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Interregional redistribution, growth and convergence

Damiaan Persyn

Koen Algoed

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VIVES
Naamsestraat 61 bus 3510
3000 Leuven - Belgium
Tel: +32 16 32 42 22
www.econ.kuleuven.be/vives

The effect of interregional redistribution on regional growth and convergence☆

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Damiaan Persyn Koen Algoed

VIVES, Faculty of Economics and Business, K.U.Leuven
Naamsestraat 61 B-3000 Leuven, Belgium, tel: +3216324230

Abstract

Even in the absence of an explicit regional policy, countries redistribute substantial amounts of wealth between regions through taxation and social security. Using data on 140 European regions between 1995 and 2007, this paper finds that interregional income redistribution leads to lower regional economic growth and to slower within-country convergence. This may explain the observed lack of within-country convergence in the EU, in contrast to relatively fast between-country convergence where such redistributive schemes do not exist. The results suggest that investment in transport infrastructure or human capital offer better means to foster both regional growth and convergence.

Keywords: solidarity, regions, economic growth, redistribution, inequality, convergence
JEL: O47; H3

1. Introduction

There exist many ways in which income is redistributed between regions with different income levels. Many federal states have set up rules with the explicit aim to equalise wealth between regions. But even in a country without an explicit regional policy, the existence of regional income inequality and progressive taxes in combination with an equal provision of public goods across regions de facto implies interregional redistribution.

Redistribution between countries is limited compared to within-country redistribution. The amount of between-country redistribution in the EU is necessarily small since the EU budget is currently capped at 1.24 percent of GNI. Gordon (1991) estimates that EU

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transfers lead to a 3 percent reduction of the initial difference in member state per capita income. Doménech et al. (2000) obtain 5 percent with more recent data. These numbers are dwarfed by 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.[1] The median euro-area country in our sample[2] compensates about 34 percent of interregional differences in primary income.

Given the substantial size of both the interregional income differentials and the amount of redistributed wealth, the question on the effect of interregional redistribution and especially the effect on regional growth and convergence is important. 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?

Empirically, poorer regions in Europe show higher average growth rates such that convergence might be reasonably expected. In contrast, regional convergence *within* individual EU member states seems to have slowed down in recent decades. 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; de La Fuente and Vives, 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 which might explain these different growth paths. Migration and trade, for example, are known to be more intensive within countries. Legislation such as labour market regulation is more homogeneous within countries. Models of economic geography predict that higher within-country factor mobility indeed may lead to regional divergence. In many neo-classical economic growth models, however, factor mobility and trade drives economic convergence, and therefore these facts would only add to the puzzle on why the observed within-country convergence rates are lower, rather than offering a possible explanation.

Both neoclassical theories and models of economic geography predict that redistribution affects regional growth and convergence through its effect on regional income and incentives for factor mobility. This paper introduces a neoclassical model which explicitly considers

[1] Also see von Hagen (2000) for other estimates of interregional redistribution in a variety of countries.

[2] Our sample consists of the eurozone countries Austria, Belgium, Germany, Spain, Finland, France, Italy, the Netherlands and Portugal.

the effects of interregional redistribution on convergence. The main contribution of this paper is empirical, however.

We investigate the effect of redistribution on growth and convergence using Eurostat data from 1995 to 2007 on 140 NUTS-2 regions in 9 euro-area countries. The dataset contains observations on various regional characteristics, primary and disposable household income, and information on the size of household transfers through taxation and social security. This allows to calculate the extent of within-country interregional redistribution as well as the speed of interregional convergence and regional growth. There exist substantial differences between regions in terms of the level and growth of regional income, and also with respect to the extent of within-country redistribution in the different countries and changes therein over time. This variation allows to identify the effect of redistribution on regional convergence and growth.

Our empirical results indicate that the lack of within-country convergence can to a large extent be attributed to the existence of distorting within-country interregional redistribution. Moreover, it is found that redistribution lowers regional growth. A typical redistributive scheme therefore decreases *current* inequality in disposable income between regions, but this comes at the double cost of lower growth on the country-level and relatively lower growth in backward regions. This latter effect may be as large as to cause regional divergence and therefore larger *future* regional income differences.

In related work Checherita et al. (2009) consider the link between redistribution, labour mobility and regional growth. Our approach differs from their contribution in some important respects, however. Our estimation equation is derived directly from a small neo-classical growth model and allows to derive a point estimate of how much redistribution affects growth and convergence. Moreover, the panel structure of our dataset allows to control for time invariant country and regional characteristics. Possible endogeneity of redistribution is controlled for by measuring the amount of redistribution on the country level while estimating the growth impact on the regional level, and -as a robustness check- by instrumenting the redistribution measure using the Arellano-Bond system GMM approach (Arellano and Bond, 1991).

The main innovation of our paper lies with introducing theory on the measurement of redistribution (Bayoumi and Masson, 1995; Mélitz and Zumer, 2002) in a standard β-convergence framework (Barro and Sala-i Martin, 1992; Mankiw et al., 1992; Blanchard, 1991) and using these insights to reconsider the effect of redistribution on growth an convergence. Although the the estimation equation follows from theory, the empirical results can also be interpreted quite independently: β-convergence occurs when initially poorer regions have higher growth rates. If any variable affects the rate of β-convergence between regions, it should therefore change this relationship between the initial level of income and regional growth. To our knowledge our paper is the first to consider the effect of a variable on convergence through this interaction effect.

The remainder of this paper consists of three sections. Section 2 briefly discusses some existing theories on interregional transfers and convergence, and introduces a small neoclassical regional growth model with interregional redistribution. Section 3 introduces the datasets, derives a measure of redistribution and describes the relationship between interregional redistribution and within-country disparity in a σ-convergence framework. Section 4 shows how income redistribution and other factors affect regional growth and convergence by means of a β-convergence analysis. A final section summarises the results and concludes.

2. Theory on regional disparities and public policy

2.1. Selected literature overview

Apt regional policies may be expected to foster regional convergence. In the neoclassical growth model of Doménech et al. (2000), for example, interregional transfers increase the growth level of the backward region by directly increasing its productive capital stock. 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. More disconcerting is the fact that some policy measures which might intuitively be expected to help poorer regions may actually adversely affect their growth rates. The following paragraphs offer some examples from the literature.

A significant part of European regional funds is invested in transport infrastructure. Models of economic geography, such as Martin and Rogers (1995); Puga (2002); Behrens et al. (2007), however, show that transport infrastructure works in a country may increase regional inequality when a sufficiently large asymmetry in market potential between the regions causes firms to relocate from the poorer to the richer region after transport costs decline. Only if transport costs within the backward region itself decline by more than the transport costs between regions, a backward region may benefit from transport infrastructure investment.[3]

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 which are financed on the national level, such as tax-breaks or production subsidies, may actually increase interregional inequality and even decrease welfare in the poorer region. 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.

These examples make clear that the predicted effects of interregional transfers on convergence depend heavily on the nature of those transfers. Transfers which are purely redistributive are mostly predicted to distort incentives, growth and convergence. Transfers which are able to increase the productivity 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. In this light, we will take care in controlling for variables such as transport infrastructure and proxies for human capital investment when modelling regional growth in the empirical section.

To illustrate how redistributive transfers may negatively affect convergence, the next section introduces a small neo-classical regional growth model. The regional growth equation derived from the model will be used as the estimation equation in the empirical section. The model is based on Blanchard (1991) and Padovano (2007).

2.2. A model on the effect of redistribution on factor mobility and convergence

Consider a world economy consisting of regions indexed by i which belong to countries indexed by n. Time is indexed by t. All regions are assumed to be identical, apart from a difference in the level of capital k_{nit} and labour l_{nit}. All variables are measured in logs.

[3] As argued by Ago et al. (2006) and Behrens (2004), however, a backward region may benefit from lower country-wide transport costs depending on its location (for example when the backward region is located in between two wealthier regions).

The world-wide amount of labour and capital is assumed to be fixed. With a a technology parameter and θ_{nit} an idiosyncratic shock, the difference between regional production q_{nit} and the geometric average of production in all regions in country n, q_{nt}, is given by

$$q_{nit} - q_{nt} = a(l_{nit} - l_{nt}) + (1 - a)(k_{nit} - k_{nt}) + \theta_{nit}.$$

The inverse relative demand for the regional specific output in region i is

$$p_{nit} - p_{nt} = -d(q_{nit} - q_{nt}) + \epsilon_{nit},$$

with ϵ_{nit} an idiosyncratic demand shock, and $d > 0$ a parameter governing the price sensitivity of demand. The shocks to regional production and demand θ_{nit} and ϵ_{nit} are allowed to be non-stationary.

Before government intervention, both capital and labour earn the value of their marginal products such that $w_{nit} = p_{nit} + a + q_{nit} - l_{nit}$ and $r_{nit} = p_{nit} + (1-a) + q_{nit} - k_{nit}$. Regional output per capita equals income per capita and is given by $y_{nit} = p_{nit} + q_{nit} - l_{nit}$. Therefore $w_{nit} - w_{nt} = y_{nit} - y_{nt}$: the relative regional wage equals relative regional income per capita.

Government intervention drives a wig between primary income and disposable income. With $y^d_{nit} - y^d_{nt}$ the relative regional disposable income per capita after government intervention, define the 'regional rate of redistribution' ρ'_{nit} as

$$\rho'_{nit} = 1 - \frac{y^d_{nit} - y^d_{nt}}{y_{nit} - y_{nt}} \tag{1a}$$

and therefore

$$y^d_{nit} - y^d_{nt} = (1 - \rho'_{nit})(y_{nit} - y_{nt}) \tag{1b}$$

such that $\rho'_{nit} < 0$ when the initial relative income position of region i is magnified by government intervention in country n; $\rho'_{nit} = 0$ if the relative income position of the region is unaffected by policy; $0 < \rho'_{nit} \leq 1$ is indicative of a redistributive policy reducing the initial regional income difference and $\rho'_{nit} = 1$ implies a complete removal thereof. The case $\rho'_{nit} > 1$ corresponds to a policy which overcompensates the initial income difference of region i relative to the country average. For now, we consider only the empirically most relevant case where $0 \leq \rho'_{nit} \leq 1$.

