Urban Design

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Abstract

This paper investigates factors that determine the average income growth and net migration using Swedish data. The main issue is to test the hypothesis that the growth rate in one municipality is affected by the growth rates in its neighboring municipalities. Our results support this hypothesis: we found a positive correlation between the growth rates in neighboring municipalities. In addition, we found a negative correlation between the initial level of average income and the subsequent average income growth, which can be interpreted in terms of conditional convergence. We also found that local government policy variables such as local public investments, expenditures, and income tax rates were important determinants of net migration and average income growth.

Keywords: Convergence, regional growth, net migration, spatial econometrics.

JEL classification: C31, R11, R58.

1. Introduction

This paper examines the average income growth and net migration rates at the local level of government in Sweden. The main issue is to test the hypothesis that the growth pattern in one municipality is affected by the growth rates in neighboring municipalities. We use the convergence hypothesis as point of departure; i.e. that initially "poorer" regions grow faster than "richer" ones. Methodologically, we follow Glaeser *et al.* (1995) and Aronsson *et al.* (2001) in that we use the initial conditions for a broad set of variables to explain the successive average income growth and net migration rates. The explanatory variables can roughly be divided in four categories: (i) indicators of earning potential such as the average income level and endowments of human capital; (ii) local and (iii) national policy decisions directed toward the local government sector; and (iv) the local socio-economic and demographic structure. In addition, we introduce spatial effect in the model; i.e., the growth pattern within municipality i is affected by the growth rate of its neighbors. We analyze net migration rates (not population growth). Net migration differs from population growth in that it does not include fertility. This means that net migration may capture the extent to which municipalities are becoming more attractive to migrants. The analysis is based on a panel data set covering 271 Swedish municipalities from 1981 to 1990.

Average income growth and net migration rates at the local level of government are important for several reasons. First, if the average (or per capita) income tends to grow faster in "poorer" regions compared with "richer" ones, income levels may become more equal between municipalities. This makes the local growth pattern important from a distributional point of view. Second, because the local income tax constitutes the major source of funds for local government in Sweden,[1] average income growth and net migration determine changes in local tax bases. Consequently, the average income growth and net migration rates will affect the local authorities' ability to fulfill the duties

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[1] Local authorities in Sweden have the right to raise local income tax.

imposed on them by national government. The local public expenditures have increased considerably in recent decades as the main expansion of the public sector in Sweden has taken place at the local level of government. The introduction of spatial effects in an analysis of the local growth pattern is important from a policy perspective because it can answer the question if the growth rates within one municipality occur at its neighbor's expense or if municipalities with high growth rates tend to have a positive effect on its neighbor's growth rates. It is also important from an econometric point of view because if the underlying data generating process includes a spatial dimension, and this is omitted, then estimates could be biased and inconsistent (see Anselin (1988)).

The literature on migration and economic growth is quite extensive.[2] Helms (1985) analyzed the impact of state and local income taxes on economic growth in states in the U.S.; he found that the crucial factor was how local public revenues are used. His results suggest that revenues used to fund transfer payments tend to reduce economic growth, whereas revenues used to improve public services such as highways, education, and public health tend to have a positive impact. Helms concludes that a high public service level attracts businesses and economic activity whereas transfer payments do not have the same positive effect on economic growth.

Many authors have taken the hypothesis of convergence as their point of departure - "poorer" regions grow faster than "richer" regions (either in absolute terms or conditioned on other explanatory variables). Barro and Sala-i-Martin (1992, 1995) find clear evidence of income convergence between states in the U.S., between Japanese prefectures, and between European countries. Persson (1997) discovers income convergence across Swedish counties. On the other hand, Glaeser *et al.* (1995) do not find significant evidence of income convergence between U.S. cities, although they do observe that cities with low manufacturing exposure, highly educated inhabitants, and low unemployment rates grow faster in terms of population than others. The results presented by Aronsson *et al.* (2001) and Lundberg (2001) suggest that there is convergence between Swedish counties and municipalities. They also report that the initial unemployment rate, the endowments of human capital, and regional public expenditures are important determinants of regional net migration. Recently, there has been an increasing interest in incorporating spatial effects in empirical analysis of regional growth. For instance, Rey and Montouri (1999) analyze regional growth in the U.S. using spatial econometric techniques. Their results suggest a strong spatial autocorrelation, which indicates that the underlying data generating process includes a spatial dimension.

Compared to previous studies on regional growth using Swedish data, his paper takes the analysis a little bit further in that we introduce spatial effects. Moreover, this paper adds to the analysis made by Rey and Montouri (1999) in that we allow for a larger set of potentially important factors and that we introduce migration into the analysis by estimating two equations, one income growth equation and one net migration equation. This approach makes it possible to relate our results to changes in labor supply and composition of the labor force.

The rest of this paper is organized as follows. Empirical specifications are discussed in Section 2.

