repeats this analysis, but separates out the three different flows which make up ρ. Although the individual coefficients are not significant, all three redistributive flows are estimated to negatively affect overall growth and are jointly significant.

Columns (II) and (IV) repeat the analysis, but include interaction terms with the initial level of income. Evaluating the effect of redistribution at different regional initial income levels reveals redistribution had a larger averse effect on growth in regions which were initially poorer. Only a few initially richer regions experienced higher growth rates after redistribution. Investment in physical capital

[7]Whereas the country-level convergence rates in column (V) reflected the estimated convergence rate in absence of any redistribution, the addition of three additional interaction terms which are unrelated to redistribution would greatly complicate the interpretation.

(gross fixed capital formation per capita *gfixpop*) in highway infrastructure *logmotor* and human capital (the share of higher educated in the population *high*), in contrast, lead to higher growth in almost all regions, and more so in initially poorer regions. This may very well be due to diminishing returns: when a factor of production is scarce in an initially poorer region, increasing its stock has a larger marginal effect on growth.

Although the above specifications control for some regional characteristics, they are restrictive in imposing an identical growth path for all regions in a country conditional on these variables. Including regional fixed effects considers region-specific growth and convergence, and is robust to scenario's where there are not only country-specific but also regional specific time invariant factors which affect both regional growth and the level of redistribution (although this improbable since redistribution is estimated on the country level). As including regional fixed effects is costly in terms of estimation efficiency, we chose to include fewer control variables. Without going into details, table 5 shows that including region fixed effects hardly affects the results on the effect of redistribution on convergence and growth: redistribution leads to overall lower growth rates, and slows convergence as the negative effect is larger for initially poorer regions. Here, again, the effect of redistribution turns out to be positive for a few initially rich regions.

Dependent variable: $(Y_{it} - Y_{it-\tau})/(\tau Y_{it-\tau})$				
	(I)	(II)	(III)	(IV)
$y_{t-\tau} \times \rho_{t-\tau}$		0.20^a		
		(0.055)		
$y_{t-\tau}$	-0.19^a	-0.27^a		
	(0.015)	(0.029)		
$\rho_{t-\tau}$	-0.045^a	-0.56^a		
	(0.0097)	(0.14)		
$y_{t-\tau} \times \xi_{i,t-\tau}$				0.18^a
				(0.042)
$y_{i,t-\tau}$			-0.18^a	-0.28^a
			(0.015)	(0.029)
$\xi_{i,t-\tau}$			-0.083	-0.56^a
			(0.059)	(0.12)
$\text{popgrowth}_{i,t}$	-0.12^b	-0.11^b	-0.10^c	-0.12^b
	(0.049)	(0.050)	(0.058)	(0.046)
$\text{logmotor}_{i,t-\tau}$	0.0030	0.0027	0.0041	0.0023
	(0.0039)	(0.0039)	(0.0026)	(0.0024)
$\text{highereduc}_{i,t-\tau}$	0.061^a	0.085^a	0.088^a	0.080^a
	(0.016)	(0.013)	(0.019)	(0.018)
$\text{gfixpop}_{i,t-\tau}$	0.14	0.19	0.082	0.015
	(0.14)	(0.17)	(0.16)	(0.12)
$\text{logyoung}_{i,t-\tau}$	0.012	-0.044^b	-0.018	-0.0014
	(0.011)	(0.019)	(0.018)	(0.016)
N	327	327	327	327

Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$

All regressions include regional fixed effects, year dummies, but exclude country-specific effects of initial income y_t.

Table 5: Regressions of regional growth rates on various determinants, including region fixed effects.

Although the coefficients on some variables (but not redistribution) become less significant when including even more variables such as in columns (I) and (II) of table 4, the point estimates remain roughly unchanged.

As a final robustness check, we replace the rate of redistribution with a measure of the net transfer received by each region. This measure is obtained from calculating

$$\xi_i = \frac{W_{it}^d}{W_t^d} \Big/ \frac{W_{it}}{W_t}.$$

ξ_i expresses the ratio of relative secondary to relative primary income of region i. Net contributing regions will have $\xi_i < 1$, net receiving regions have $\xi_i > 1$. If ξ_i increases fast when moving to regions with a lower relative primary income, this implies a high rate of redistribution ρ in a country. In the within-estimation approach which we are taking here, the effect of ξ_i will be identified by comparing increases of ξ_i within each region over time, and changes in subsequent growth.