Assume that labour is internationally immobile ($l_{nt} = l_{n,t-1}$), but relocates within countries to regions with relatively high disposable income according to the following law of motion:

$$l_{ni,t+1} - l_{n,t+1} = l_{nit} - l_{nt} + b_n(y^d_{nit} - y^d_{nt}),$$

where y^d_{nit} denotes the log of disposable regional income -income after all government transfers- and y^d_{nt} is its geometric average over all regions within country n in year t. b_n is the speed of within-country migration in response to regional income differentials. This parameter is allowed to differ between countries.

This allows to write the labour mobility equation as a function of primary regional income, the regional measure of redistribution ρ'_{nit}, and the speed of within-country migration b_n:

$$l_{ni,t+1} - l_{n,t+1} = l_{nit} - l_t + b_n(1 - \rho'_{nit})(y_{nit} - y_{nt}).$$

Recursively using the above results then allows to derive the time-series behaviour of regional total income per capita $y_{nit} = q_{nit} + p_{nit} - l_{nit}$ relative to the country average:

$$y_{nit} - y_{nt} = (y_{ni,t-1} - y_{n,t-1}) - \beta_{ni,t-1}(y_{ni,t-1} - y_{n,t-1}) + z_{nit},$$

where

$$\beta_{nit} = b_n(1 - \rho'_{nit})[1 - (1 - a)(1 - d)],$$
$$z_{nit} = [(1 - d)\theta_{nit} + \epsilon_{nit}] - [(1 - d)\theta_{ni,t-1} + \epsilon_{ni,t-1}].$$

The growth rate of the regional income per capita therefore is given by

$$y_{nit} - y_{ni,t-1} = (y_{nt} - y_{n,t-1}) - \beta_{ni,t-1}(y_{ni,t-1} - y_{n,t-1}) + z_{nit},$$

which is the standard β-convergence estimation equation, augmented by an effect of income redistribution on convergence. More redistribution (a higher $\rho'_{ni,t-1}$) implies slower within-country convergence (a smaller $\beta_{ni,t-1}$) towards the country-year average income level. Redistribution slows convergence by reducing differences in disposable income and thus discouraging convergence enhancing labour relocation. 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.[4]

Since the relative return to factors of production is key to migration and investment decisions, it is the extent to which transfers affect these relative regional factor prices which

[4] This will no longer hold in the case of regional differences in capital endowment and capital mobility. See Blanchard (1991) for details.

matters for convergence in this framework, rather than the absolute amounts transferred. This focus on relative regional factor prices is an important difference between our approach and other recent studies investigating the link between transfers and convergence such as Kessler and Lessmann (2008) and Checherita et al. (2009).

Up to this point, only within-country labour mobility was considered. Within-country labour mobility gave rise to within-country convergence of regional income. Introducing between-country labour mobility will similarly lead to between-country convergence. Assume now that labour relocates as a function of both within-country and between-country differences in disposable income, according to the following law of motion:

$$l_{ni,t+1} - l_{t+1} = l_{nit} - l_t + b_{1n}(y^d_{nit} - y^d_{nt}) + b_2(y^d_{nt} - y^d_t),$$

where the geometric average of a variable over all regions in all countries is indexed by t. Factor mobility is known to be much higher within countries, which would imply that $b_{1n} > b_2$ for all countries n. Moreover, income redistribution operates almost exclusively within countries through the fiscal system and social security, diminishing the difference of regional income relative to the country-level average rather than between countries, and therefore

$$l_{ni,t+1} - l_{t+1} = l_{nit} - l_t + b_{1n}(1 - \rho'_{nit})(y_{nit} - y_{nt}) + b_2(y_{nt} - y_t).$$

Express the regional production and demand relative to the geometric average over all countries:

$$q_{nit} - q_t = a(l_{nit} - l_t) + (1 - a)(k_{nit} - k_t) + \theta_{nit}$$
$$p_{nit} - p_t = -d(q_{nit} - q_t) + \epsilon_{nit}.$$

Following the same reasoning as above then allows to derive the expression for regional growth:

$$y_{nit} - y_{ni,t-1} = (y_t - y_{t-1}) - \beta_{1ni,t-1}(y_{ni,t-1} - y_{n,t-1}) - \beta_2(y_{n,t-1} - y_{t-1}) + z_{nit}, \qquad (2)$$

where

$$\beta_{1nit} = b_{1n}(1 - \rho'_{nit})((1 - a(1 - d))$$
$$\beta_2 = b_2((1 - a(1 - d)).$$

The coefficient $\beta_{1ni,t-1} > 0$ reflects the speed of within-country convergence. Changes in b_{1n} or $\rho_{ni,t-1}$ imply changes in $\beta_{1ni,t-1}$. The coefficient β_2 reflects the speed of between-country convergence, expressing how regional growth changes with the relative income position of the country the region i belongs to. Excluding international income redistribution and imposing an equal speed of international labour mobility b_2 in all countries implies a constant speed of between-country convergence β_2.[5]

In the absence of redistribution ($\rho'_{nit} = 0$) and if interregional and international labour mobility are equally fast ($b_{1n} = b_2$), the speed of within-country convergence and between-country convergence is equal ($\beta_{1nit} = \beta_2$). All regions then converge equally fast towards the average income over all regions y_t. Higher levels of within-country income redistribution ρ'_{nit} tend to slow within-country regional convergence but this does not affect the speed of between-country convergence. In the absence of within-country redistribution ($\rho'_{nit} = 0$), and if within-country labour mobility is faster than between-country labour mobility between ($b_{1n} > b_2$), the speed of within-country convergence will exceed between-country convergence ($\beta_{1nit} > \beta_2$).

In the presence of redistribution ($\rho'_{nit} > 0$) and if interregional and international labour mobility are equally fast ($b_{1n} = b_2$), within-country convergence will be less than between-country convergence ($\beta_{1nit} < \beta_2$). But if within-country labour mobility is sufficiently fast compared to between-country labour mobility ($b_{1n} \gg b_2$), within-country convergence may still exceed the speed of between-country convergence ($\beta_{1nit} > \beta_2$) despite the presence of some redistribution.

3. Measuring interregional redistribution and inequality

Before turning to the estimation of growth regression such as equation (2), this section first describes the data, the measurement of redistribution, and analyses the relationship between redistribution and within-country inequality in the data.

3.1. Data description

The analysis uses publicly available Eurostat data on 140 NUTS-2 level regions in 9 euro-area countries for the years 1995-2007.

The European Union provides an interesting case to study the evolution of regional inequality and the effect of redistribution. There are no legal limits to international labour

[5] Allowing b_2 and β_2 to differ between countries does not add much insight. It also does not change the main empirical results.

and capital mobility between EU member states, an important condition for regional convergence in the neoclassical framework presented in the previous section. Income differences are significant, both within and between member states. Redistributive schemes are significant in size, but large differences exist both between member states and over time.

To consider only comparable economies and avoid issues due to large exchange rate fluctuations the sample is limited to euro-area countries. Ireland consists of only two regions at the NUTS-2 level. Slovenia and Luxembourg consist of one single NUTS-2 region. This does not suffice to (reliably) calculate interregional redistribution. Greece had to be excluded on basis of data reliability.[6] This limits our sample to Austria, Belgium, Germany, Spain, Finland, France, Italy, the Netherlands and Portugal.[7]

The empirical results are robust to excluding any of these 9 countries from the sample, or including Greece and Ireland despite the data issues and limited number of observations for these countries. The results are also valid for a wider sample including the UK, Sweden and Poland which are the non euro-area countries for which sufficient regional data is available. We limit the analysis to the larger euro-area countries, however, in order to consider relatively homogeneous economies with sufficient observations and to avoid problems with exchange rate fluctuations.

To allow for cross-sectional comparison, monetary variables were ppp-corrected using 1995 ppp-indices for all years. These variables were subsequently deflated using the country-wide consumer price index.

3.2. Measuring interregional redistribution

Measuring redistribution on the regional level using equation (1a) poses several problems. First, from a numerical perspective, the division by a value which may lie arbitrarily close to zero leads to erratic results.[8] This makes the ρ'_{nit} most variable for those (many) regions

[6] There is a break in the Greek series in the year 2000. This is unfortunate since Greece is an interesting case for the study of redistribution: it is the only country in the sample with a redistributive scheme which enlarges existing income differences.

[7] Of these 9 countries, the following overseas regions were excluded: ES63, ES64, ES53 (Ceuta, Melilla and the Balearic Islands for Spain); FR91, FR92, FR93, FR94 (Guadeloupe, Martinique, Guyane and Reunion for France); PT20, PT30 (the Azores Archipelago and Madeira for Portugal).