[2] Examples of cross-country studies are Baumol (1986), Romer (1986) De Long (1988), Lucas (1988) and Barro (1991). Barro and Sala-i-Martin (1991), Blanchard and Katz (1992), Borjas *et al.* (1992), Glaeser *et al.* (1992), Sala-i-Martin (1996) and Terrasi (1999) are examples of cross regional studies. See Quah (1996) for a more critical review of some of the empirical findings.

The data set used is described in Section 3. The results and interpretations are presented in Section 4 and a summary is made in Section 5.

2. Empirical specification

Following Glaeser *et al.* (1995) and Aronsson *et al.* (2001), we allow for a broad spectrum of potential determinants of average income growth and net migration. By assuming that the rate of return is equal between municipalities, the attractiveness of a community for migrants will depend on the earnings opportunities as well as on the characteristics that affect individual's well being. The net migration pattern will then mainly capture the extent to which municipalities are becoming more attractive habitats and labor markets. The set of indicators of earning possibilities to be used in the empirical analysis consists of two variables: the level of average income and an indicator of human capital endowments in the municipality.

The net migration rate and the average income growth also probably depend on local and national policy decisions (see Helms (1985), Glaeser *et al.* (1995), and Aronsson *et al.* (2001)). For instance, the local income tax rate is one factor that might influence migration between municipalities located in densely populated areas near major cities, where the decision to move does not necessarily mean that the individual changes his/her place of work. Similarly, the local government consumption per capita and local government investments per capita probably provide indicators of the present and expected future service levels, which makes them potential determinants of net migration and income growth. In addition, in order to maintain national standards in local public services, national decision-makers have felt a need to equalize financing opportunities between locations. For example, the location of public universities and university colleges in particular areas together with intergovernmental subsidies are, in many respects, designed to affect migration patterns and average income growth.

Migration and average income growth may also depend on factors that relate to the individual well being in the region. This is related to socio-economic and demographic factors such as unemployment rates, the local industrial structure, population density and the age structure of the population, and whether the municipality is located in the more sparsely populated northern part of the country where the distances between municipal centers are relatively large.

To be more specific, the growth rate of the average income and the net migration rate are assumed to depend on the following explanatory variables:[3]

- (i) economic "opportunity" factors [the average income level (Y) and the endowment of human capital (h)];
- (ii) local policy decisions [the local income tax rate (tax), local government expenditures (exp), and local government investments ($invest$)];
- (iii) national policy decisions [a dummy variable indicating the presence of a university (u), a dummy variable indicating the presence of a university college (uc), and intergovernmental grants ($grants$)];

[3] Explicit definitions of all the variables are given in Appendix 1.

- (iv) socio-economic and demographic structure [the unemployment rate (*unemp*), the proportion of the local industrial structure consisting of agriculture or industry (*industry*), the percentage of the population aged 0-15 years ($age\ 0-15$), above 65 years ($age\ 65-$), population density (*dens*) and a dummy variable indicating whether the municipality is located in the northern part of the country (*north*)].

Denote by $mig_{i,s}$ the annual net migration into a municipality i at time s and the population at time $t-T$ by $p_{i,t-T}$. Then the net migration rate between years $t-T$ and t can be approximated as $m_i = ln\left(1+\left(\sum_{s=t-T}^{t} mig_{i,s}\right)/p_{i,t-T}\right)$. Moreover, denote by y_i the average income growth between years T and t, and the average income level at time t by $Y_{i,t}$, then y_i is defined as $y_i = ln\left(Y_{i,t}/Y_{i,t-T}\right)$. Given this, we assume that the net migration rate (m_i) and average income growth (y_i) develop according to the following equations:

$$\begin{aligned} m_i \;=\; & \alpha^m + \rho^m \cdot W \cdot m_i + \beta^m \cdot ln\left(Y_{i,t-T}\right) + \delta_h^m \cdot ln\left(h_{i,t-T}\right) + \delta_{tax}^m \cdot ln\left(tax_{i,t-T}\right) + \\ & \delta_{exp}^m \cdot ln\left(exp_{i,t-T}\right) + \delta_{invest}^m \cdot ln\left(invest_{i,t-T}\right) + \delta_{grant}^m \cdot ln\left(grant_{i,t-T}\right) + \\ & \delta_u^m \cdot u_{i,t-T} + \delta_{uc}^m \cdot uc_{i,t-T} + \delta_{unemp}^m \cdot ln\left(unemp_{i,t-T}\right) + \\ & \delta_{industry}^m \cdot ln\left(industry_{i,t-T}\right) + \delta_{age\ 0-15}^m \cdot ln\left(age\ 0-15_{i,t-T}\right) + \\ & \delta_{age\ 65-}^m \cdot ln\left(age\ 65-_{i,t-T}\right) + \delta_{dens}^m \cdot ln\left(dens_{i,t-T}\right) + \delta_{north}^m \cdot north_i + \varepsilon_i^m \end{aligned} \tag{1}$$

