# Regional Growth In Central Europe: Long-Term Effects Of Population Structure

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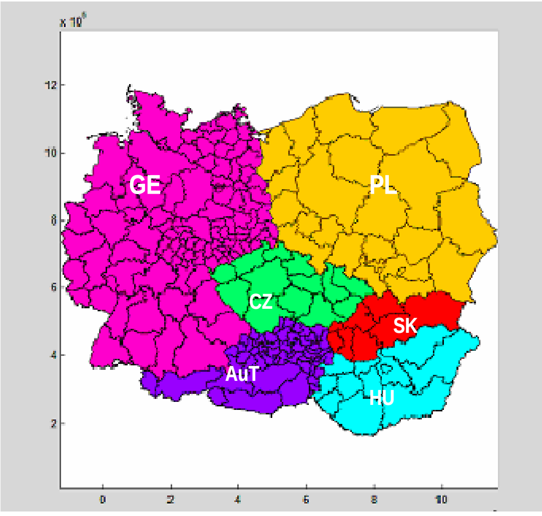
## EXTENDED ABSTRACT

In a simple growth model we explore the current and future growth effects of the population structure. Regional growth in 227 regions of 6 countries in central Europe (see Figure 1.0) is explored as how they depend on the young and old dependency ratio. The young dependency ratio (YDR) is defined as ratio of the less than 20 years old and the old dependency ratio (ODR) as the more than 60 years old divided by the total population. We found that there is a medium sized negative correlation of these demographic dependency ratios on regional growth and the long-term forecast for the year 2020 is for most regions rather bleak.

The distribution of the YDR is right skewed and the distribution of the ODR is left skewed and the correlation coefficient is negative: -0.82. While the negative dependence of growth on ODR is significant in both models, the coefficient on YDR is not significant. Furthermore it changes sign when we go from the aggregate model to the disaggregated fixed effect model. This behavior is consistent with a phenomenon that is called Simpson paradox.

A main result is: A 10 %-point positive difference in the DR will decrease GDP growth by about 1%-point for YDR and by -1.8%-points for ODR. If there were no old or young people in the population we see from the fixed effects that average growth could lie between 6.5% per annum (in the Czech R.) and 9.9% (in Slovakia).
The size of the "demographic stress" effects varies also across countries: While GDP growth in the regions of Germany, Hungary and Slovakia will be almost not affected by a changing population structure, most regions in Poland, Austria and the Czech Republic will suffer from adverse population structure effects.
To quantify the effect on GDP growth for the year 2020, we have calculated the difference in the forecasted values based on the regional model. The forecast scenarios for 2020 show very different patterns in the 6 central European countries of regional growth according to the three variables GDP, employment and population growth. On average the demographic stress factor, caused by the current population structure, will affect real GDP growth in regions by -0.5 %-point.

**Figure 1.0** The 6 Central European countries (coloured from left: Germany, Poland, Czech R., Slovakia, Austria, Hungary)



## 1. INTRODUCTION

Age structure and population growth have become a highly disputed topic for growth scenarios of countries around the world. Several papers have explored the impact of the age structure on economic growth (see e.g. Brunow and Hirte 2005). Only a few results are available on a regional level with panel data. This short note explores the effect of regional growth in 6 European countries for the period 1995 to 2001: Austria, Hungary, Slovakia, Poland, Germany and the Czech Republic.

Figure 1.1 shows the young dependency ratio over the 227 regions and we see a large dependency ratio along the eastern border of Poland and Slovakia. But surprisingly, also some smaller regions of upper Austria, Eastern Tyrol, Vorarlberg (on the Swiss border to Austria) and Salzburg have a dependency ratio of above 25%. Small values of the young dependency ratio can be seen for the regions in Saxony.