[8] Say region i has a primary income level which is 0.5 percent below the country average. With $y_{nit} - y_{nt} = -0.005$, ρ'_{nit} will take on the values 1.5,0.5 or -1.5 for values of $y^d_{it} - y^d_t$ equal to -0.0075,-0.0025 and 0.0075 respectively; for $y_{nit} - y_{nt} = -0.0025$ this becomes -3, -1 and 3. This shows how a minor change in the relative position of a region may greatly affect the measure ρ'_{it} if $y_{nit} - y_{nt}$ is small. In our dataset the estimated ρ'_{nit} range from -1238 (The Cantabria region in Spain, 2007) to 67 (The Umbria region in Italy, 2001). Most regions have values of ρ'_{nit} which are well behaved, however. The 25 and 75 percentiles of the distribution of ρ'_{nit} are 0.16 and 0.47 respectively.

with initial income levels relatively close to the country average, where redistributive policies are likely to matter less. One solution might be to set $\rho'_{nit} = 0$ (no income redistribution) if $y_{nit} - y_{nt}$ and $y^d_{nit} - y^d_{nt}$ are both small, but this is arbitrary, causes loss of information and introduces some bias. Second, from an empirical perspective, ρ'_{nit} might be endogenous in a regression of regional income growth since it is measured on the regional level and depends directly on regional income. Third, the dependency of ρ'_{nit} on regional income may lead to multi-colinearity issues given that regional income is often a key regressor in empirical regional growth analysis.

To avoid these problems associated with regionally estimated measures of redistribution ρ'_{nit}, a measure of redistribution ρ_{nt} can be defined at the country level as

$$\mathrm{E}\left[y^d_{nit} - y^d_{nt} \middle| \, y_{nit} - y_{nt} \right] = (1 - \rho_{nt}) \left[y_{nit} - y_{nt} \right]. \tag{3}$$

Estimating ρ_{nt} amounts to running a regression of $y^d_{nit} - y^d_{nt}$ on $y_{nit} - y_{nt}$ separately for every country and year in the sample. A constant term is not required because the average deviation of regional income from the country average is zero. The coefficient on $y_{nit} - y_{nt}$ then corresponds to $1 - \rho_{nt}$. It expresses how much of a relative regional difference in primary income is translated into a relative regional difference in secondary income, on average between all regions within a certain country and year. The parameter ρ_{nt} again is a 'rate of redistribution', expressing the share of the relative regional difference in primary income which is removed by government intervention. Measures of within-country redistribution closely related to the measure based on equation (3) have been introduced and estimated in different forms by, for example, Bayoumi and Masson (1995) and Mélitz and Zumer (2002).

Note that the country-level measure of redistribution ρ_{nt} can straightforwardly replace the regional rate of redistribution ρ'_{nit} defined in equation (1a) in the model of section 2. With redistribution defined on the country level the following regional growth equation replaces equation (2)

$$y_{nit} - y_{ni,t-1} = y_t - y_{t-1} - \beta_{1n,t-1}(y_{ni,t-1} - y_{n,t-1}) - \beta_2(y_{n,t-1} - y_{t-1}) + z_{nit}, \tag{4}$$

where $\beta_{1n,t-1} = b_{1n}(1 - \rho_{n,t-1})((1 - a(1 - d))$. Using a country-year specific measure of redistribution, the parameter governing within-country convergence $\beta_{1n,t-1}$ in the growth equation now also varies only between countries and over time.

Figure 1 provides a graphical illustration of the measurement of redistribution at the regional level (ρ'_{nit}) according to equation (1a), and at the country level (ρ_{nt}) according to equation (3). The figure shows the case of Belgium in the year 2000. The time index $t = 2000$ is omitted in the graph and in this paragraph to avoid cluttering. The horizontal axis shows the deviation of the regional primary per capita household income from the country-year average, i.e. the relative regional income position before redistribution. The vertical axis shows the deviation of the regional disposable (or secondary) per capita household income from the country-year average, after redistribution. The country level

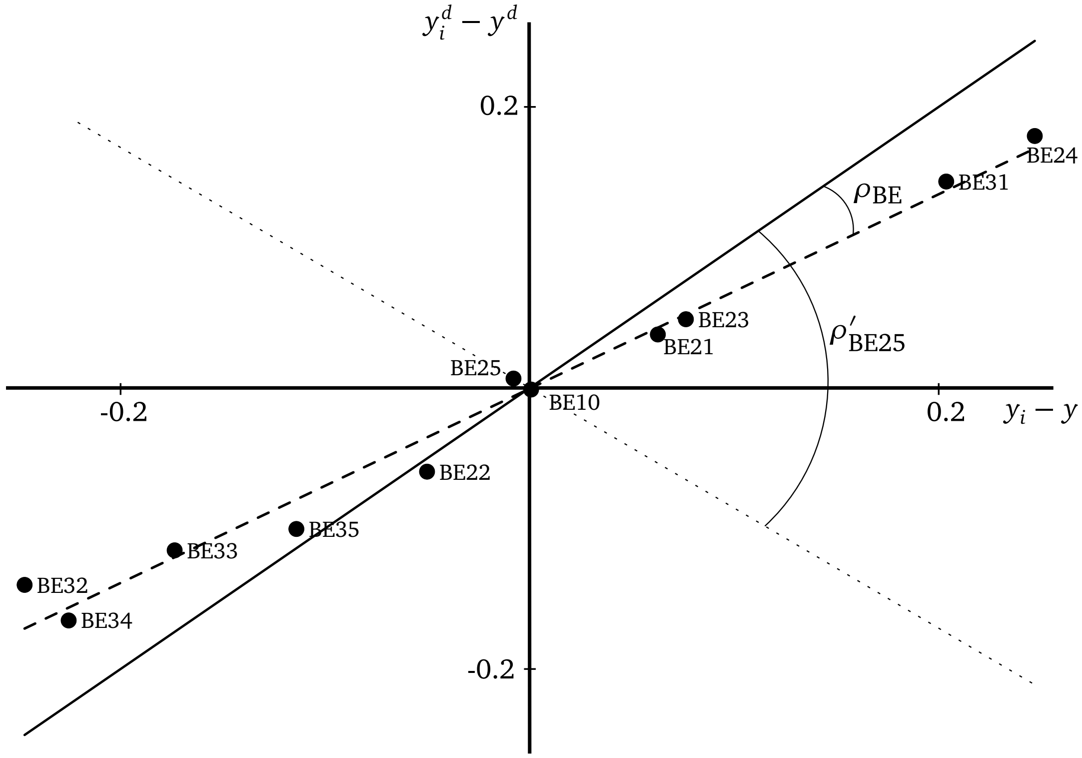

Figure 1: Interregional redistribution between the NUTS2 regions in Belgium in the year 2000. The horizontal axis shows the relative deviation of the regional per capita primary income from the country average. The vertical axis shows the relative deviation of the regional per capita disposable income from the country average. The dashed line shows the linear fit, and the difference of the slope of this line with the solid 45-degree line shows the average rate of redistribution in the country ρ_n for the given year. The difference between the slope of the 45-degree line and the slope of the ray through the origin for each region corresponds to the regional redistribution rate ρ'_{ni}.

redistribution measure ρ_{BE} is given by the difference between the slope of the linear fit including all regions (dashed line) and the solid 45 degree line which has a slope of 1. The regional redistribution measures ρ'_{ni} are given by the difference between the slope of the 45 degree line and the ray through the origin for the region i under consideration. For most regions, the value of ρ'_{ni} is relatively close to the country-wide measure $\rho_{\text{BE}} = 0.32$. Yet, for some regions ρ'_{ni} takes on extreme values. The case of BE25 (West-Vlaanderen) is illustrated in the graph (dotted line). The value $\rho'_{\text{BE25}} = 1.85$ signifies that policy has reversed the initial disadvantageous average income position of this region. This is not very informative, however, given that the income difference relative to the country average is quite small for this region both before and after government intervention. Moreover, for regions close to the origin the regional ρ'_{ni} are erratic over time.[9] Overall, the fit of regression (3) is quite good and as such the country-level redistribution measure ρ_{nt} captures the overall redistributive policy of the countries quite well. This also holds for other countries and years. Given the problems associated with estimating regional redistribution rates described in this section, we therefore use the country level measure of redistribution ρ_{nt} in the remainder of this paper.

The first column of table 1 shows the rate of redistribution obtained from estimating equation (3) for all euro area countries in our sample in 1995. The rate of redistribution for France in table 1 is close to the value of 0.38 reported by Mélitz and Zumer (2002).

	ρ_{1995}	$\rho_{2007} - \rho_{1995}$	cv_{1995}	$cv_{2007} - cv_{1995}$	y_{n1995}	y_{n2007}	regions
FI	0.60	−0.09	0.19	−0.04	2.18	2.54	5
NL	0.43	0.03	0.09	0.03	2.50	2.68	12
FR	0.39	0.01	0.13	−0.02	2.40	2.62	22
BE	0.37	−0.06	0.15	0.01	2.67	2.80	11
DE	0.33	0.05	0.17	0.00	2.67	2.80	39
PT	0.31	−0.04	0.20	0.05	2.01	2.12	5
ES	0.28	−0.08	0.21	−0.01	2.19	2.47	16
AT	0.21	0.21	0.10	−0.04	2.61	2.86	9
IT	0.15	0.05	0.28	−0.04	2.54	2.58	21

Table 1: The rate of interregional redistribution ρ_{nt}, the coefficient of variation in regional primary income cv_{nt}, and changes therein between 1995-2007 in the different EU member states in the sample. The last three columns show the 1995 and 2007 level of per capita primary income (in logs), and the number of retained NUTS 2 regions.

[9] For Brussels (BE10), for the year 2000 shown in the graph $\rho'_{\text{BE10}} = 2.64$, but in 1998 the value was −3.06, for example.

3.3. Redistribution and within-country inequality

The third column of table 1 reports the level of regional disparity in primary income in 1995 in each country as expressed by the coefficient of variation.[10] The level of redistribution and the level of regional primary income disparity are clearly inversely related. The left panel of figure 2 further illustrates this cross-sectional relationship between redistribution and regional disparities by plotting the time-averaged regional disparities within a country against the time-averaged rate of interregional redistribution.