and

$$\begin{aligned} y_i \;=\; & \alpha^y + \rho^y \cdot W \cdot y_i + \beta^y \cdot ln\left(Y_{i,t-T}\right) + \delta_h^y \cdot ln\left(h_{i,t-T}\right) + \delta_{tax}^y \cdot ln\left(tax_{i,t-T}\right) + \\ & \delta_{exp}^y \cdot ln(exp_{i,t-T}) + \delta_{invest}^y \cdot ln\left(invest_{i,t-T}\right) + \delta_{grant}^y \cdot ln\left(grant_{i,t-T}\right) + \\ & \delta_u^y \cdot u_{i,t-T} + \delta_{uc}^y \cdot uc + \delta_{unemp}^y \cdot ln\left(unemp_{i,t-T}\right) + \\ & \delta_{industry}^y \cdot ln\left(industry_{i,t-T}\right) + \delta_{age\ 0-15}^y \cdot ln\left(age\ 0-15_{i,t-T}\right) + \\ & \delta_{age\ 65-}^y \cdot ln\left(age\ 65-_{i,t-T}\right) + \delta_{dens}^y \cdot ln\left(dens_{i,t-T}\right) + \delta_{north}^y \cdot north_i + \varepsilon_i^y \end{aligned} \tag{2}$$

where the α:s, β:s, ρ:s, and δ:s are parameters to be estimated and ε is the error term. The spatial weights matrix W is of dimension $(n \times n)$ where n is the number of municipalities. The elements in W assign to each municipality its neighbors. Here, neighbors are defined as those municipalities who share a common border. That is, the elements in W take the value one if two municipalities share a common border; otherwise, the elements in W take the value of zero. Moreover, W is row-standardized meaning that the row-sum is always equal to 1 and the diagonal contains zeros only.

When introducing spatial effects, OLS yields unbiased parameter estimates while the parameter's variances will be biased. Consequently, inference based on OLS might in this case be misleading. Therefore, equations (1) and (2) are estimated via maximum likelihood.[4]

In the literature, equations such as (1) and (2) are often referred to as spatial lag models. The other type of spatial regression model often discussed in the literature is the spatial error model. The

[4] See Anselin (1988) for a more detailed description of spatial econometrics, estimation techniques and the design of weights matrixes.

difference between the spatial lag and the spatial error model is that in the spatial error model $\rho = 0$ and $\varepsilon = \lambda W \varepsilon + \mu$, rearranging gives $\varepsilon = (I - \lambda W)^{-1} \mu$ where $\mu \sim N\left(0, \sigma^2 I\right)$, and I is an identity matrix of dimension $(n \times n)$. In terms of interpretation, in the spatial lag model, the hypothesis of spatial effects corresponds to the parameter ρ where $H_0 : \rho = 0$. If H_0 is rejected, this results in two possible interpretations. A positive and significant parameter estimate of ρ indicates a positive correlation between the growth rates in neighboring municipalities, and may be interpreted in terms of cooperation and/or complementariness between neighboring municipalities. That is, growth rates tend to "spillover" to the neighboring municipalities. However, this effect could also be negative which indicates that the growth within one municipality tends to be at its neighbor's expense. In the spatial error model, the dependence between municipalities works through the error process as the errors from different states may display spatial covariance. Here, the hypothesis of spatial correlation corresponds to the parameter λ where $H_0 : \lambda = 0$. If H_0 is rejected, a random shock in municipality i will either have a positive or negative impact on the growth rate within its neighbors. Preferable, equations (1) - (2) should be estimated simultaneously. However, due to complications with the estimation of the spatial error model, the two equations are estimated separately.

3. Data

The data used in this study originate from the official statistics on municipalities provided by Statistics Sweden and refer to the period 1981-1990. During this period, the number of municipalities varied between 279 in 1981 and 284 in 1990. Responsibilities and structures differ somewhat between municipalities. In contrast to the other municipalities, Gotland, Göteborg, and Malmö are responsible for the provision of health care, which is normally provided at the county level. This makes it difficult to obtain comparable data for these municipalities and they are, therefore, excluded from the empirical analysis. Municipalities whose borders were changed during the estimation period are also excluded. This leaves us with a data set containing 271 Swedish municipalities.

The exclusion of some municipalities from the analysis is unfortunate because it will automatically induce spatial "holes" in the data set. We are aware of this problem. Yet, instead of manipulating the data and trying to construct comparable figures for these municipalities we choose to exclude them from the analysis.

Table 1 presents descriptive statistics of the variables in the data set. Unfortunately, we lack measures of the differences in price levels between municipalities. Therefore, all monetary variables are deflated by the national index for consumer prices. Note that the average income growth (y) and the average income level (Y) are only measured for the population aged 20 or above. By measuring income in this way, we avoid some of the dependence between the age composition of the population and the average income level. This is reasonable as we disregard natural population growth.