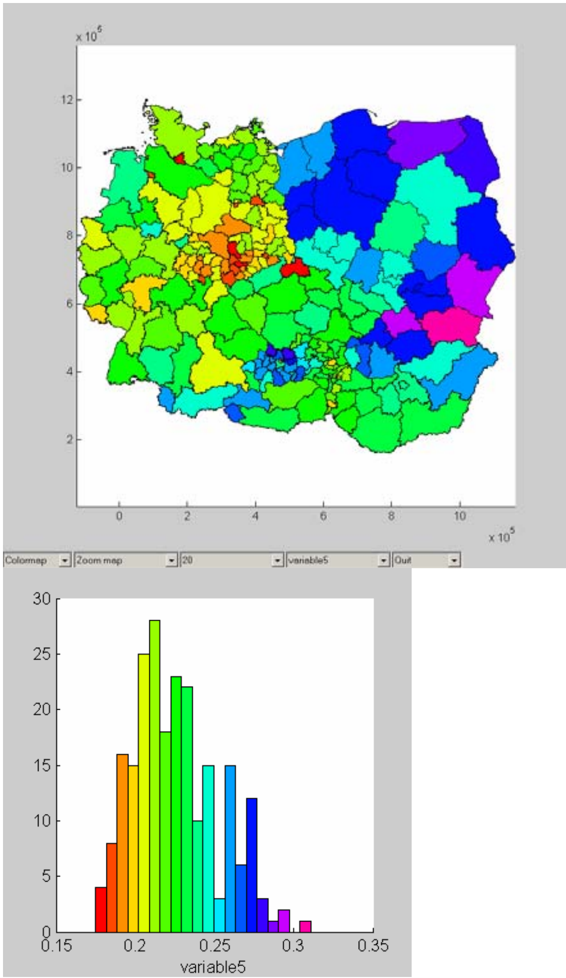



**Figure 1.1** Young dependency ratio YDR: (0-20 years old in total population)

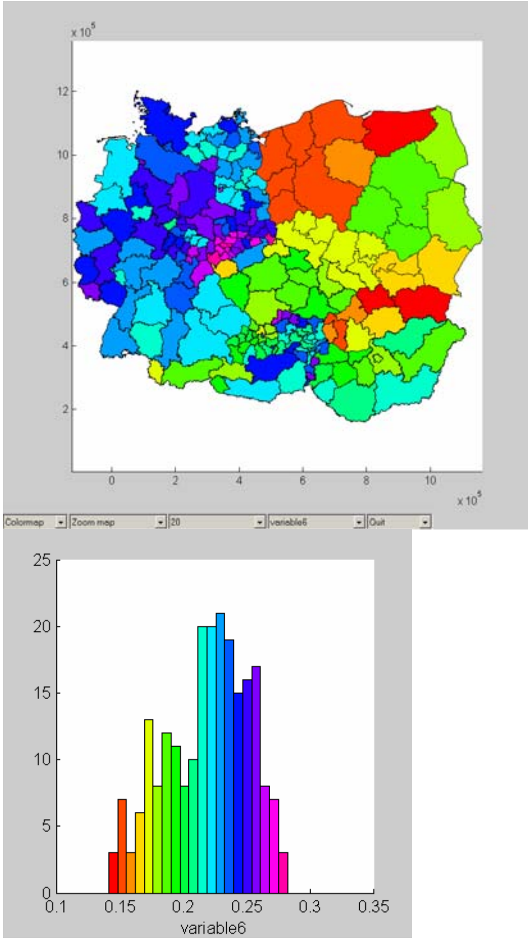



**Figure 1.2** Old dependency ratio ODR: (60+ in total population.)

The largest old dependency ratio is found for regions in Eastern Germany, in particular in Saxony, (see Figure 1.2, the large values are pink). But the map shows that in Western Germany there is a regional pattern; also, that regions bordering East Germany show high values. In Austria we see the northern regions of lower Austria, Burgenland and Upper Styria to have high old dependency ratios (in dark blue). In Poland we see 4 regions if we cluster by the old dependency ratio. In the Czech Republic and Hungary we find medium sized old dependency ratios (in green).

### 1.1 The outline of the paper

The goal of the paper is to explore the long-term effect of the present population structure on GDP growth by exploring the spatial regional structure in Europe. Since the basic model is a dynamic panel model with 227 regions but only 6 years of observations, we are also limited by the number of regressors that are available on a regional (called NUTS 3 by EUROSTAT) level. The effect of the (old and young) dependency structure on GDP is in all countries negative, and in a simple forecasting analysis we explore the effect of the present population structure for the year 2020.