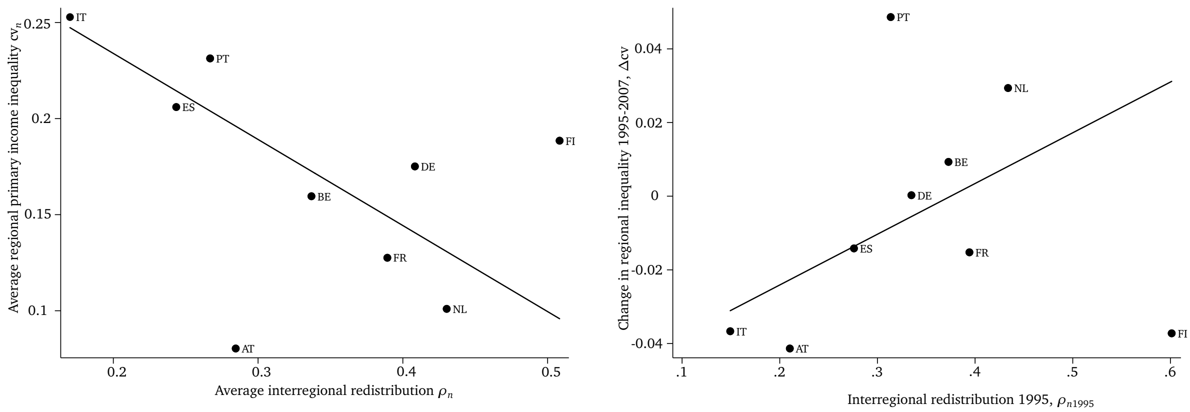

Figure 2: Left panel: within-country regional disparities as measured by the average coefficient of variation in the regional primary income over the years 1995-2007 (vertical axis) and the average rate of within-country interregional redistribution ρ_n (vertical axis). Right panel: the relationship between interregional redistribution in 1995 (horizontal axis) and the *change* in regional inequality over the years 1995-2007 (vertical axis). The linear fit shown in the graph weighs by country population.

Although studying the relationship between the levels of redistribution and inequality is interesting, investigating the *evolution* of inequality is more relevant for an analysis of regional convergence. The right panel of figure 2 shows that the observed negative correlation between the level of redistribution and the level of regional inequality is completely reversed when considering the relation between the level of redistribution in 1995 and the *change* in regional inequality in primary income over the years 1995-2007. This positive relationship between the level of within-country redistribution and subsequent change in inequality was also found by Kessler and Lessmann (2008) for a set of highly developed OECD countries.

The following regression addresses more formally how the rate of redistribution ρ_{nt} and a vector of other determinants X_{nt} in a country relate to changes in regional income

[10] The coefficient of variation equals the standard deviation divided by the average.

disparities as measured by changes in the coefficient of variation cv_{nt}. We allow for country dummies η_n and year dummies ξ_t.

$$\Delta cv_{nt} = \rho_{n,t-1} + \gamma X_{n,t-1} + \eta_n + \xi_t + \epsilon_{nt}. \tag{5}$$

This specification is essentially a type of conditional σ-convergence analysis. When including country fixed-effects, the change in regional income variation should be interpreted as changes relative to the country average, thus controlling for country-specific trends in the evolution of regional inequality and levels of the rate of redistribution which might differ between countries in a non-random fashion. The specification also includes year dummies to control for unobserved common shocks to both dependent and independent variables which might affect the results.

Table 2 reports the result of estimating various versions of equation (5). Given that the large differences in country sizes affect how relevant the country-level observations are to the overall evolution of regional inequality, the estimations use weighted least squares with total country population as weights. Column (I) first considers the effect of the level of

Dependent variable: Δcv_{nt}					
	(I)	(II)	(III)	(IV)	(V)
$\rho_{n,t-\tau}$	0.114*	0.0123***	0.0428***	0.0371***	0.0622***
	(0.0596)	(0.00429)	(0.0134)	(0.0131)	(0.0199)
$\text{covunemp}_{n,t-\tau}$					0.0486***
					(0.0122)
$\text{covold}_{n,t-\tau}$					−0.130*
					(0.0766)
$\text{covdeath}_{n,t-\tau}$					0.00251
					(0.00424)
$\text{covagrishare}_{n,t-\tau}$					−0.000170
					(0.0256)
constant	−0.0459**	−0.00489***	−0.0152***	−0.0125***	−0.0125
	(0.0168)	(0.00152)	(0.00406)	(0.00444)	(0.0141)
N	9	108	108	108	77
R^2	0.289	0.072	0.208	0.357	0.585
year dummies	No	No	No	Yes	Yes
country dummies	No	No	Yes	Yes	Yes
τ	12	1	1	1	1

Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

redistribution in 1995 on the change in regional inequality between 1995 and 2007, without other covariates, and excluding country or time dummies. This cross-sectional specification corresponds to the linear fit shown in the right panel of figure 2. The positive coefficient on the 1995 level of redistribution indicates that -on average- countries with a high level of redistribution in 1995 are characterised by a subsequent interregional divergence in primary income over the period 1995-2007. Column (II) repeats this analysis while pooling cross-sectional and time series information. It considers the effect of the one-year-lagged level of redistribution on the subsequent year-on-year change in regional inequality. Column (III) adds country-fixed effects to this specification, while column (IV) considers the case with both country and year dummies. Column (V) includes some other factors which might be correlated with both the level of redistribution and subsequent changes in inequality, such as the coefficient of variation of unemployment, the share of elderly people in the regional population, the mortality rate, and the share of agriculture in regional employment. The positive relationship between redistribution and subsequent changes in regional inequality holds over all specifications.[11]

How the negative cross-sectional correlation between the level of redistribution and the level of inequality can co-exist with a positive relation between the level of redistribution and the change in inequality is an interesting question. One explanation could be that only countries with small levels of regional inequality are willing and able to set a high rate of redistribution, thereby decreasing regional inequality in disposable income significantly in relative terms, without this implying or necessitating large absolute interregional income flows. Such a policy would severely slow down convergence of regions in the case of an asymmetric negative regional economic shock, however, and therefore one can expect a positive correlation between the level of redistribution and the change in regional inequality. In the long run the high rate of redistribution may become untenable since the same level of redistribution implies higher absolute interregional redistributive flows when regional inequality rises. For countries with large interregional income differences, sustaining a high rate of redistribution may simply not be an option politically or otherwise. If countries with high levels of regional inequality are forced to use low rates of redistribution in the long run, this could explain the negative correlation in levels observed cross-sectionally.

The previous paragraphs considered the relationship between redistribution and within-country regional income differences. As a country-level summary statistic the coefficient of variation in regional primary income is hardly suited for an analysis of the differences in

[11]The coefficient on redistribution in column (I) should be divided by 12 when comparing with the other columns which consider yearly changes.

regional growth rates which are driving 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 be expected. In turn, by considering how redistribution affects the relationship between the initial level of income and regional growth, the effect of redistribution on regional convergence can be determined.

4. Redistribution as a determinant of regional growth and β-convergence

Our empirical strategy to asses the effect of redistribution on growth and convergence consists of four parts.

Section 4.1 stays close to the growth equations suggested by theory. The average growth rate over the entire time span of the sample is considered as the dependent variable. The initial levels of variables in 1995 are used as explanatory variables. In such a cross-sectional setting it is impossible to simultaneously identify an effect of redistribution and allow for fixed differences in the within-country convergence rates.

Section 4.2 uses year-on-year growth rates as the dependent variable and one-year lagged variables as explanatory variables. Pooling cross-sectional and time-series data allows to estimate an effect of redistribution while controlling for time-constant differences in convergence rates between countries. This approach adds greatly to robustness: only changes over time in the rate of redistribution and within-country convergence rate are used to identify the effect of redistribution on convergence.

Section 4.3 takes the analysis one step further by controlling for regional fixed effects. Such an approach is robust in the presence of time-invariant omitted variables on the regional level. Including regional fixed effects implies that convergence is considered towards region-specific steady states, however. Such a type of conditional convergence analysis is interesting in its own respect but may be less informative towards explaining observed cross-sectional regional income disparity in the EU.

As a robustness-check for endogeneity of redistribution, section 4.4 uses the GMM technique of Arellano and Bond (1991) to identify the effect of redistribution on convergence.

4.1. Cross-sectional analysis of redistribution and β-convergence

Figure 3 shows a scatterplot of the log of regional primary income per capita in 1995 versus the average annual growth rate of this variable over the years 1995-2007, for all

140 NUTS2 regions in the 9 euro area countries in our sample. The overall shape of the point-cloud points to β-convergence: on average initially poorer regions grew faster over the period under consideration. The bold line illustrates a specific type of *between*-country convergence as the estimated weighted linear relationship between 9 pairs of country-averages of initial regional income and growth, using the number of regions in each country as weights. The slope equals -0.0194, which corresponds to an annual between-country convergence rate of about 2.2 percent.[12] The thinner dashed lines in figure 3 illustrate *within*-country convergence as the relationship between initial regional income per capita and subsequent growth, for regions within individual countries. An important observation is that, with the exception of Austria, all countries in the sample are characterised by slower within-country regional convergence rates compared to the between country convergence rate. The upward slopes for Belgium, Portugal and the Netherlands indicate that these countries experienced regional β-divergence. The fourth column of table 1 shows that this was accompanied by an increase in regional income disparity in these countries as measured by the change in the coefficient of variation of primary income.