Human capital (h) is measured as the share of the population aged 25 or above with post-senior high school studies. Unfortunately, there is no such information available for 1981. Statistics Sweden did not collect this type of information at the municipal level prior to 1985. Therefore, we use information on the educational status within the municipalities for 1985 as an approximation for 1981. The highest endowments of human capital are found in the Stockholm area and in municipalities with a university.

Table 1. Descriptive statistics for year 1981.

Variable	Mean	Median	Std dev	Min	Max
Net migration rate 1981-1990	0.02	0.01	0.05	-0.18	0.17
Average income growth 1981-1990	0.19	0.19	0.02	0.12	0.26
Average income level (Y)	50.09	49.15	5.99	39.96	87.60
Human capital (1985) (h)	0.12	0.10	0.06	0.05	0.42
Local income tax rate in percent (tax)	28.78	28.75	1.18	24.10	32.25
Local government expenditures (exp)	10.86	10.57	1.85	7.68	19.53
Local government investments (invest)	1.57	1.41	0.71	0.56	6.57
Intergovernmental grants (grant)	3.28	3.14	0.74	1.01	6.93
University (u)	0.02	0.00	0.13	0.00	1.00
University college (uc)	0.07	0.00	0.26	0.00	1.00
Unemployment rate (unemp)	0.02	0.02	0.01	0.00	0.09
Industry (industry)	0.50	0.50	0.14	0.10	0.80
Population density (dens)	10.35	2.68	34.60	0.03	345.59
Population aged 0-15 years (age 0-15)	0.22	0.21	0.03	0.13	0.34
Population aged 65 years or above (age 65-)	0.17	0.18	0.04	0.05	0.26
North (north)	0.24	0.00	0.43	0.00	1.00

Primary and secondary education and social care account for a large proportion of local government expenditure (*exp*) (24 and 20 percent respectively in 1980, Statistics Sweden (1984)). These services, to a large extent, are financed by a local income tax, where the tax rate (*tax*) is chosen by the municipality and intergovernmental grants (*grant*). Local government investments (*invest*) may also be financed by income taxes or intergovernmental grants. Alternatively, they may be funded by loans or funds built up through budget surpluses. The number of universities (u) has been constant during this period while the number of municipalities with a university college (uc) has increased from 20 in 1981 to 22 in 1990.[5] In the category socio-economic and demographic structure, the unemployment rate (*unemp*) is measured in percentage points and the industry index (*industry*) as the percentage of the local industrial structure consisting of agriculture or industry.

A more detailed description of the average income growth and net migration rates are shown in Figure 1 and 2 below. Municipalities with low, medium, high and highest average income growth and net migration rates are marked in blue, light blue, pink and red respectively. While some municipalities located near the major city areas (Stockholm, Göteborg, and Malmö) have experienced a large increase in net migration during the period of study; many municipalities in the northern and middle parts of the country have experienced large increase in out migration. For instance, as a result of net migration alone, Sundbyberg near Stockholm has increased its population by 17 percent, whereas the population of Kiruna in the very north of the country has declined by 18 percent. The highest average income levels are also found near the major cities, and the lowest in the sparsely populated areas in the north

[5] The large increase of the number of university colleges took place in 1976.

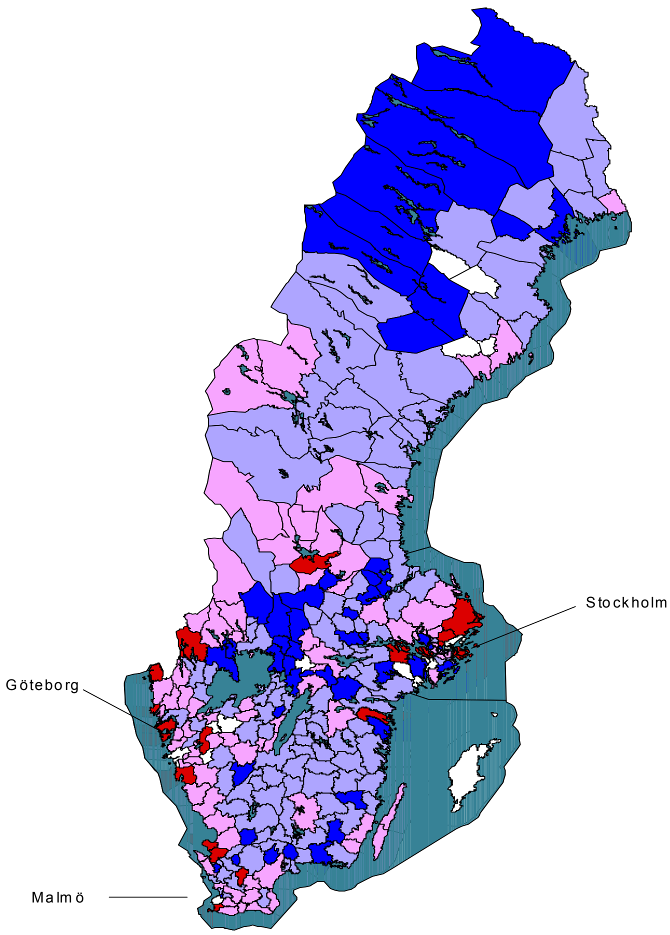

Figure 1: Net migration 1981-1990.