## 2. GDP GROWTH AND POPULATION STRUCTURE

In this section we explore the relationship between regional GDP growth (GDP%) and the young (YDR) and old dependency ratios (ODR).

**Table 2.1.** Correlation matrix of GDP growth and the dependency ratios YDR and ODR

| | GDP% | YDR | ODR |
|---|---|---|---|
| GDP% | 1.00 | 0.39 | -0.41 |
| YDR | 0.39 | 1.00 | -0.82 |
| ODR | -0.41 | -0.82 | 1.00 |

Note: All correlations are significantly different from zero.

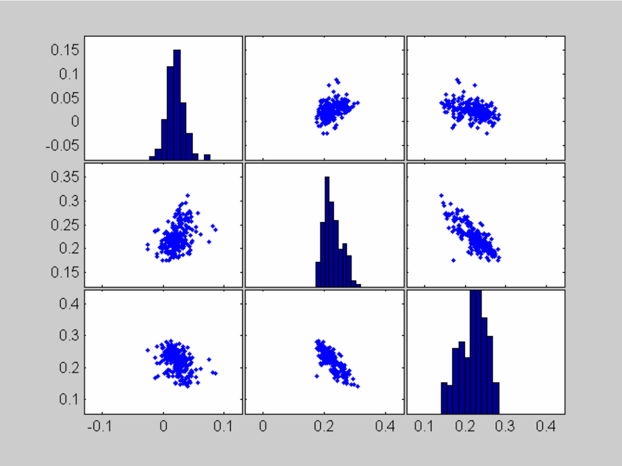



**Figure 2.1** Scatterplot matrix of GDP growth and the dependency ratios YDR and ODR

From Figure 2.1 and the pairwise correlations in Table 2.1 we see that the correlation coefficient between GDP growth and the young dependency ratio is positive while the correlation coefficient between GDP growth and the old dependency ratio is negative. Clearly, both dependency ratios (ODR and YDR) are negatively correlated. This can be also seen from the scatter plot matrix that summarizes the 227 regions in central Europe.

### 2.2 Long Term Forecast Implications

For the year 2020 long-term population growth projections are available from the statistical offices in the 6 countries. From these forecasts for 2020 we computed the future young and old dependency ratio and used them for a conditional forecast for the GDP growth in the year 2020. In order to compare the impact of the population structure on GDP growth we also computed the difference between the past estimates and the estimated forecasts.

The simple model for modelling structural demographic stress on GDP growth is

(2.1) $y = \alpha + X\beta + u$

where X = {YDR, ODR} and the fixed effect model is:

(2.2) $y = D\,\alpha + X\beta + u$

where $D = \{D_{At}, D_{Ge}, \ldots D_{Hu}\}$.

First, we computed in the simple regression models to explore the effects of old and young dependency ratios on the GDP growth rate (Table 2.1). Second, we computed the fixed effect regression model, for example we replaced in the simple model the intercept by the 6 dummy variables for 6 countries (Table 2.2).

In Figure 2.1 we plotted the fitted models as a map for 2000 and in Figure 2.2 the forecasts of the model for the regression data of 2020. These fitted values are the point forecast for GDP growth for the year 2020, given the (official) forecasts of young and old dependency ratios for 2020, but the coefficients of the model are based on the data observation from 1995 to 2001.

**Table 2.2** Regression estimates for the model with the dependency ratios (DR) only

| OLS | coeff. | confidence- | interval |
|---|---|---|---|
| variables | b | b_lower | b_upper |
| intercept | 0.030 | -0.017 | 0.076 |
| young DR | 0.096 | -0.025 | 0.218 |
| old DR | -0.130 | -0.230 | -0.031 |
| | $R^2$ | F-Stat | p-value |
| | 0.175 | 23.68 | 0 |

