Demographic and Geographic Determinants of Regional Physician Supply

(preliminary version)

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February 27, 2009

Abstract

We provide a theoretical framework which allows us to analyse how physician supply at regional level depends on demographic (population size, age structure, mobility and fertility rates) and geographic determinants. Using regional data for Germany, we estimate the relationship between physician supply and the population share of 60plus (20minus), population flows and a rurality index, also controlling for spatial interactions. We find that physician supply is related negatively to the population share of 60plus within rural areas and positively to population growth (due to migration or fertility). In addition, spatial interactions are significant and positively related to regional physician supply.

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Keywords: age structure, physician supply, regional population ageing, regional migration, panel data.

JEL classification: I11, J44, J10, R23, C23

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1 Introduction

Population ageing is widely expected to come with an increased per capita demand for (ambulatory) physician services. Everything else equal regions with high population shares of old persons should then be particularly attractive on economic grounds for the location of physician practices and should therefore exhibit high physician to population ratios. However, cursory evidence suggests that this may not be the case. In Germany it appears that many rural regions with a high share of the elderly population are in particular danger of being under-doctored. Ageing may therefore lead to a widening gap in some regions between a high need for health care and a low supply that may well warrant policy intervention. Furthermore, there are concerns about growing regional disparities in the provision of health care. Generally, however, too little is known yet about how demographic, economic and spatial features of a region interact as determinants of physician supply.

This study uses panel data at regional level to examine the relationship between regional physician supply and its demographic and geographic determinants. In so doing, we note that demographic developments and geographical location imply a framework with both an intertemporal and a spatial dimension. Given that physicians' location choices are mostly long-term decisions, the intertemporal aspect implies that not only the current population structure will matter but also the expected population. In as far as they constitute measures of population change, we would therefore expect net population growth (births – deaths) and net migration to constitute significant determinants for physician supply besides the population and its age structure in of themselves. Furthermore, we would expect that spatial interactions in terms of physician density are important. More specifically, our hypothesis is that the propensity to locate in a particular region is positively related to the physician density in neighbouring districts. This is because high densities of physicians in neighbouring regions are likely to be associated with strong competition. In turn, this would imply a greater relative attractiveness for the region under consideration. Finally, we adopt the hypothesis that demographic and geographic characteristics do not determine in isolation the attractiveness of a region from a physician's perspective but interact in a particular way. More specifically, we posit that the high demand for services by elderly patients may be less attractive for a physician if it has to be served within a rural context. Long travel times and poor availability of public transport deter frail elderly patients from attending the physician's practice, implying a high demand for home visits as compared to an urban context. Furthermore, due to the long travel times the provision of home visits is more costly for the physician in rural areas. Thus, a high demand from old populations may be served at a relatively low cost within an urban region but only at a high cost within a rural context. Given that the reimbursement system does not fully account for these differences, one should expect a positive correlation between age-structure and a measure of urbanity in its effect on physician supply.

Using annual data for 439 regions at the district level in Germany for the period 1995 to 2004 we examine if the share of 60+ in the population affects the physician density negatively in rural regions. We control for several regional characteristics which, according to the literature, are relevant for the geographical distribution of physician practices. In a first step we use a fixed effects panel estimator to analyze the effects of population aging and population shrinking. Following Driscoll and Kraay (1998) we use standard errors that are robust to heteroskedasticity and spatial correlation. In the next step we apply a spatial dynamic panel data estimator as suggested by Lee and Yu (2007) and Yu et al. (2008), to find out if spatial interactions in physician density are of importance.

It is common to approximate physician location decisions with the physician density (i.e. physicians per capita) at the macro level. However, if ageing at the regional level is intensified by interregional migration, this measure could comprise a measurement error, e.g., because younger and older people exhibit differences in regional mobility. In fact it is observed empirically that younger people leave rural areas more often than older people. The number of habitants in these regions falls and, hence, the physician density increases for a given number of physicians. At the same time the share of older people increases and is therefore positively correlated with the physician density. Given that physicians' location choices are made for the long term, physician density comprises a measurement error that is expected to be positive. Therefore, we employ the number of physicians as an alternative dependent variable not subject to such a bias.

According to the results, physician supply is negatively related to the population share of 60+ within rural areas, while it is not significantly related to the share within urban regions. The effects of the population size are significant positive, which is consistent with theory. Hence, population ageing and shrinking affects physician geographic decisions as expected. Spatial interactions measured in contiguity effects are significantly related to the number of physicians in the local district. However, the effect is smaller in magnitude than the population effects. Since the speed of population ageing is much faster in rural regions, policy should provide incentives to move into these regions not only on equity grounds but also because a worsening provision of basic goods and services, such as health care, may reduce even further the development prospects (e.g. by way of job creation) for such regions. In addition, many rural regions in East Germany have a rural contiguity neighbor, which means that the benefit from the spatial effect disappears here.