and mid-west of the country. In 1981, the highest average income level was 2.19 times the lowest income level and the corresponding figure for 1990 was 2.27 times.

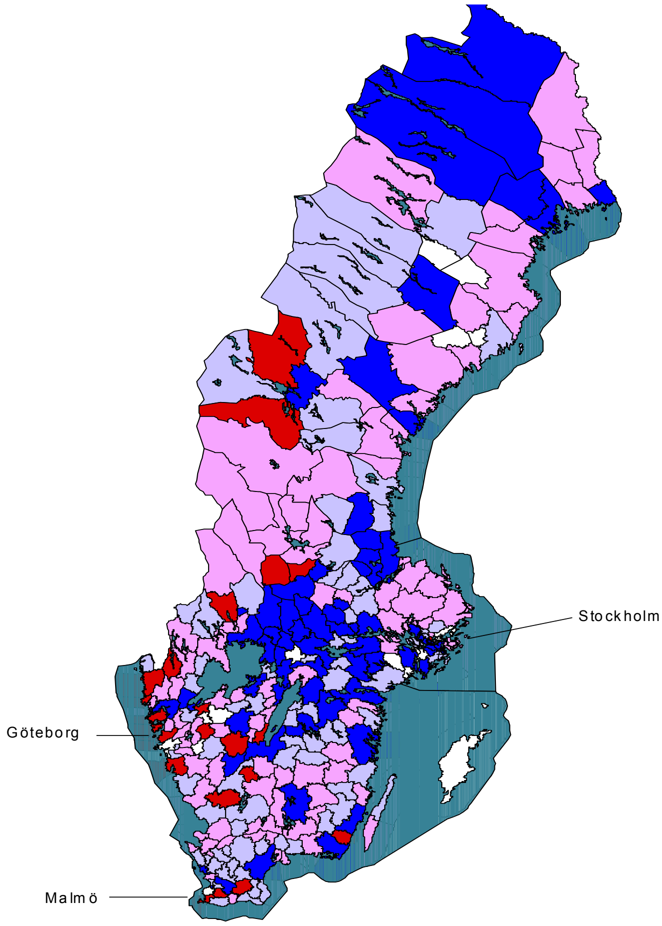

Figure 2: Average income growth 1981-1990.

4. Results

Before we present and discuss the parameter estimates, we will discuss the three test statistics presented in Table 2. The Moran's I[6] is probably the most frequently used test statistic for spatial correlation. A positive and significant Moran's I, which is the case here, indicate that municipalities with similar growth rates are more spatially clustered than could be caused by pure chance. However, the Moran's I give no guidance when it comes to the choice between a spatial lag or error structure of the dependence. Therefore, the Moran's I is complemented by two Lagrange Multiplier test statistics. When deciding between a lag and an error specification, Anselin and Rey (1991) suggest that these two Lagrange Multiplier tests are preferable used in combination. In the first (second) of these two tests, the null hypothesis of the spatial error (lag) model being the right specification is tested against the alternative of no spatial correlation. As the test statistic increases and the probability decreases,

[6] For a more detailed description of this test statistic, see for instance Anselin (1988).

the probability of the spatial error (lag) model being the most proper specification increases.

Table 2. Specification tests.

	m		y	
	Value	Prob	Value	Prob
Moran's I	3.91	0.00	5.33	0.00
Robust Lagrange Multiplier (error)	20.50	0.00	18.39	0.00
Robust Lagrange Multiplier (lag)	20.81	0.00	1.36	0.24

The positive and significant Moran's I test suggest a positive spatial correlation, which indicates that municipalities with similar average income growth and net migration rates are more spatially clustered than could be expected by pure chance. Consequently, we conclude that there is a spatial correlation and that the spatial dimension should be incorporated in the empirical analysis. From the two Lagrange Multiplier tests presented in Table 2, it is not possible to discriminate between the spatial error and lag model for the net migration equation, while the results indicate that the spatial error specification should be used for the average income growth equation. Therefore, we will estimate and present parameter estimates for both equations using a lag and error specifications.