**Table 2.3** Regression estimates for the 6 fixed effect model plus YDR and ODR

| OLS | coeff. | confidence | interval |
|---|---|---|---|
| variables | b | b_lower | b_upper |
| d_austria | 0.091 | 0.042 | 0.140 |
| d_slovakia | 0.099 | 0.052 | 0.147 |
| d_hungary | 0.090 | 0.042 | 0.138 |
| d_germany | 0.080 | 0.031 | 0.128 |
| d_poland | 0.093 | 0.045 | 0.140 |
| d_czech R | 0.065 | 0.019 | 0.110 |
| Young DR | -0.099 | -0.220 | 0.023 |
| Old DR | -0.182 | -0.299 | -0.065 |
| | $R^2$ | F-Stat | p-value |
| | 0.376 | 18.88 | 0 |

For interpretation purposes we refer to the measurement scale of dependency ratios, i.e. the values from 0 to 1 as percentages or 100 basis points (bp). From the simple model we see that the increase of 10 basis points in the YDR increase the GDP growth by about 1%-point. The effect of 10 basis points of the ODR is negative and large: about -1.3%-points in GDP%. Note that in the fixed effect model both effects are negative and ODR coefficient is doubled the size of the YDR coefficient. A 10%-point positive difference in the DR will decrease GDP growth by about 1%-point for YDR and by -1.8%-points for ODR. If there were no old or young people in the population the fixed effects that average growth could lie between 6.5% per annum (in the Czech R.) and 9.9% (in Slovakia). The YDR coefficient is not significant in both models: This explains also the sign change.

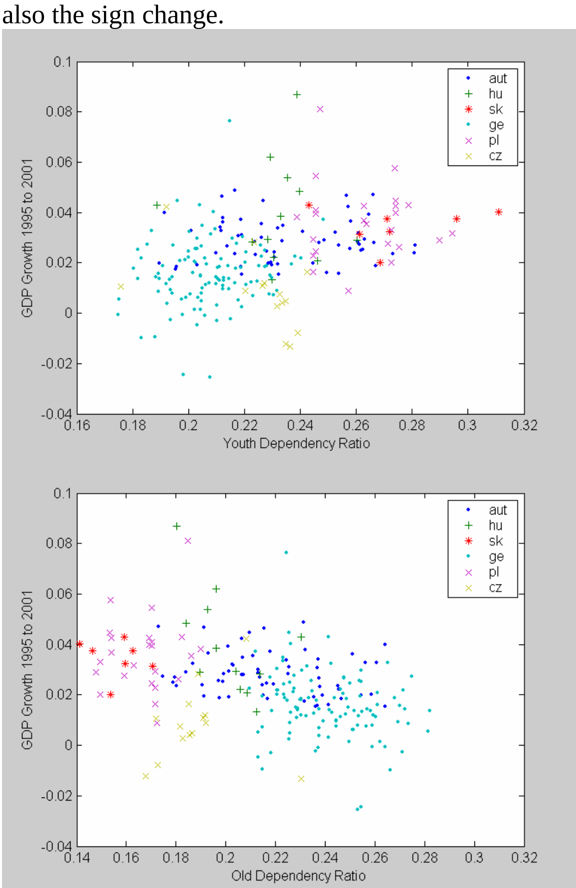



**Figure 2.2** Scattergram of GDP% with YDR and ODR: Simpson paradox visualized (AUT=Austria, HU=Hungary, SK=Slovakia, PL =Poland, GE = Germany, CZ= Czech Republic)

The regression estimates in Table 2.1 and Table 2.2 show that the so-called Simpson effect is present in the data. While in the simple regression model the coefficient of the young dependency ratio is positive, it is negative for the fixed effect model. This means that if we allow the intercept to vary across countries but impose the same slope coefficient for GDP growth in these 6 countries, then we obtain a negative correlation between growth and young dependency ratio. Recall, that we see a positive slope in the simple regression model, implying that the growth rates of the 6 countries are rather widely and heterogeneously distributed.

Note that the change in the sign of the YDR coefficient can be best explained by Simpson's Paradox[1]. The overall scatterplot shows: the young YDR is increasing across countries (see Figure 2.2), because the new accession states have a high growth rate and a high YDR. But the connection of GDP growth and YDR within all these countries is negative. Even if a country is growing on average on a higher level, we find that within this country more YDR is dampening the GDP growth effect.