Although ξ_i may appear more suited for a test of the effect of transfers on growth, there are several potential issues it. Firstly, the level of ξ_i may be related to unobservable time-variant characteristics on the regional level which are also related so subsequent regional growth. This is not the case with ρ which is estimated on the country level. Secondly, the regional level of primary income is used directly in the calculation of ξ_i. This may introduce a spurious dependency between ξ_i and regional growth (especially if the effect of initial income on growth is non-linear). Despite these issues, we find in columns (III) and (IV) that the estimated effect of ξ_i is very similar to that of ρ. Ignoring the aforementioned issues with ξ_i, this would imply that increasing transfers to a region negatively affects growth (column III) and this is the case especially in backward regions, with a low level of initial income (column IV).

What pertains is that in all specifications, with and without controlling for a large set of regional characteristics and fixed effects, with and without year dummies, considering convergence towards a country or regional specific balance growth path, and irrespective of allowing for time-constant differences in country specific convergence rates, the effect of redistribution on convergence is significantly negative. While some specifications pointed to a positive overall growth effect (but a smaller positive growth effect in lagging regions), the more robust specifications find a negative overall growth effect (and a larger negative effect in lagging regions). These latter specifications control for time-invariant differences in convergence rates between countries, include regional characteristics and regional fixed effects. Factors which lead to more within-country convergence are investment in transport infrastructure and investment in human and physical capital.

Section B.2 briefly considers the effect of redistribution on β-convergence between US states. Splitting the sample in nine 5-year subsamples, the results confirm that years with a relatively high rate of redistribution were associated with a slower subsequent convergence rate. Since this dataset lacks a cross-sectional counterpart, it is hard to draw further conclusions on the effect of redistribution on regional growth and convergence in the US.

Conclusion

This paper investigated the link between within-country interregional redistribution through taxation, social security and direct transfers on regional growth and convergence.

Using data on 173 regions from 10 EU member states for the years 1995-2005, it was found that the difference between relatively fast overall convergence between EU regions and relatively slow within-country convergence (and within-country divergence in some cases) can be attributed to the existence of large within-country interregional redistributive schemes.

A 10 percentage point increase in the percentage of regional primary income differentials which are equalised by redistribution reduces the aggregate yearly growth rate by about 0.5 percent in the most general specifications. Redistribution slows convergence by lowering growth by more in poorer regions. The region at the 25 percentile of the income distribution faces about a 1 percent decrease in the average yearly growth rate, while for a region at the 75 income percentile the growth decline is only 0.28 percent. The growth effect even becomes positive for regions above the 90th income percentile. Although it might be surprising that redistribution to backward regions might have a positive effect only on the more prosperous regions, this is a prediction of models such as Padovano (2007) and Martin (1998).

Regional redistribution poses an expensive type of equity-efficiency trade-off: whereas redistribution has the immediate effect of equalising disposable income between regions, it comes at the double cost of a lower aggregate growth rate, and a larger negative growth effect in backward regions. The lower growth rates in backward regions imply redistribution may require even more redistribution in the future, making the system impossible to maintain, or leading to increasing tensions between regions within the same country as can be observed in some EU member states. For moderate levels of redistribution, however, convergence still prevails, albeit at a slower rate. In case future income flows are discounted, possibly in combination of the existence of disutility from regional inequality, some level of redistribution might be optimal despite its long run growth effects. The optimal rate of interregional redistribution and its evolution over time then depends on the exact assumptions.

Our results suggest that increasing the regional physical or human capital stock or improving the local infrastructure in backward regions is a more promising route to foster growth in backward regions. Whereas the growth effects of such investments have been shown to be positive, our results explicitly point out they may simultaneously lead to faster regional convergence since these growth effects are found to be significantly larger in backward regions. These investments should preferably be paid for by

income taxes which are not overly regionally progressive, or taxes which are neutral with respect to regional factor prices.