Figure 3 can be seen as a graphical illustration of equation (4) after adapting it to consider the average regional growth over a 12 year time-span:

$$\frac{y_{ni2007} - y_{ni1995}}{12} = c - \frac{\beta_{1n1995}}{12}(y_{ni1995} - y_{n1995}) - \frac{\beta_2}{12} y_{n1995} + z_{ni1995}. \tag{6}$$

Equation (6) is essentially a cross-sectional regression. All variables which are constant such as the overall initial income level y_{1995} are absorbed by the constant. Column (I) in table 3 shows the corresponding estimated coefficients. The point estimate of the coefficient on the initial country-wide average income level y_{n1995} expresses the speed of between-country convergence and corresponds to the slope of the bold line in figure 3.[13]

As was already clear from figure 3, the estimated within-country convergence rates (the country-specific coefficients on $y_{ni1995} - y_{n1995}$) shown in column (I) are lower than the estimated between country convergence rate (the coefficient on y_{n1995}), except for Austria. The estimated homogeneous within-country convergence rate in column (II) (obtained when

[12] A country with a 1995 per capita income one unit above the 1995 average has an estimated average annual growth rate over the period 1995-2007 which is 0.0194 below the sample-wide average growth rate. In 2007 its income will therefore be 1 - 12×0.0194 above the average income. This value -by definition- equals the value $(1-r)^{12}$ where r is the rate at which economies converge. Equating both values and solving for r shows $r = 1 - (1 - 12 \times 0.019)^{1/12} = 0.022$.

[13] The coefficient on y_{n1995} corresponds exactly to the slope of the bold line in figure 3 because the linear fit in the graph weighs the country-averaged income and growth by the number of regions in each country.

Dependent variable: $(y_{ni2007} - y_{ni1995})/12$			
	(I)	(II)	(III)
$[y_{ni1995} - y_{n1995}]\times$I(AT)	−0.0401		
	(0.0324)		
$[y_{ni1995} - y_{n1995}]\times$I(BE)	0.00392		
	(0.00284)		
$[y_{ni1995} - y_{n1995}]\times$I(DE)	−0.00594**		
	(0.00279)		
$[y_{ni1995} - y_{n1995}]\times$I(ES)	−0.00939		
	(0.00669)		
$[y_{ni1995} - y_{n1995}]\times$I(FI)	−0.0166		
	(0.0257)		
$[y_{ni1995} - y_{n1995}]\times$I(FR)	−0.0119		
	(0.0102)		
$[y_{ni1995} - y_{n1995}]\times$I(IT)	−0.0124		
	(0.00798)		
$[y_{ni1995} - y_{n1995}]\times$I(NL)	0.0225**		
	(0.0102)		
$[y_{ni1995} - y_{n1995}]\times$I(PT)	0.0179		
	(0.0385)		
$[y_{ni1995} - y_{n1995}]$		−0.00843**	−0.0160**
		(0.00339)	(0.00637)
$[y_{ni1995} - y_{n1995}] \times \rho_{n1995}$			0.0281
			(0.0201)
y_{n1995}	−0.0194***	−0.0194***	−0.0168***
	(0.00402)	(0.00404)	(0.00379)
ρ_{n1995}			0.0320***
			(0.00491)
constant	0.0623***	0.0623***	0.0454***
	(0.0102)	(0.0103)	(0.0101)
N	140	140	140

Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Cross-sectional analysis of regional growth and convergence. A specification with heterogeneous speed of within-country convergence and excluding an effect of redistribution (column I), homogeneous within-country convergence excluding an effect of redistribution (column II), and homogeneous within-country convergence including an effect of redistribution (column III).

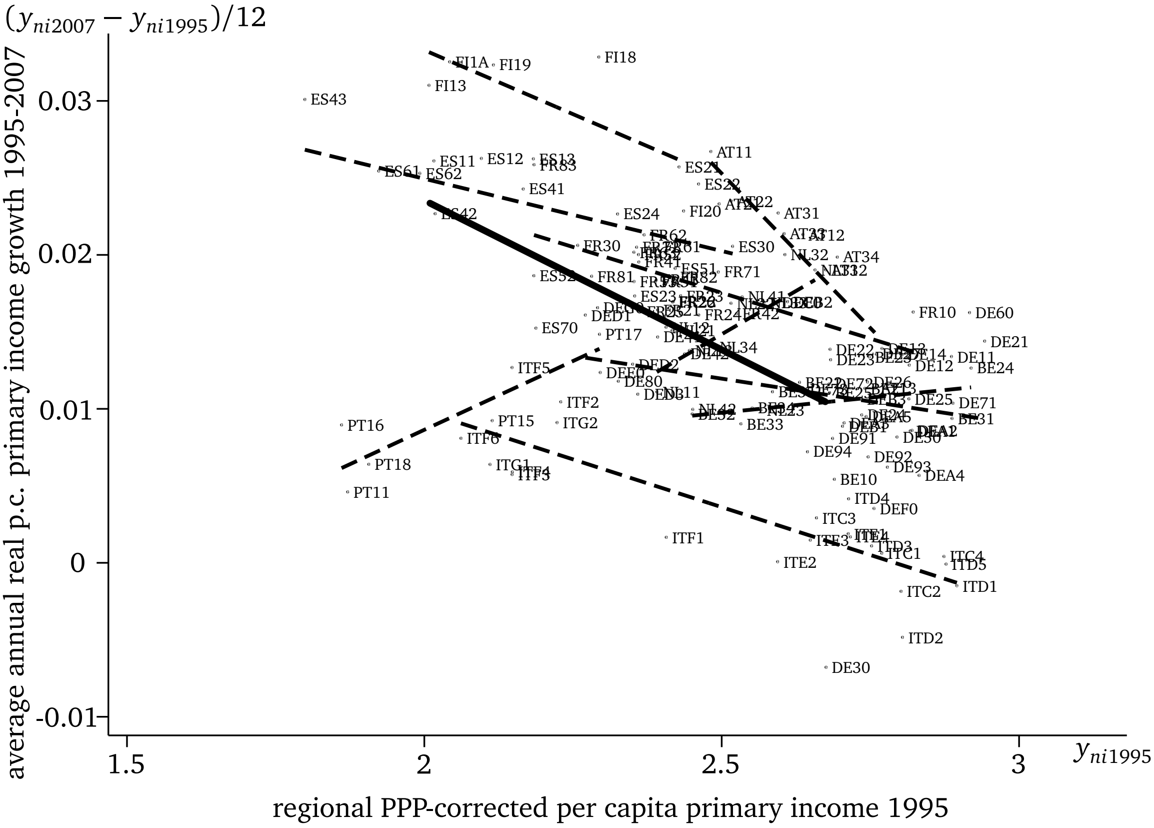

Figure 3: β-convergence in per capita primary income. There is clear evidence for convergence in that poorer countries are growing faster than richer regions (bold line). There is less evidence of convergence within countries (dashed lines). Many member states experience slow regional convergence or even divergence.

imposing $\beta_{1n} = \beta_1$) is about half the between-country convergence rate. This difference is significant at the 5 percent level.[14]

As argued in the previous sections, the observed lack of within-country regional convergence may be related to distorting redistributive schemes on the country level, as opposed to convergence between member states where redistribution is much more limited. Equations (4) and (6) can straightforwardly be rewritten to single out the effect of redistribution

[14]It is unsurprising that the point estimate of the between-country convergence rate does not change between column (I) and (II), since the variable $[y_{ni1995} - y_{n1995}]$ is by construction mean-zero on the country-year level and thereby strictly uncorrelated with variables on the country-year level such as y_{n1995}. Vice-versa, adding or removing country-year level variables does not affect the estimated speed of within-country convergence and these estimates therefore are robust to the omission of any variable on the country-year level.

on convergence.[15] In a cross-sectional setting there are insufficient degrees of freedom to allow for a country-specific convergence rate and simultaneously investigate the effect of redistribution thereon. Homogeneity of the within country convergence rates is therefore imposed when analysing the effect of redistribution on this rate in a cross-section. Collecting all time-invariant terms in the constant as before, we have

$$\frac{y_{ni2007} - y_{ni1995}}{12} = c - \frac{\beta_1^0}{12}(y_{ni1995} - y_{n1995}) + \frac{\beta_1^0}{12}\rho_{n1995}(y_{ni1995} - y_{n1995}) - \frac{\beta_2}{12}y_{n1995} + z_{ni1995}. \quad (7)$$

This specification essentially attributes all between-country differences in the average within-country convergence rates over the years 1995-2007 solely to differences in their 1995 rate of redistribution ρ_{n1995}. Column (III) of table 3 shows the results. The positive interaction effect of redistribution and relative regional income implies that countries with high 1995 rates of redistribution on average have slower 1995-2007 convergence rates. The p-value on this coefficient is only 0.164, however.

The coefficients on country-level income and relative regional-level income in column (III) are about equal in size and are not significantly different. This implies that in the absence of redistribution ($\rho = 0$) the estimated speed of within and between country convergence is about equal. This is compatible with the theoretical framework only if factors are equally mobile within and between countries, which seems unlikely. Moreover, if the coefficient on the interaction term $\rho_{n1995}(y_{ni1995} - y_{n1995})$ indeed exceeds the coefficient on relative regional income $(y_{ni1995} - y_{n1995})$ in absolute value, this would imply that regional income diverges within countries under a policy of complete income redistribution ($\rho = 1$). This behaviour is not consistent with the neoclassical framework developed above, where the coefficients on relative regional income and on the interaction with the rate of redistribution are predicted to be of equal size but opposite sign (see equation (7)).

The coefficient on ρ_{n1995} reflects the marginal effect of redistribution on growth for a region with an initial income level equal to the country average (for which $y_{ni1995} - y_{n1995} = 0$). Redistribution was not predicted to have such an 'overall' effect on regional growth rates in the model of section 2.2. Nevertheless, the estimated overall effect of redistribution on growth is positive and significant.[16] This will no longer be the case in any of the

[15] Define $\beta_{1n}^0 = b_n(1 - (1 - a)(1 - d))$ such that $\beta_{1nt} = \beta_{1n}^0 - \beta_{1n}^0\rho_{nt}$.