The parameter estimates of equations (1) - (2) are presented in Table 3 below. Let us first concentrate on the parameter estimates of ρ and λ. Our results suggest positive and significant parameter estimates for λ and ρ in both models. For the spatial error model, the interpretation is that random shock into the system tends to have a positive impact on the growth pattern within neighboring municipalities. This is important in the sense that shocks into the system do not only affect the municipality where the shock has its origin; these shocks will spread across the country. The positive parameter estimate of ρ suggests that high (or low) average income growth and net migration rates tend to "spillover" to neighboring municipalities and have a traction power on their growth rates. This is important from a policy perspective as it indicates that the growth rate within one municipality is not at its neighbor's expense. Instead, fast growing municipalities tend to have a positive impact on the growth rates within its neighbors. These results are also interesting in the sense that the local growth pattern does not only depend on characteristics within the municipality but also on growth rates within neighboring municipalities.

Turning to the hypothesis of conditional convergence, our model predicts a negative and significant correlation between the initial average income level (Y) and the subsequent average income growth (y). This implies convergence in the sense that municipalities with low initial income levels tend to grow faster than municipalities with high initial income levels conditional on the other explanatory variables. This is in line with previous studies using data on U.S. states (Barro and Sala-i-Martin (1992, 1995)) and Swedish municipalities (Lundberg (2001)) and counties (Persson (1997) and Aronsson *et al.* (2001)). One explanation for the negative relationship between the initial income level and income growth, given in Aronsson *et al.* (2001), is that capital mobility tends to make municipalities (in their case counties) more homogeneous over time. They also point out that the centralized system of wage formation during part of this period may have compressed the wage distribution.

Table 3. Parameter estimates of equations (1) - (2) via maximum likelihood.

	Spatial error				Spatial lag			
Dependent variable	m		y		m		y	
Constant (α)	1.98	(6.38)	1.17	(7.01)	1.72	(6.00)	1.04	(6.35)
λ	0.36	(4.77)	0.42	(5.90)	-	-	-	-
ρ	-		-	-	0.32	(5.09)	0.12	(2.11)
Economic 'opportunity' factors								
Average income (β)	-0.38	(-6.25)	-0.09	(-2.85)	-0.35	(-6.10)	-0.10	(-3.12)
Human capital (δ_h)	0.11	(7.72)	0.00	(0.53)	0.11	(7.58)	0.01	(0.87)
Local government policy variables								
Local income tax rate (δ_{tax})	0.00	(0.05)	-0.11	(-3.14)	0.03	(0.50)	-0.09	(-2.72)
Local government expenditures (δ_{exp})	-0.05	(-2.55)	-0.03	(-2.75)	-0.06	(-3.07)	-0.04	(-3.74)
Local government investments (δ_{invest})	0.01	(1.69)	0.01	(2.13)	0.01	(1.83)	0.01	(2.03)
National policy variables								
Intergovernmental grants (δ_{grant})	-0.02	(-1.15)	0.01	(1.70)	-0.02	(-1.01)	0.02	(2.59)
University (δ_u)	-0.02	(-1.25)	0.00	(0.26)	-0.02	(-1.03)	0.00	(0.16)
University college (δ_{uc})	-0.02	(-2.04)	-0.01	(-1.35)	-0.02	(-2.25)	-0.01	(-2.06)
Socio-economic / demographic structure								
Unemployment rate (δ_{unemp})	-0.02	(-2.93)	-0.01	(-1.35)	-0.02	(-2.85)	-0.01	(-2.65)
Industry ($\delta_{industry}$)	-0.04	(-4.47)	-0.00	(-0.29)	-0.04	(-4.49)	-0.00	(-0.66)
Pop. density (δ_{dens})	0.01	(2.01)	0.00	(1.07)	0.01	(1.67)	0.00	(1.95)
Pop. aged 0-15 years ($\delta_{age\ 0-15}$)	0.08	(2.00)	0.10	(5.19)	0.05	(1.55)	0.08	(3.91)
Pop. aged 65 years or above ($\delta_{age\ 65-}$)	0.07	(3.36)	0.03	(2.56)	0.05	(2.94)	0.02	(1.85)
North (δ_{north})	-0.00	(-0.47)	0.01	(2.20)	-0.00	(-0.17)	0.01	(3.19)
AIC	-1 035.45		-1 379.98		-1 040.74		-1 359.01	

Note: t-values (given within parentheses) are heteroskedastic consistent using White's robust standard errors.

For purposes of interpretation, it is important to recognize how the initial average income level affects the subsequent net migration. This relationship is negative and significant, which is in contrast to the findings in Aronsson *et al.* (2001). Such a result may suggest that high income levels do not attract migrants. However, future earnings opportunities within a municipality depend not only on the average income: they may also depend on the initial endowments of human capital (h). Because the average income and the indicator of human capital endowments are highly correlated (the correlation coefficient is 0.86), it becomes difficult to identify separate effects of these two variables. For instance, if the human capital indicator is excluded from the migration function during the estimation, then the effect of the average income becomes positive and insignificant. However, the results presented in Table 2 suggest that human capital has a positive effect on net migration while no significant effect on average income growth. One interpretation is that a high average income level tends to have a positive effect on housing prices making the cost of living more expensive, which in turn has a negative effect on net migration. A high educational level within the municipality is attractive in the sense that it signals high social status.