Using a dataset with long time series on primary and secondary income in the US suggests a similar mechanism may be at work. In the US, a significant increase in the rate of inter-state flows through taxes and the social security system preluded the stagnation of inter-state convergence, and even subsequent divergence in primary income between US states. Because the US dataset lacks a cross-sectional dimension, our analysis for the US was necessarily limited in comparison to the analysis of EU regional growth and convergence.

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Appendix A: Some theory on the effect of redistribution on factor mobility and convergence

This section is based on Blanchard (1991) and Padovano (2007). Assume a country is composed of R regions, indexed by i. The regions are assumed to be identical, apart from a difference in the initial level of capital and labour. The total amount of labour and capital in the country are assumed to be fixed. Total production in region i in year t is given by $q_{it} = \alpha l_{it} + (1-\alpha)k_{it}$, where all variables are expressed in logs. The difference between the regional production q_{it} and the geometric average of production in all R regions q_t is given by

$$q_{it} - q_t = a(l_{it} - l_t) + (1-a)(k_{it} - k_t) + \theta_{it},$$

and for the relative demand for the regional specific output in region i:

$$p_{it} - p_t = -d(p_{it} - p_t) + \epsilon_{it}.$$

The error terms θ_{it} and ϵ_{it} are allowed to be non-stationary. Assume that capital is homogeneously distributed over all regions and is immobile such that $k_{it} = k_t$. Labour is assumed to be mobile, and the mobility is defined by

$$l_{it+1} - l_{t+1} = l_{it} - l_t + b(w_{it}^d - w_t^d),$$

where w_{it}^d denotes the log of labour income after all government transfers, and w_t^d is its geometric average over all regions.

Write W_{it}^d for the level of labour income after all government taxes and subsidies, and W_{it} for the primary labour income, before transfers. Assuming that equation (1) holds equally for all types of income, it can be written as

$$\mathrm{E}\left[\frac{W_{it}^d}{W_t^d}\right] = \beta_0 + (1-\rho)\frac{W_{it}}{W_t}. \qquad (7)$$

Here $(1-\rho)$ expresses how much of a relative regional difference in primary labour income is translated into a relative difference in secondary labour income in a country. ρ expresses the 'rate of redistribution', the share of the relative regional difference in primary labour income which is removed through redistribution. Subtract the mean from each side of the equation to obtain

$$\mathrm{E}\left[\frac{W_{it}^d}{W_t^d}-1\right]=(1-\rho)\left(\frac{W_{it}}{W_t}-1\right),$$

or

$$\mathrm{E}\left[\frac{W_{it}^d-W_t^d}{W_t^d}\right]=(1-\rho)\frac{W_{it}-W_t}{W_t},$$

which is well approximated by

$$\mathrm{E}\left[\log\left(\frac{W_{it}^d}{W_t^d}\right)\right]=(1-\rho)\log\left(\frac{W_{it}}{W_t}\right),$$

or writing lower case letters for variables in logs as before,

$$\mathrm{E}\left[w_{it}^d-w_t^d\right]=(1-\rho)(w_{it}-w_t).$$

The labour mobility equation can then be approximated in function of primary labour income

$$l_{it+1}-l_{t+1}=l_{it}-l_t+b(1-\rho)(w_{it}-w_t).$$

Assuming both factors earn the value of their marginal products and recursively using the above results then allows to derive the time-series behaviour of regional total income per capita $y_{it}-q_{it}\quad p_{it}\quad l_{it}$ relative to the country average:

$$y_{it}-y_t=(y_{it-1}-y_{t-1})-\beta(y_{it-1}-y_{t-1})+z_{it},$$

where

$$\beta = b(1-\rho)[1-(1-a)(1-d)],$$
$$z_{it} = [(1-d)\theta_{it} + \epsilon_{it}] - [(1-d)\theta_{it-1} + \epsilon_{it-1}].$$

The growth rate in region i is given by

$$y_{it} - y_{it-1} = (y_t - y_{t-1}) - \beta(y_{it-1} - y_{t-1}) + z_{it}, \tag{8}$$

which is the standard β convergence estimation equation, taking into account the effect of labour income redistribution on convergence. Note that the original error terms enter in first differences, such that the growth equation can be consistently estimated even in the presence of persistent production and demand shocks. In this framework redistribution slows convergence by reducing differences in secondary labour income, and thereby slowing convergence enhancing labour relocation.