[16] Some channels through which redistribution could have an overall effect on regional growth may include a stabilising effect of redistribution, reducing social tension. An example of a possible direct negative effect would be the financing of non-productive government expenditure through progressive direct taxes, which at the same time would lower the propensity to work or invest. We leave it up to the data to reveal whether

specifications including country or regional fixed effects which are considered below.

The cross-sectional empirical analysis presented so far is simple and the results can be graphically illustrated and interpreted as in figure 3. A cross-sectional analysis has several limitations, however. Within-country convergence rates may differ because of factors such as inherent differences in within-country labour mobility between different countries, and these factors may be related to the rate of redistribution. A time series analysis allows to estimate both heterogeneous country-specific within-country convergence rates and measure the effect of redistribution thereon. The estimated effect of redistribution on convergence then is robust to the omission of time-constant factors on the country level.

4.2. Pooled cross-section time-series analysis of redistribution and β-convergence

Rather than identifying the effect of redistribution on convergence in a purely cross-sectional framework as above, we now turn to a pooled cross-section time series analysis. To this aim the yearly regional growth rate $y_{nit} - y_{ni,t-1}$ replaces the average regional growth between 1995 and 2007 as the dependent variable. The estimation equation becomes

$$y_{nit} - y_{ni,t-1} = \eta_t - \beta_1^0(y_{ni,t-1} - y_{n,t-1}) + \beta_1^0\rho_{n,t-1}(y_{ni,t-1} - y_{n,t-1}) - \beta_2 y_{n,t-1} + z_{nit}. \quad (8)$$

Time dummies η_t absorb all terms in equation (4) which change only over time. Table 4 shows the results, but only column (II) corresponds fully to estimation equation (8).

Column (I) deviates from equation (8) in that it does not separate out the effect of redistribution on within-country convergence. As in the cross-sectional analysis, it is found that -without controlling for redistribution- within-country convergence typically is slow and some countries even show regional divergence. All countries but Austria exhibit slower within country convergence compared to between-country convergence.

Column (II) considers the effect of redistribution on within-country convergence. The coefficients on the variables $y_{ni,t-1} - y_{n,t-1}$ show the within-country regional convergence rate (towards the country-year specific average) in the hypothetical case $\rho_{n,t-1} = 0$. The typical predicted speed of within-country convergence under $\rho_{n,t-1} = 0$ is fast, in the order of 10 percent annually, although the rates differ significantly between countries. Redistribution is predicted to slow within-country convergence. The estimated effect is large and statistically highly significant. The estimated overall effect of redistribution on growth is positive and significant.

the total direct effect is positive or negative.

Dependent variable: $y_{nit} - y_{ni,t-1}$						
	(I)	(II)	(III)	(IV)	(V)	(VI)
$[y_{nit-1} - y_{nt-1}]\times$I(AT)	-0.0425^{*}	-0.115^{***}	-0.115^{***}			
	(0.0221)	(0.0343)	(0.0292)			
$[y_{nit-1} - y_{nt-1}]\times$I(BE)	0.00304	-0.0930^{***}	-0.0930^{***}			
	(0.00614)	(0.0307)	(0.0285)			
$[y_{nit-1} - y_{nt-1}]\times$I(DE)	-0.00367	-0.120^{***}	-0.120^{***}			
	(0.00243)	(0.0366)	(0.0340)			
$[y_{nit-1} - y_{nt-1}]\times$I(ES)	-0.00908	-0.0798^{***}	-0.0798^{***}			
	(0.00584)	(0.0223)	(0.0204)			
$[y_{nit-1} - y_{nt-1}]\times$I(FI)	-0.0151	-0.159^{***}	-0.159^{***}			
	(0.0187)	(0.0499)	(0.0458)			
$[y_{nit-1} - y_{nt-1}]\times$I(FR)	-0.0149^{*}	-0.125^{***}	-0.125^{***}			
	(0.00904)	(0.0355)	(0.0330)			
$[y_{nit-1} - y_{nt-1}]\times$I(IT)	-0.0144^{***}	-0.0616^{***}	-0.0616^{***}			
	(0.00515)	(0.0166)	(0.0154)			
$[y_{nit-1} - y_{nt-1}]\times$I(NL)	0.00851	-0.113^{**}	-0.113^{**}			
	(0.0262)	(0.0465)	(0.0456)			
$[y_{nit-1} - y_{nt-1}]\times$I(PT)	0.0143	-0.0610^{**}	-0.0610^{**}			
	(0.0147)	(0.0283)	(0.0250)			
$[y_{nit-1} - y_{nt-1}]$				-0.00817^{***}	-0.0225^{***}	-0.0225^{***}
				(0.00238)	(0.00726)	(0.00687)
$[y_{nit-1} - y_{nt-1}] \times \rho_{nt-1}$		0.284^{***}	0.284^{***}		0.0486^{**}	0.0486^{**}
		(0.0894)	(0.0829)		(0.0214)	(0.0204)
y_{nt-1}	-0.0176^{***}	-0.0234^{***}	-0.126^{***}	-0.0176^{***}	-0.0234^{***}	-0.126^{***}
	(0.00244)	(0.00262)	(0.0172)	(0.00246)	(0.00265)	(0.0174)
ρ_{nt-1}		0.0338^{***}	-0.0456^{***}		0.0338^{***}	-0.0456^{***}
		(0.00477)	(0.0133)		(0.00476)	(0.0134)
N	1680	1680	1680	1680	1680	1680
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	No	No	Yes	No	No	Yes

Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Pooled cross-section time-series analysis of annual regional growth, 1995-2007. Column (I) includes country×year effects which also capture any effect of the initial country-level income $y_{n,t-1}$ Column (II) allows for an effect of redistribution on within-country convergence rates. Column (III) uses only year dummies, but also includes an effect of country-level initial income.

Specification (II) closely follows the simple theoretical framework presented in section 2. In reality, however, an important concern is that there might be omitted variables correlated both with regional growth and the rate of redistribution. As was already argued, such omitted variables on the country-year level are by construction uncorrelated with the variable $y_{ni,t-1} - y_{n,t-1}$ and its interaction with redistribution and can not bias the estimated effect of redistribution on convergence. But they could still bias the estimated speed of between-country convergence and the overall effect of redistribution on regional growth.

Column (III) is our preferred specification. It uses country dummies to control for any omitted time-invariant variable on the country level. Only within-country variation over time is used to identify the speed of within-country convergence, how it is affected by redistribution, and for the effect of redistribution on growth. The introduction of country dummies does not affect the results related to within-country convergence. It does matter greatly for the interpretation of the estimated speed of between-country convergence. The coefficient on $y_{n,t-1}$ now reflects the speed of convergence towards a country-specific mean (adjusted for shocks common to all countries in a specific year given the presence of year dummies). Importantly, controlling for country fixed effects, the overall effect of redistribution on growth becomes negative and significant.

Taking the average of the country-specific coefficients on $y_{ni,t-1} - y_{n,t-1}$ in column (I) shows that the average rate of within-country convergence in all countries in our sample is about 0.4 percent annually. Belgium, the Netherlands and Portugal exhibit regional divergence. According to the results presented in specifications (II) and (III), a decrease in the rate of redistribution with about 20 percent (not percentage points) in all countries is predicted to restore regional convergence in all countries in the sample. It would result in an average rate of within-country convergence of 2.5 percent. This is about the size of the estimated rate of between country convergence (2.34 percent) in column (II). Further lowering $\rho_{n,t-1}$ leads to predicted rates of within-country convergence which significantly exceed the estimated rate of between-country convergence.

These results point to redistribution as the main reason why the observed within-country convergence rates are below the between-country convergence rates. For low levels of redistribution convergence of regional income towards the country-year average is predicted to be much faster compared to the rate of convergence of countries towards the EU-year average. The results are consistent with theory if labour mobility in function of disposable income differences is much faster within countries compared to between countries, which seems very likely.

The results are also robust to the omission of any variable on the country-year level. This also explains why specifications (II) and (III) provide the same quantitative results regarding convergence. Adding country×year dummies to specification (II) or (III) would result in identical estimates for convergence and the effect of redistribution thereon.

To further illustrate the interpretation of the results Appendix A considers Germany as a specific example.

Column (IV) to (VI) correspond to the specifications in columns (I) to (III), except for imposing homogeneity of within-country convergence rates. The estimated homogeneous rate of within-country convergence under $\rho = 0$ from column (V) is much smaller than the heterogeneous counterparts in column (II). One reason for this is the bias which is introduced by imposing a homogeneous slope parameter when the true underlying parameters are heterogeneous. Another, however, is that with heterogeneous slopes, only purely within-country variation is used to estimate the speed of within-country convergence. With homogeneous slopes, also between-country variation in regional growth and the relative income position (of regions vis-a-vis the country-year average) is used for identification. The main results remain, however: redistribution significantly slows convergence, and when controlling for country-fixed effects the effect of redistribution on regional growth for a region with an initial income close to the country average is negative.

4.3. Controlling for regional characteristics: redistribution and conditional β-convergence

The specifications in section 4.2 used pooled time series and cross-sectional information. None of these regressions included regional fixed effects. Within-country regional convergence was considered relative to the country-year specific average income level. Region-specific steady states were not considered.

Region-specific omitted variables -say the cultural background of a region or the presence of a past severe and persistent negative regional productivity shock- may cause steady state growth rates to differ between regions. Lack of convergence may be due to correlation between regional growth impeding conditions and initial income. Such factors are unlikely to be correlated with the measure of redistribution, however, given that redistribution is measured on the country level. Still, these factors would affect the estimated speed of within-country convergence. This section therefore reconsiders the effect of redistribution on convergence and growth when regional fixed effects are controlled for. Including regional dummies implies that convergence is considered towards a region-specific steady state growth path, conditional on all omitted time-constant factors on the regional level.