Let us turn to the impact from previous fiscal decisions made by local and national governments. Investments or investment ratios are often considered to be one of the key factors for economic growth (see for instance Barro (1991) and Mankiw *et al.* (1992)). Our results suggest that, at the 90-percent level of significance, initial local government investments (*invest*) have a positive impact on net migration and average income growth (at the 95-percent level of significance). Local government expenditures (*exp*) are estimated to have a negative impact on net migration and average income growth. In addition, we also find evidence suggesting that the initial income tax level (*tax*) has a negative effect on average income growth.

It is difficult to distinguish between different interpretations for these results because the local councils were not required to balance their budget each year during this period. This means that the local government expenditure and income tax rates not only reflect the current service level and cost for taxpayers, but they may also signal future policy changes. In an attempt to distinguish between different interpretations of the effects of previous decisions made by local government, Lundberg (2001) included information on local budget surpluses in the model. However, this did not provide any additional information for the analysis.

The national policy variables are found to have mixed influence on net migration and average income growth. The results suggest that intergovernmental grants (*grant*) given at the start of the period tend to have (at the 90-percent level of significance) a positive effect on the average income growth. However, the location of a university (u) had no effects on net migration or average income growth while a university college (uc) tends to have a negative effect. One possible explanation for the insignificant effect of a university pointed out by Lundberg (2001) is that a university may have different effects on m and y depending on where it is located. In other words, it might be the (economic) environment surrounding the university or university college that is important for its effects on net migration and average income growth. It might also be the case that new and old universities affect migration and income growth patterns differently. The negative correlation between uc and the two variables m and y could be explained by the fact that many of these university colleges where established during the second half of the 1970s. One motive for the establishment of new university colleges during this period was to encourage individuals to stay in the area and to secure the local tax base. However, the results presented here suggest that it is quite difficult to change such a pattern by the location of universities and university colleges. To capture the effects of a university or a university college, it might be necessary to study a longer time period and/or to have more sophisticated measures like total expenditures on research, the number of professors, and Ph.D. students at each seat of learning.

The measures of socio-economic and demographic structure are also important to the analysis. The results suggest that the initial unemployment rate (*unemp*) has a negative effect on net migration and average income growth. One interpretation is that highly skilled individuals tend to migrate from regions with high unemployment rates. This, in turn, tends to have a negative effect on the average income growth and productivity in the region. The share of the local industrial structure consisting of agriculture and industry (*industry*) tends to have a negative effect on net migration (m) although it has no significant effect on average income growth (y). This result suggests that the out-migration from municipalities with this type of industrial structure offsets the decreased demand for agricultural and industrial workers. As a consequence, the average income growth is left unaffected. In the error model, population density (*dens*) is estimated to have a positive effect on net migration. This indicates that individuals migrate to more densely populated regions. The proportion of inhabitants aged 0-15 years ($age0-15$) and above 65 ($age65-$) is correlated positively with average income growth and net migration respectively. Finally, the results presented in Table 3 suggest that the average income growth is slightly higher in those municipalities located in the northern part of the country. However, there is no evidence suggesting a different migration pattern in the north compared to the rest of the country.

Table 4. Parameter estimates of equations (1) - (2) via OLS.

Dependent variable	m		y	
Constant (α)	2.09	(6.95)	1.13	(6.99)
Economic 'opportunity' factors				
Average income (β)	-0.43	(-7.40)	-0.11	(-3.44)
Human capital (δ_h)	0.12	(8.14)	0.01	(1.19)
Local government policy variables				
Local income tax rate (δ_{tax})	0.02	(0.31)	-0.10	(-2.84)
Local government expenditures (δ_{exp})	-0.07	(-3.07)	-0.04	(-3.58)
Local government investments (δ_{invest})	0.01	(1.83)	0.01	(1.87)
National policy variables				
Intergovernmental grants (δ_{grant})	-0.02	(-1.12)	0.02	(2.27)
University (δ_u)	-0.03	(-1.36)	0.00	(0.11)
University college (δ_{uc})	-0.02	(-2.50)	-0.01	(-1.95)
Socio-economic / demographic structure				
Unemployment rate (δ_{unemp})	-0.02	(-3.63)	-0.01	(-2.54)
Industry ($\delta_{industry}$)	-0.04	(-4.17)	-0.00	(-0.67)
Pop. density (δ_{dens})	0.01	(2.76)	0.00	(1.68)
Pop. aged 0-15 years ($\delta_{age\ 0-15}$)	0.04	(1.10)	0.07	(3.62)
Pop. aged 65 years or above ($\delta_{age\ 65-}$)	0.05	(2.27)	0.02	(1.59)
North (δ_{north})	0.00	(0.09)	0.01	(3.02)
AIC	-1 021.69		-1 356.43	

Note: t-values (given within parentheses) are heteroskedastic consistent using White's robust standard errors.