The rate of redistribution estimated by equation (1) is a measure of redistribution on the country level. As such, it has the important advantage of being independent from unobserved regional characteristics which might be correlated with both the initial level of primary income and subsequent growth. Nevertheless, one could define a regional measure of redistribution expressing how policy is affecting the original interregional difference in primary income and hence interregional mobility and convergence. A straightforward measure would be obtained from changing equation (1) into

$$\frac{W_{it}^d}{W_t^d} = \xi_i \frac{W_{it}}{W_t}. \tag{9}$$

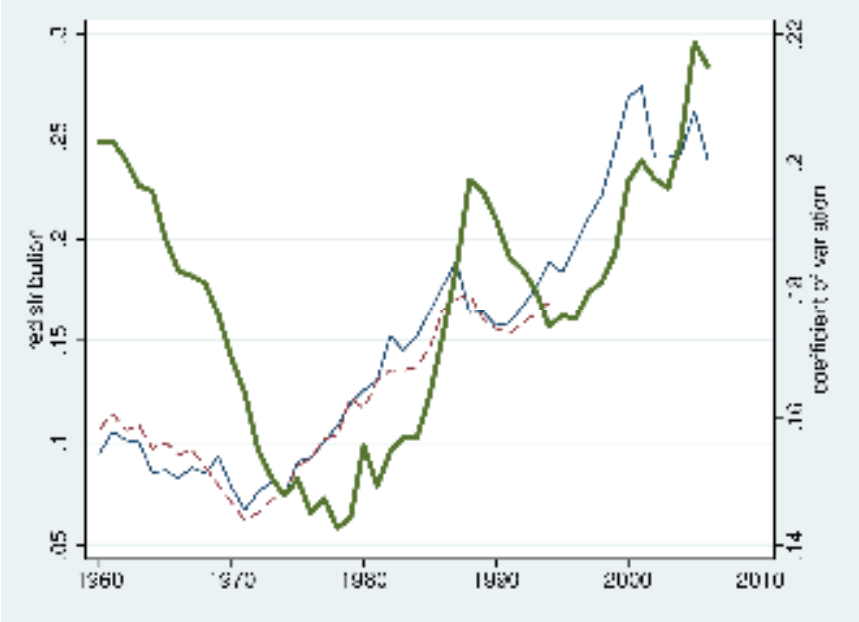
where $\xi_i > 1$ implies a net transfer towards region i, and $\xi_i < 1$ implies a net transfer from region i. Obviously, ξ_i can be calculated per region as

$$\xi_i = \frac{W_{it}^d}{W_t^d} \Big/ \frac{W_{it}}{W_t}.$$

Importantly, although equation (7) and equation (9) look similar, the coefficients need to be interpreted rather differently. The coefficient $(1-\rho)$ in equation $(??)$ expresses how much of a relative difference in primary income is translated into a relative difference in secondary income, when comparing different regions within a country. ρ then expresses how much of a relative difference in primary income is removed through redistribution, on average within a country. The coefficient ξ_i in equation (9) in contrast simply expresses the regional secondary income (relative to the country average) relative to the regional primary income (relative to the country average). When ξ_i decreases fast when moving from poorer to richer regions within a country, this would imply a low estimate of (1-ρ) and subsequently, a high rate of redistribution ρ.

Appendix B: Interregional redistribution and income disparities in the US

The thin line (left axis) in figure 3 shows the evolution of interregional redistribution between 48 US states8 obtained from estimation equation (1) by year. After a period of stable and even declining redistribution, a clear upward trend has emerged around 1974.



[8]Excluding Alaska, The District of Columbia and Hawai.

Figure 3: The evolution of interregional redistribution (thin and dotted line, left axis) and interregional disparities (bold line, right axis) in the US. The dotted line shows the rate of redistribution using the dataset of Mélitz and Zumer (2002).