Table 5 shows the result of several regional growth regressions which include regional fixed effects. Columns (I) and (III) do not include an effect of redistribution, columns (II) and (IV) separate out the effect of redistribution on regional growth and conditional regional convergence. The estimated homogeneous convergence rates in columns (III) and (IV) are lower compared to their typical heterogeneous counterparts in columns (I) and (II), as before.

As expected, the estimated rate of convergence conditional on the regional fixed effects is much faster compared to the rate of unconditional regional convergence towards the country-year average presented in the previous section. Again Austria is an exception. The effect of redistribution on growth and convergence is large and significant in all specifications. As the size of the coefficient on the interaction effect with redistribution is about half the size on the coefficient on initial relative regional income, even with complete redistribution most regions are predicted to converge. In specification (IV), in the absence of within-country redistribution the estimated speed of regional convergence (towards a region-specific steady state) is higher than the estimated speed of convergence of countries towards their country-specific (common year effect corrected) steady state.

To illustrate the robustness of these results, table 6 takes the fixed-effects analysis one step further by including more covariates. All specifications in table 6 impose homogeneity of convergence rates between countries to preserve some degrees of freedom.

Column (I) shows a specification including 108 country$\times$year dummies. Apart from these dummies and the regional fixed effects, relative regional income and the interaction effect with redistribution are the sole covariates. As before, redistribution is predicted to considerably slow regional convergence. Nevertheless, even with full redistribution the speed of convergence towards regional specific steady state remains fast, as in table 5.

Column (II) adds the length of the regional highway system and a regional index of human resources in science and technology as covariates. These variables are used as proxies for transport infrastructure and human capital, potentially important drivers of regional growth. Both are expressed as deviations from the country-year average.[17] It turns out that both transport infrastructure and human capital have a significant overall effect on regional growth. The growth effects are also stronger for initially poorer regions (given the negative sign of the interactions with $y_{ni,t-1} - y_{n,t-1}$). A policy increasing the overall level of transport infrastructure or human capital is therefore predicted to significantly increase

[17] Different from the case $\rho_{nt} = 0$, the question on the speed of convergence for extremely low levels of transport infrastructure (logmotor=0) or human capital (loghigher=0) is hardly interesting.

Dependent variable: $y_{nit} - y_{ni,t-1}$				
	(I)	(II)	(III)	(IV)
$[y_{nit-1} - y_{nt-1}]\times$I(AT)	0.00334	−0.0187		
	(0.0569)	(0.0966)		
$[y_{nit-1} - y_{nt-1}]\times$I(BE)	-0.172^{**}	-0.214^{**}		
	(0.0694)	(0.0835)		
$[y_{nit-1} - y_{nt-1}]\times$I(DE)	-0.106^{***}	-0.172^{***}		
	(0.0191)	(0.0374)		
$[y_{nit-1} - y_{nt-1}]\times$I(ES)	−0.0496	−0.0993		
	(0.0634)	(0.0703)		
$[y_{nit-1} - y_{nt-1}]\times$I(FI)	−0.103	-0.155^{***}		
	(0.0743)	(0.0521)		
$[y_{nit-1} - y_{nt-1}]\times$I(FR)	-0.356^{***}	-0.416^{***}		
	(0.0557)	(0.0609)		
$[y_{nit-1} - y_{nt-1}]\times$I(IT)	-0.264^{***}	-0.260^{***}		
	(0.0479)	(0.0501)		
$[y_{nit-1} - y_{nt-1}]\times$I(NL)	-0.435^{***}	-0.501^{***}		
	(0.120)	(0.109)		
$[y_{nit-1} - y_{nt-1}]\times$I(PT)	−0.273	−0.297		
	(0.193)	(0.213)		
$[y_{nit-1} - y_{nt-1}]$			-0.178^{***}	-0.217^{***}
			(0.0271)	(0.0318)
$[y_{nit-1} - y_{nt-1}] \times \rho_{nt-1}$		0.162^{*}		0.143^{**}
		(0.0823)		(0.0694)
y_{nt-1}	-0.107^{***}	-0.126^{***}	-0.107^{***}	-0.126^{***}
	(0.0160)	(0.0179)	(0.0162)	(0.0185)
ρ_{nt-1}		-0.0456^{**}		-0.0456^{**}
		(0.0179)		(0.0188)
N	1680	1680	1680	1680
region dummies	Yes	Yes	Yes	Yes
year dummies	Yes	Yes	Yes	Yes

Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Pooled cross-section time-series analysis of regional growth, including regional dummies (regional fixed effects) and year dummies.

Dependent variable: $y_{nit} - y_{ni,t-1}$				
	(I)	(II)	(III)	(IV)
$[y_{nit-1} - y_{nt-1}]$	-0.214^{***}	-0.222^{***}	-0.216^{***}	-0.257^{***}
	(0.0229)	(0.0229)	(0.0359)	(0.0442)
$[y_{nit-1} - y_{nt-1}] \times \rho_{nt-1}$	0.112^{**}	0.113^{**}	0.136^{*}	0.218^{**}
	(0.0505)	(0.0507)	(0.0746)	(0.0881)
$[y_{nit-1} - y_{nt-1}] \times \text{logmotor}_{nit-1}$		-0.0252^{**}	-0.0112	-0.00835
		(0.0121)	(0.0140)	(0.0155)
$[y_{nit-1} - y_{nt-1}] \times \text{loghigher}_{nit-1}$		-0.0475^{**}	-0.0448	-0.0604^{**}
		(0.0217)	(0.0281)	(0.0302)
logmotor_{nit-1}	0.00805^{***}	0.00622^{**}	0.00706^{**}	0.00120
	(0.00274)	(0.00302)	(0.00353)	(0.00480)
loghigher_{nit-1}	0.0178^{***}	0.0149^{***}	0.0178^{***}	0.0134^{*}
	(0.00526)	(0.00556)	(0.00660)	(0.00758)
$y_{n,t-1}$			-0.132^{***}	-0.216^{***}
			(0.0212)	(0.0298)
$\rho_{n,t-1}$			-0.0586^{***}	-0.0838^{***}
			(0.0190)	(0.0260)
$\text{logcov}_{n,t-1}$			-0.0563^{***}	-0.0117
			(0.0110)	(0.0157)
$\text{covunemp}_{n,t-1}$			-0.0269^{***}	-0.0348^{***}
			(0.00612)	(0.00749)
$\text{covagrishare}_{n,t-1}$			0.0677^{***}	0.0594^{***}
			(0.0199)	(0.0230)
$\text{covold}_{n,t-1}$				0.317^{***}
				(0.0801)
$\text{unemprate}_{ni,t-1}$				-0.0292
				(0.0298)
$\text{agrishare}_{ni,t-1}$				-0.120^{**}
				(0.0527)
$\text{oldrate}_{ni,t-1}$				0.0886
				(0.0619)
N	1628	1628	1556	1327
year dummies	No	No	Yes	Yes
country×year dummies	Yes	Yes	No	No
region dummies	Yes	Yes	Yes	Yes

Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Pooled cross-section time-series analysis of regional growth, including regional fixed effects.

growth in all regions, and more so in initially poorer regions. A regional policy specifically targeting poorer regions would obviously benefit poorer regions even more.

The country×year dummies which were added in columns (I) and (II) make it impossible to estimate the speed of between-country convergence or the overall effect of redistribution on growth, since ρ_{nt} and y_{nt} vary only on the country-year level. Rather than including the country×year dummies, specification (III) controls for some possibly relevant omitted variables on the country-year level. The lagged country-level disparity in four variables is added: primary income, the unemployment rate, the sectoral share of agriculture, and the share of elderly people in the population. As expected, this does not greatly affect the estimated effect of redistribution on regional convergence. If anything, the effect of redistribution on regional convergence becomes even stronger in this specification. The estimated overall effect on growth is negative.

Column (IV) shows furthermore that the main result pertaining to the effect of redistribution on growth and convergence remain to hold when adding the regional unemployment rate, share of agriculture and share of elderly in the population as covariates, although the overall significance of the results deteriorates given the small number of observations for which all these covariates is available.

Overall, in the presented results with regional fixed effects, a decrease in the level of redistribution is predicted to slow regional convergence towards a region-specific steady state. In the specifications without country×year dummies the overall growth effect of redistribution could also be estimated. In all of these specifications, a reduction in the rate of redistribution is predicted to increase the growth rate of per capita primary income all regions and the growth effect is stronger in initially poorer regions.