The results presented above suggest that the spatial dependence between municipalities is an important determinant of the local growth. However, it is reasonable to expect a positive correlation between the initial endowments of human capital (*Hcap*) and the average income growth. In addition, it is resonable to expect a positive correlation between the presence of a university or a university college and y and m. Could these results be due to the inclusion of the weights matrix? Could it even be the case that the inclusion of the spatial dimension interferes with the other variables in the model making them non-significantly determined at the same time as the spatial dimension does not significantly contribute to the model? To study this possibility, we imposed the restrictions $\rho = \lambda = 0$ and re-estimated equations (1) - (2) using ordinary least squares (OLS). The results are presented in Table 4. At the bottom of Table 3 and 4, we present the Akaike Information Criterion (AIC), which is basically the log likelihood function corrected for the number of parameters ($AIC = -2L+2K$, where L is the value of the log likelihood function and K the number of parameters). Using the Likelihood Ratio tests[7] based on the AIC, we conclude that the spatial lag and error models perform better than the OLS except for the lag specification of the average income growth equation. Moreover, there are only small differences in parameter estimates and significance between the results presented in Table 3 and 4.

5. Summary

The main issue in this paper has been to test the hypothesis that the average income growth and net migration rates at the municipal level in Sweden is affected by the growth rates in neighboring municipalities. Using a data set covering 271 municipalities during the period 1981-1990, we found evidence in favor of this hypothesis. In particular, we found that the average income growth and net migration rates in one municipality are affected positively by the average income growth and net migration rates within its neighbors. These results suggest that growth rates tend to "spillover" on neighboring municipalities and that shocks into the system do not stay in the municipality where the shock has its origin but will spread across the country. From an econometric point of view, our results indicate that there is a spatial dimension in the underlying data generating process that has to be taken into account, which might have implications for future empirical research on regional growth.

In addition to the spatial effects, our results support the hypothesis of conditional income convergence across municipalities in the sense of a negative relationship between the initial level of average income and its subsequent growth. This is in line with results presented in previous studies of income convergence across Swedish counties (e.g. Persson (1997) and Aronsson *et al.* (2001)) and municipalities (Lundberg (2001)). Local public investments are found to have a positive effect on the subsequent average income growth, which is in contrast to the findings in Lundberg (2001) who do not find any effect from local public investments. However, we have not found any evidence suggesting that the location of universities or university colleges affect the average income growth or net migration, which is in line with Lundberg (2001). To capture the effects of a university or a university college, it might be necessary to study a longer time period and/or to have more sophisticated measures such as total expenditures on research, the number of professors, and/or Ph.D. students at each seat of learning. However, this is left for future research.

[7] Here, the LR test statistic $= -2\,(AIC_0 - AIC_1)$, distributed asymptotically as chi-square. In this case with 1 degree of freedom the critical value is 3.84 at the 95-percent level of significance.

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Appendix 1: Variable definitions

Endogenous variables:

- Net migration, m: Net migration rate. Defined as $ln\left(1+\frac{\sum m_{i,s}}{p_{i,t-T}}\right)$, where m is net migration and p population.
- Average income growth, y: Defined as $ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right)$, where y is the average income level.

Explanatory variables:

Economic 'opportunity' factors (i):

- Average income level, Y: Measured in thousand SEK per year for the population twenty years old or above.
- Human capital, h: Measured as share of the population aged 25 or above with post senior high school studies.

Local government policy variables (ii):

- Local income tax rate, *tax*: Local plus regional income tax rate measured in percentage points.
- Local government expenditures, *exp*: Local government operating costs per capita. Measured in thousand SEK per capita.
- Local government investments, *invest*: Local government investments measured in thousand SEK per capita.

National policy variables (iii):

- Intergovernmental grants, *grant*: Total intergovernmental grants. Measured in thousand SEK per capita.
- University, u: Dummy variable indicating the presence of a university.
- University college, uc: Dummy variable indicating the presence of a university college.

Socio-economic and demographic structure (v):

- Unemployment rate, *unemp*: The unemployment rate in percentage points.
- Industry, *industry*: The share of the local industrial structure consisting of agriculture or industry.
- Population density, *dens*: Inhabitants per square kilometers.
- Population aged 0-15 years, $age\ 0-15$: Share of population aged 15 years or below.
- Population aged 65 years or above, $age\ 65-$: Share of population aged 65 years or above.
- North, *north*: A dummy variable indicating whether the municipality is located in the northern part of Sweden.

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