The dotted line is the result of using the data used Mélitz and Zumer (2002) which was kindly made available to us. The fact the dotted line closely follows our own estimated amount of redistribution illustrates that the small changes in accounting rules which have taken place since the study of Mélitz and Zumer (2002) have only a modest impact on the results. Figure 3 also plots the evolution of regional disparities in the US as measured by the coefficient of variation in regional primary income (bold line, right scale). Both the redistribution and disparity series underwent a trend reversion in the 1970's. Changes in the rate of redistribution appear to antedate changes in disparity.

The first four columns of table 6 provide an overview of the rate of redistribution and convergence in the US. Increases in the rate of redistribution over time have been accompanied by an increasing disparity in primary income between US states.

	ρ_t	$\rho_t - \rho_{t-10}$	cv_t	$cv_t - cv_{t-10}$	β	conv. rate
1965	0.086	-	0.188	-	-	-
1975	0.091	0.004	0.150	−0.038	−0.032	0.038
1985	0.164	0.073	0.164	0.013	−0.009	0.009
1995	0.184	0.020	0.176	0.012	−0.002	0.002
2005	0.263	0.079	0.219	0.043	0.017	−0.015

Table 6: The coefficient of variation in regional primary income, interregional redistribution and cross-sectional variation in convergence rates in the US for different decades.

The amount of interregional redistribution in the US reaches a level comparable to some EU member states such as Spain, Portugal or Italy around 1995. Considering the relationship between the levels of regional disparity and redistribution as was done in figure 1, the US exhibits a pattern comparable to most EU member states only in the later years. With a coefficient of variation in inter-state primary income of about 0.22 and a rate of redistribution of 0.26, the US would show up in the vincinity of Portugal and Spain in figure 1. For earlier years, the US clearly deviates from the average behaviour of EU member states, with a rate of redistribution which is much lower considering the level of interregional disparity.

Table 7 shows the result of estimating equation (2) for the US, with one observation taken every five years, and without controlling for other possible determinants of the increase in regional disparities apart from the effect of inter-state redistribution.

Dependent variable: $\Delta \log(cv_t)$	
ρ_{t-5}	1.13^b
	(0.372)
constant	-0.149^c
	(0.0555)
N	9
R^2	0.444

Robust standard errors in parentheses
^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$

Table 7: The effect of redistribution on the subsequent evolution of inter-state disparity in primary income in the US.

The results confirm for the US that years with an above average level of redistribution were characterised by a subsequent increase in the interregional disparity of primary income in the US.

Redistribution as a determinant of regional growth and convergence in the US

For the study of regional convergence between and within European member states, we were able to make use of the rich cross-sectional dimension of the data. The fact we observe different regions within each member state allowed us to calculate separate convergence rates per member state. When estimating convergence between US states, there is does not exist a cross-sectional counterpart which could be used to compare the convergence rate to. The US dataset on State-level income made available by the BEA does have a comparatively long time dimension with data covering the years 1960 to 2006. This invites to use a different approach, and compare convergence not to some other cross-sectional unit, but rather consider changes in the convergence rate over time. Figure 4 illustrates convergence between the US states by plotting initial levels of primary income per capita at the state level against subsequent growth in this variable. The left panel considers the 23 year time-span in the first half of our sample, between 1960 and 1983. The right panel considers the equally long span between 1983 and 2006. There is

strong proof for convergence in the first time period, but convergence seems to have come to a complete standstill in the later decades, despite the fact that substantial differences in per capita primary income continue to exist between the different states. The lack of convergence in the second half of the sample was already clear from the evolution of the coefficient of variation in regional primary income shown in figure 3.