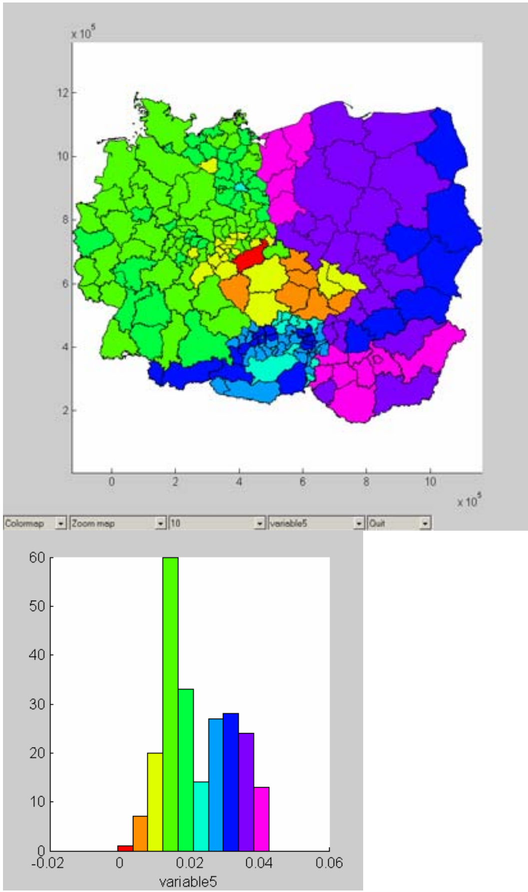



**Figure 2.1** Fitted GDP growth (yhat) for 2000 with histogram legend

[1] 'Simpson's Paradox refers to the reversal of the direction of a comparison or an association when data from several groups are combined to form a single group' (see Moore and McCabe, 2003, p.190).

The negative slope can be estimated if we control for the within country relationships by the fixed effects. Note that these country dummies are doubling the size of the $R^2$; nevertheless the overall strength of the relationship is small and it is not surprising if this effect on population structure can not be found in complex (dynamic) regression models of GDP growth.