4.4. Instrumenting redistribution using the Arellano and Bond (1991) method

Despite the fact that it is unlikely that the growth performance of an individual region affects the country-wide rate of redistribution, it might be interesting to apply standard methods to control for the possible endogeneity of the redistribution variable as a robustness check. To control for endogeneity we apply the methodology of Arellano and Bond (1991). Their method can be summarised as first-differencing of the growth regression to remove the regional fixed effects, and subsequently using lags of the potentially endogenous variables as instruments for the equation in differences. Adding more lags gives more identification restrictions which can be exploited in a GMM framework. If appropriate conditions hold, adding the growth equation in levels and using differenced variables as instruments allows for even more identification restrictions. Lately, the dangers of using too many instruments

Dependent variable: $y_{nit} - y_{ni,t-1}$			
	(I)	(II)	(III)
$[y_{nit-1} - y_{nt-1}]$	-0.103^{**}		-0.143^{**}
	(0.0449)		(0.0696)
$[y_{nit-1} - y_{nt-1}] \times \rho_{nt-1}$	0.499^{***}	0.551^{***}	0.539^{*}
	(0.153)	(0.164)	(0.297)
y_{nt-1}		-0.211^{***}	-0.186^{**}
		(0.0743)	(0.0755)
$[y_{nit-1} - y_{nt-1}]\times$I(AT)		-0.169	
		(0.151)	
$[y_{nit-1} - y_{nt-1}]\times$I(BE)		-0.111	
		(0.0907)	
$[y_{nit-1} - y_{nt-1}]\times$I(DE)		0.155	
		(1.219)	
$[y_{nit-1} - y_{nt-1}]\times$I(ES)		-0.132	
		(0.291)	
$[y_{nit-1} - y_{nt-1}]\times$I(FI)		0.00400	
		(0.182)	
$[y_{nit-1} - y_{nt-1}]\times$I(FR)		-0.144	
		(0.136)	
$[y_{nit-1} - y_{nt-1}]\times$I(IT)		-0.123^{**}	
		(0.0510)	
$[y_{nit-1} - y_{nt-1}]\times$I(NL)		-0.378	
		(0.299)	
$[y_{nit-1} - y_{nt-1}]\times$I(PT)		0.00506	
		(0.356)	
ρ_{nt-1}		-0.236^{***}	-0.243^{**}
		(0.0860)	(0.100)
constant	0.0166^{***}	0.614^{***}	0.555^{***}
	(0.00274)	(0.201)	(0.214)
N	1680	1680	1680
Number of instruments	4	22	6
Hansen	0.363	0.462	0.693
AR(1)	< 0.001	< 0.001	< 0.001
AR(2)	0.264	0.406	0.414

Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: GMM estimation. Column (I) includes country×year dummies. Column (II) includes year dummies only, but allows for a heterogeneous within-country convergence rate. Column (III) imposes identical regional convergence rates in all countries apart from the effect of redistribution.

has been emphasised by several authors, such as Roodman (2009). We therefore restrict the lag structure of the instruments to a maximum of two and collapse the instrument matrix. Our results are robust to using only level instruments for the equation in differences. The resulting number of instruments is reported with the estimation results in table 7.

Column (I) shows a specification including country×year dummies. The relative income position and the interaction with redistribution are the sole other covariates. They are instrumented by the third and fourth lag in the equation in first differences, and their first differences are used as instruments for the equation in levels. The Hansen test of over-identifying restrictions is given in the table and does not reject the validity of the instruments on standard significance levels.

Column (II) includes only year dummies, not country×year dummies. The within-country convergence rates are instrumented using the third and fourth lag. All other variables (except for the year dummies) are instrumented using the fourth and fifth lag. The heterogeneous within-country convergence rates at $\rho_{nt} = 0$ are estimated very imprecisely. The estimated effect of redistribution is large and significant, however.

The specification in column (III) is identical to column (II) except for imposing homogeneity of the within-country convergence rate. Both the estimated level effect of redistribution and the effect on within-country convergence is rather similar in column (II) and (III) and are in line with earlier findings.

5. Summary and conclusion

Countries redistribute significant amounts of wealth between regions. Economic theory suggests that these flows may have an effect on regional growth and convergence between regions. This paper introduced a simple neo-classical model showing a possible negative effect of redistribution on convergence. The model provided a regional growth equation encompassing between-country convergence, within-country convergence, and an effect of income redistribution on within-country convergence.

The effect of within-country interregional income redistribution on regional income growth and convergence was then empirically investigated using data on 140 regions from 9 EU member states for the years 1995-2007. The empirical analysis is inspired by the growth equation derived from theory, but also considers various more flexible specifications. In a wide variety of settings interregional income redistribution was found to substantially slow regional within-country income convergence.

Cross-sectional differences between countries in the 1995 levels of within-country interregional income redistribution entirely explain the difference between relatively fast overall convergence between EU countries and relatively slow within-country convergence over the years 1995-2007 (table 3). However, attributing all observed differences between countries in within-country convergence rates solely to differences between countries in redistribution is flawed in the presence of omitted variables influencing both variables.

Using pooled cross-section time-series this paper therefore subsequently allowed for time-invariant differences between countries in the speed of within-country convergence, and used only information on changes in redistribution and subsequent changes in the speed of within-country convergence to identify the effect of redistribution on convergence. In these specifications, the estimated effect of redistribution on within-country convergence is strong. According to these results, all of the observed difference between the convergence rate of regions towards the country-year average income and the rate of convergence of countries towards the EU-year average can be explained by differences in the rate of redistribution between countries. The estimated rate of within-country convergence is predicted to equal the rate of between-country convergence, should levels of redistribution be lowered by 20 percent relative to their current levels. At lower levels of redistribution, the predicted within-country convergence rate significantly exceeds the between-country convergence rate.

Specifications including regional fixed effects are quite different in that they consider region-specific steady states. These 'conditional' rates of convergence tend to be much faster than their unconditional counterparts. Redistribution is also found to significantly slow conditional convergence, but the effect is smaller in relative terms.

These results on conditional convergence are confirmed after controlling for covariates such as the regional dispersion of unemployment in a country, and when using system-GMM to control for possible endogeneity. Adding proxies for transport infrastructure and human capital suggest a positive effect on regional growth without an economically or statistically significant effect on convergence. Policy measures targeting transport infrastructure and education in poorer regions may therefore be better means to achieve higher regional growth and convergence. These investments should preferably be paid for by taxes which are neutral with respect to relative regional factor prices.

Whereas redistribution has the obvious effect of equalising disposable income between regions, our results suggest it comes at the double cost of a lower aggregate growth rate, and an even lower growth rate in backward regions. The lower growth rates in backward regions imply that redistribution causes slower convergence or even divergence, and may thus create a need for redistribution over a longer time period, or even more redistribution in the future. This would make redistributive systems impossible to maintain, or lead to increasing tensions between regions within the same country as can be observed in some EU member states today.

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Appendix A. The case of Germany as an example

This section considers the estimated effect of redistribution on growth and convergence for the case of Germany as an illustration.

The effect of redistribution on convergence

We use the results from specification (II) and (III) in table 4 to estimate the effect of redistribution on convergence. These specifications pool time series and cross-sectional information, which allows for heterogeneous levels of within-country convergence apart from the effect of redistribution thereon. This is important in order to control for time-invariant country characteristics which may be correlated both with the level of redistribution and the speed of convergence.

We specifically do *not* consider specifications with regional fixed effects in this section as we want to focus on convergence of regional per capita income towards a common country-year specific steady state. Including regional dummies would imply region-specific steady states which are less relevant to explaining within-country regional income differences.

Consider the case of Germany in the year 2000. The observed rate of redistribution $\rho_{n,t-1}$ was 0.43. Using the results from column (II) or (III) in table 4, the total coefficient on regional relative initial income $y_{ni,t-1} - y_{n,t-1}$ at this level for redistribution equals $-0.120 + (0.43)(0.284) = 0.0021$. Regional income therefore is predicted to diverge at a rate of 0.21 percent in 2000, but this rate is not significantly different from zero.

In the hypothetical case of a ten percentage point decrease in the German rate of redistribution to $\rho_{nt} = 0.33$, the predicted rate of within-country convergence would be 2.63 percent annually. This rate is significantly different from zero. It is rather similar in magnitude as the speed of convergence of countries towards the EU average (2.34 percent annually). Setting $\rho_{nt} = 0$ results in a predicted annual within-country convergence rate of 12 percent for Germany.

The effect of redistribution on regional growth

In contrast to the effect on within-country convergence, the question of how an increase in redistribution affects regional growth can only be answered if we are willing to assume that there is no need to include country×year dummies such that overall effect of the rate of redistribution on growth can be estimated. It is possible -and probably wise- to include country dummies to control for country-specific omitted variables, as was done in specification (III) of table 4. The importance of these omitted variables is illustrated by the significant change in the coefficient on $\rho_{n,t-1}$ between columns (II) and (III) when country dummies are included.

Table 8 shows the estimated growth rates for German regions in the year 2000 at various relative regional income positions in 1999 (approximately 10 percent below the average regional income, at the average regional income, and approximately 10-percent above the average regional income) and at three different rates of redistribution (the observed 1999 rate of 0.4323, and a rate 10 percentage points below and above this level).[18] Note that at

[18]Take a region with a 1999 regional per capita income 10 percent below the country average, and a hypothetical rate of redistribution of 0.33 (0.1 below the observed rate of 0.43). The region is predicted to grow at a yearly growth rate of 0.35657 + 0.018459 + (-0.125)(2.7131) + (-0.1)(-0.119) + (-0.1)(0.281)(0.33) +(-0.0450)(0.33) = 0.023 annually; where 0.3914 and 0.033309 are country and year effects which are omitted from table 4.

	$y_{ni1995} = 2.61$	$y_{ni1995} = 2.71$	$y_{ni1995} = 2.81$
$\rho_{n1995} = 0.33$	0.0236	0.0211	0.0185
$\rho_{n1995} = 0.43$	0.0163	0.0165	0.0168
$\rho_{n1995} = 0.53$	0.0089	0.0120	0.0151

Table 8: Predicted regional growth rates for German regions, at various levels of 1999 regional income and redistribution rates.

the observed rate of redistribution $\rho_{n1995} = 0.43$ Germany regional income is predicted to diverge slowly (but insignificantly).

Decreasing the rate of redistribution by 10 percentage points is predicted to restore regional convergence. The decrease in $\rho_{n,t-1}$ is also predicted to increase growth in both relatively backward and relatively rich regions. The growth effect of the decrease in redistribution is smaller for richer regions. For a few relatively rich regions in Germany, the predicted growth effect even becomes negative. This is effect is not significantly different from 0 however for any region, however.