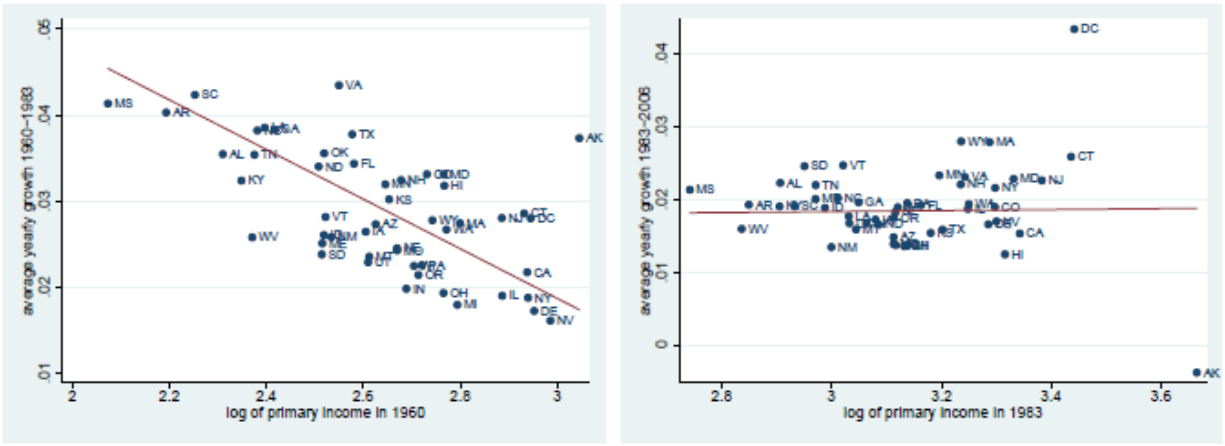


Figure 4: Regional convergence in the US between 1960 and 1983 (left panel) and 1983 and 2006 (right panel). There is strong proof of β-convergence in the first time period, but convergence seems to have come to a standstill in the later decades.

The fifth and sixth column of table 6 show the estimated β coefficients and the corresponding convergence rate for the last four 10 year periods in the US-sample. Essentially, only the decade 1965-1975 was characterised by substantial convergence in terms of both σ and β convergence. The decade 1995-2005 was even characterised by substantial divergence in inter-state primary income.

Redistribution and growth and convergence in US states

In this section we briefly consider the effect of redistribution on growth and convergence between US states, without controlling for regional characteristics. Since there is no cross-sectional variation in the rate of redistribution, the inclusion of year dummies makes it impossible to assess the aggregate growth effect of redistribution. Column (I) of table 8 shows the result of a simple β-convergence analysis after splitting the sample in nine 5-year periods.

Dependent variable: $(Y_{it} - Y_{it-\tau})/(\tau Y_{it-\tau})$		
y_{t-1}	-0.0126^{a}	-0.0439^{a}
	(0.00330)	(0.00760)
$y_{t-1} \times \rho_{t-1}$		0.224^{a}
		(0.0582)
N	423	423

Robust standard errors in parentheses ^{a} $p < 0.01$

Table 8: The effect of redistribution on growth and convergence between US states. The results indicate that the rate of convergence would almost double in the absence of transfers.

The effect of redistribution on convergence can still be derived in this setting: the positive effect on the interaction term of redistribution and the initial log primary state income indicates that richer regions grow relatively faster (or poorer regions are more hurt) by redistribution.