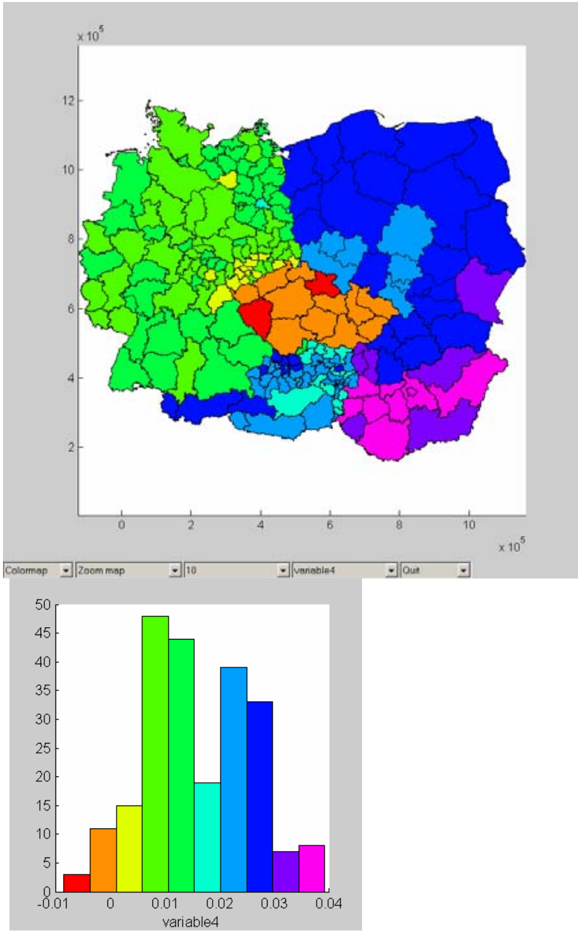



**Figure 2.2** Forecasted GDP growth (yhat) for 2020 with histogram legend

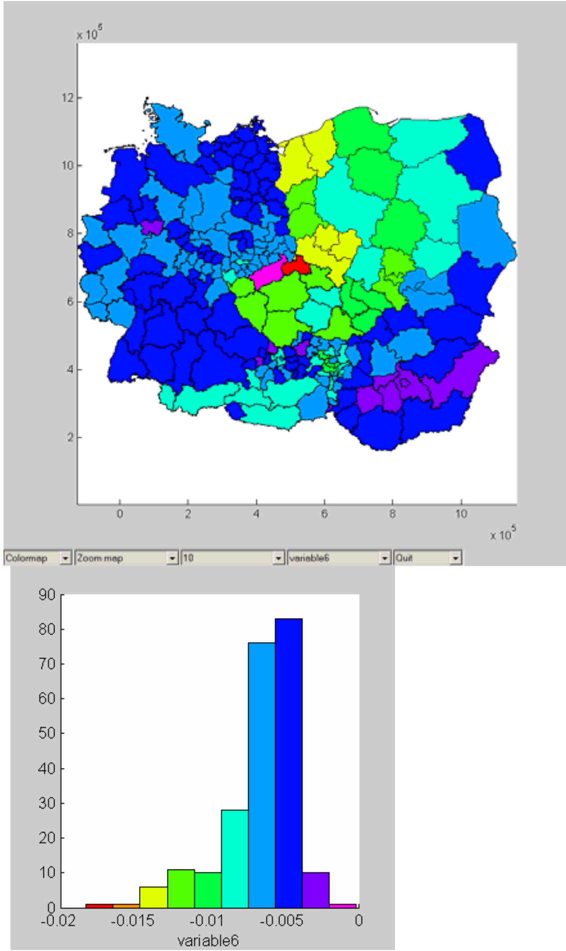



**Figure 2.3** Difference of fitted and forecasted values (yhat 2020 - yhat 2000) with histogram legend

The difference of the forecasted minus the fitted GDP growth (yhat 2020 - yhat 2000) in Figure 2.3 shows that the values for all regions are negative. We see that the maximum and minimum negative effects on yearly GDP growth are observed for northern Bohemia (which might reflect also some data problems in structural difficult regions). Also around Szczecin and Wroclaw (in Silesia, Poland) the regions suffer from the predicted old dependency ratio ODR in 2020 (in yellow). Note that whole of Germany (including Eastern Germany), Hungary and Slovakia will be not affected. Some regions in the Czech Republic and central Poland will have growth disadvantages due to population structure. Similar growth impediments can be seen for most regions in Poland, except for the eastern border regions. Surprisingly, the alpine regions in Austria except Eastern Tyrol will loose in GDP growth due to adverse population structure until 2020. Note that these results exclude the migration behaviour, since no reliable migration data could be found for this period in the 6 countries. Thus, the relationship should be explored in more detail, especially if these data sets can be reconstructed from reliable data sources.

## 5. Sensitivity Analysis

In this section we explore if this phenomenon can be reproduced by a model which explains the 5 year average growth rate 1995 to 2000. Since the year 2001 has produced a depressed GDP growth (because of the 9/11 New York events). Using the year 2000 as a forecast basis, we see a somewhat more optimistic long-term outlook for GDP growth. Thus, the demographic structure could lead to a long-term zero growth scenarios, while other factors will push (real) GDP growth in some regions into solid positive growth. Furthermore, certain centre regions – in particular in the East – will experience quite large GDP growth that will exceed average growth in similar regions in the West.

## 6. Conclusions

The regional forecasting study using short dynamic panel data has shown that the future regional GDP growth rates can suffer heavily by the regional heterogeneous age structure, i.e. the dependency ratios in the year 2020. If no other factors will dominate GDP growth in the future, the present regional GDP growth rate in central Europe could not be sustainable in the future. On average the demographic stress factor, caused by the current population structure, will affect real GDP growth in regions by -0.5 %-point (see Figure 2.3). In some regions the effect might be as high as -1.5 %.

Similar regression results and forecast scenarios can be also obtained for employment and population growth. Interestingly, the employment rate depends only significantly negatively on the ODR, while the population growth depends positively on the ODR and YDR (see Polasek and Berrer 2005). A spatial analysis of this data set can be found in Polasek (2005) and LeSage and Polasek (2005).

## 6. References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