Appendix C: Figures and tables

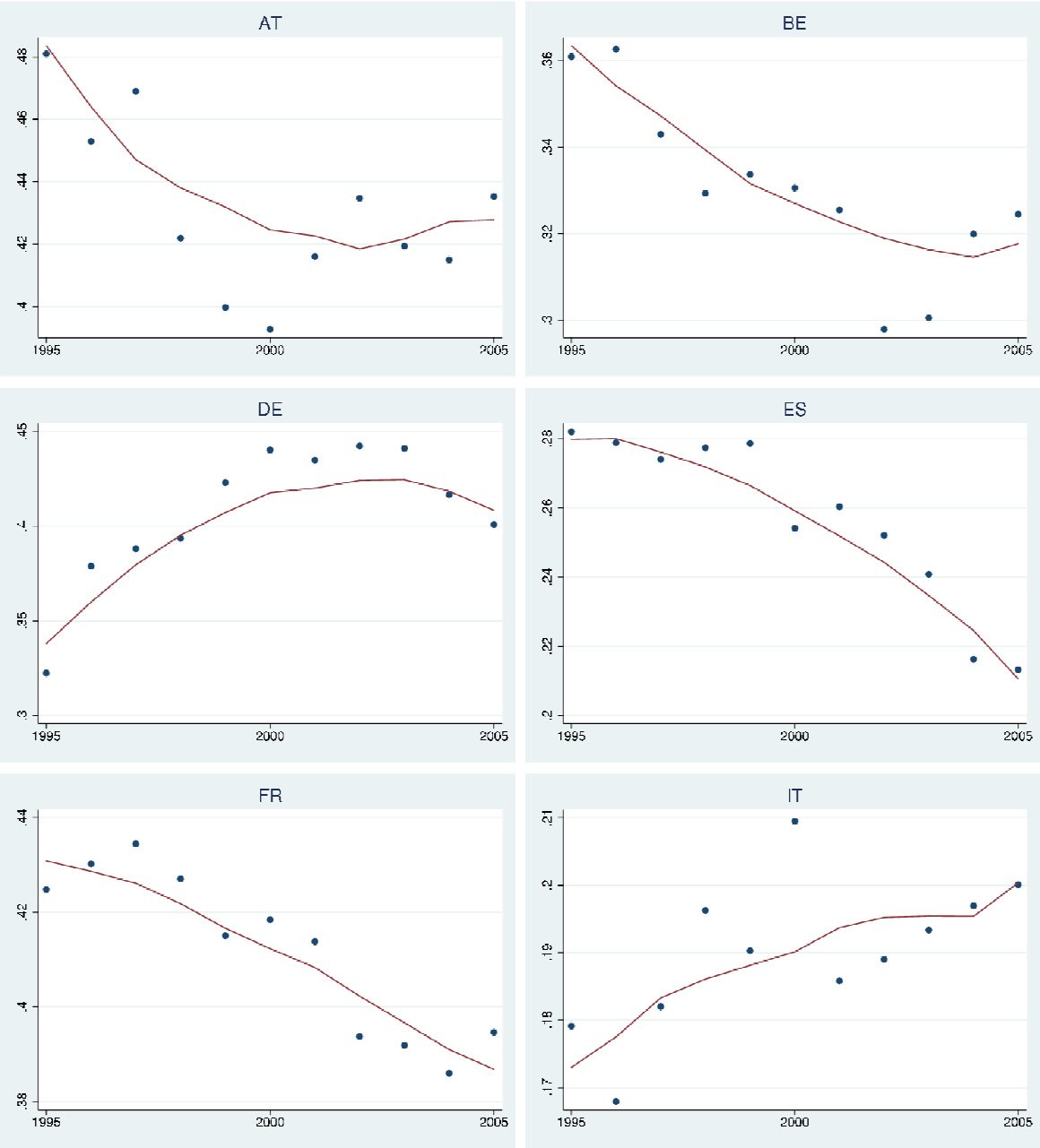


Figure 5: The rate of interregional redistribution from 1995-2005. The line shows the four year moving average which was used in the regressions.

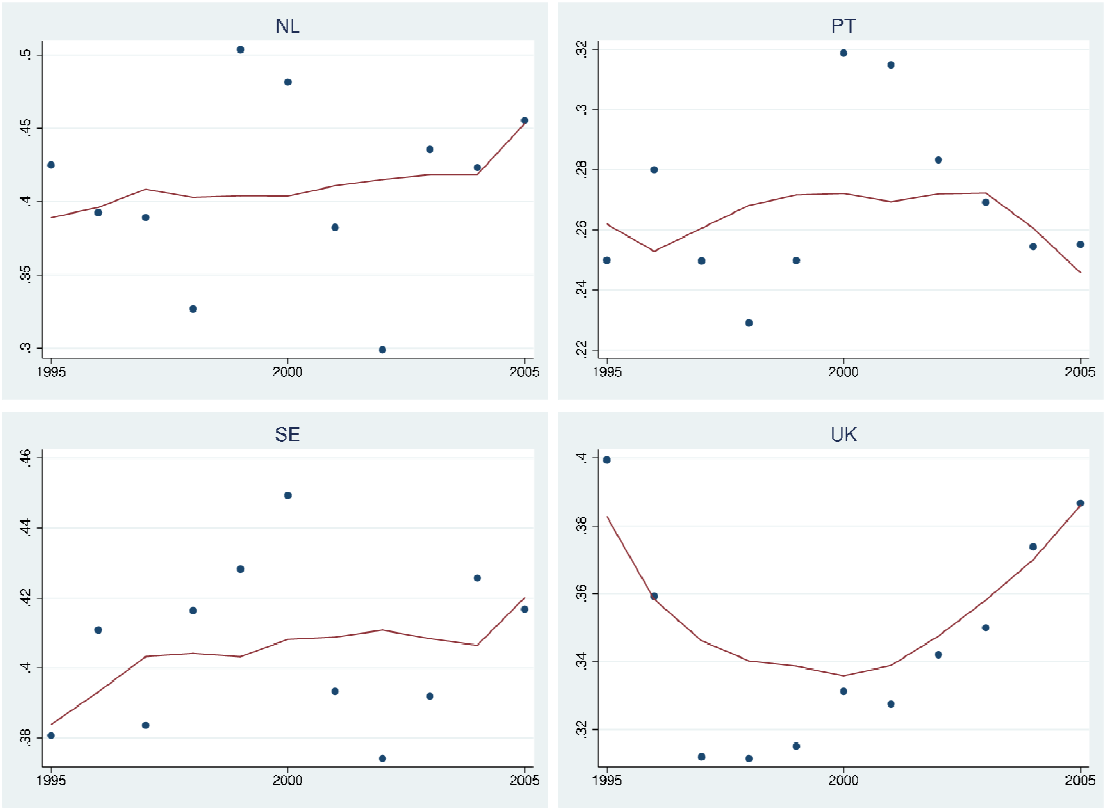


Figure 6: …continued from last page: The rate of interregional redistribution from 1995-2005. The line shows the four year moving average which was used in the regressions.

Dependent variable: average regional growth $(Y_{it} - Y_{it-\tau})/(\tau Y_{it-\tau})$					
$I(Q1t-\tau)$	0.0590^a	0.0520^a	0.0611^a	0.0668^a	0.101^a
	(0.00142)	(0.00432)	(0.00355)	(0.00560)	(0.0213)
$I(Q2t-\tau)$	0.0602^a	0.0468^a	0.0567^a	0.0598^a	0.0671^a
	(0.00117)	(0.00637)	(0.00346)	(0.00619)	(0.0103)
$I(Q3t-\tau)$	0.0543^a	0.0293^a	0.0559^a	0.0479^a	0.0474^a
	(0.00147)	(0.00396)	(0.00355)	(0.00540)	(0.00678)
$I(Q4t-\tau)$	0.0492^a	0.0236^a	0.0544^a	0.0376^a	0.0409^a
	(0.00175)	(0.00487)	(0.00358)	(0.00562)	(0.0110)
$I(Q1t-\tau)\times\rho_{t-\tau}$		0.0231^c		-0.0177	-0.0613^b
		(0.0133)		(0.0159)	(0.0288)
$I(Q2t-\tau)\times\rho_{t-\tau}$		0.0356^b		-0.00695	-0.0378
		(0.0157)		(0.0175)	(0.0330)
$I(Q3t-\tau)\times\rho_{t-\tau}$		0.0695^a		0.0230	0.0467^b
		(0.00981)		(0.0140)	(0.0190)
$I(Q4t-\tau)\times\rho_{t-\tau}$		0.0784^a		0.0511^a	0.0694^a
		(0.0144)		(0.0161)	(0.0210)
τ	5	5	5	5	5
N	338	338	338	338	338
Country dummies	No	No	Yes	Yes	Yes
Country specific effect of I(Q)'s	No	No	No	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$

I(Qjt): Indicator function which takes on the value 1 if a region belongs to the j-th income quartile in year t.

Table 9: Table 3 repeated, but with four income classes rather than a linear effect of income. Different compared to table 3 is also the fact that $\tau = 5$ in all specifications, with $t = \{2005, 2060\}$.