2 Literature

Hingstman & Boon (1989) analyse the regional dispersion of primary health care professionals (GPs, dentists, physiotherapists, midwives and pharmacists) in the Netherlands. Using cross-sectional data, they examine the effect of local earning opportunities (average income, share of elderly, birth rate, population density) and local amenities (share of green belt, distance to nearest training centre) on the aggregated location choices of practicioners as measured by densities (i.e. number of practitioner per capita) within a region. Within a simple OLS regression, they identify a significant (at 5 percent) negative effect of the share of elderly on the densities of all practitioners (except midwives). The intuition for this turns on the features of the payment system. GPs and pharmacists are reimbursed a capitation for each publicly insured patient. This turns the elderly into relatively unprofitable patients as the relatively high treatment intensities have to be financed out of a fixed budget per patient. In contrast, dentists are reimbursed by fee for service. While this renders profitable the treatment of patients with high demand, for dentistry it is the young rather than the hold who require intensive treatment.

Kraft & v.d. Schulenburg (1986) employ cross sectional data from Switzerland to estimate jointly various measures of treatment intensity and the physician density. The share of old patients (55+) has a positive but insignificant impact on physician density.

Kopetsch (2007) uses cross sectional data (yr 2000 reimbursement data from KBV combined with German regional statistics INKAR) to estimate various measures of treatment intensity each combined with physician density within a 2SLS framework. Here, the share of population 50+ is used in the density equation and generally has a significant effect for most types of physicians, with the exception of psychotherapists.

Using cross-sectional data from German regional statistics (INKAR 2002), Juerges (2007) also obtains a positive impact of the population share 65+ on regional physician densities.

[TO BE COMPLETED]

3 Theoretical Framework

In this section we develop a theoretical framework as a basis for organising and interpreting our empirical findings. We consider a set of I regions, indexed by $i \in \{1, 2, ...I\}$. Define k_i as a set of regional characteristics. For concreteness, we will sometimes understand k_i to be a (continuous) index of (increasing) 'rurality'. The demographic structure, of each region is described by, ℓ_i, the size of the local population, and by $\lambda_i \in [0, 1]$, the share of the elderly within a population consisting of two age groups, the old (o)

and the young (y). Let n_i denote the number of physicians who practice in region i. Physicians draw their demand from the local population (only) and, facing a remuneration system parametrised by τ_i, they earn an income $Y(n_i, \ell_i, \lambda_i, k_i, \tau_i)$. Let $U(\ell_i, \lambda_i, k_i)$ denote the physician's utility from residing within a region. This obviously depends on the regional structure k_i but may also reflect a physician's preferences over the demographic make-up of a region.[1] Assuming additive separability of income, we can then write

$$V(n_i, \ell_i, \lambda_i, k_i, \tau_i) = Y(n_i, \ell_i, \lambda_i, k_i, \tau_i) + U(\ell_i, \lambda_i, k_i)$$

for a physician's full utility from settling in region i. We assume that physicians are homogeneous in their preferences and practice technology but that they can be ranked according to their outside utility $\overline{V}(n)$. Here, $n = \sum_i n_i$ is at the same time equivalent to the total supply of physicians and to the index of the last physician who has entered the profession (wherever her location).[2] Assuming that physicians are free in their location choice, entry into region i takes place as long as long as $V(n_i, \ell_i, \lambda_i, k_i, \tau_i) > \max\left\{V(n_{i'}, \ell_{i'i}, \lambda_{i'}, k_{i'}, \tau_{i'}), \overline{V}(n)\right\}$, for any i and $i' \neq i$. Assuming

$$\frac{dV(n_i^*, \ell_i, \lambda_i, k_i, \tau_i)}{dn_t} = \frac{dY(n_i^*, \ell_i, \lambda_i, k_i, \tau_i)}{dn_i} - \overline{V}_n(n^*) \leq 0$$

and ignoring the integer issue, an entry equilibrium is then described by the condition

$$V(n_i^*, \ell_i, \lambda_i, k_i, \tau_i) = \overline{V}(n^*) \quad \forall i,$$

where $n^* = \sum_i n^{i*}$ denotes the total supply in entry equilibrium. Generally, it is reasonable to assume $\frac{dY(n_i, \ell_i, \lambda_i, k_i, \tau_i)}{dn_i} < 0$, implying that greater competition leads to a reduction in the physician's income, but note that even if for some reason $\frac{dY(n_i, \ell_i, \lambda_i, k_i, \tau_i)}{dn^i} > 0$ applies, a unique entry equilibrium is still guaranteed as long as the rate of change in outside opportunity (or entry cost) $\overline{V}_n(n^*)$ is sufficiently large.[3]

[1] E.g. the physician (as indeed any other individual) may have a preference for intermediate population densities - and thus against living in over-crowded or under-populated regions. Similarly young physicians may prefer to live in an environment which is reasonably 'young' and thus express a preference against a high λ.

[2] See Goddard et al. (2008) for a similar set-up, however, without the detailed consideration of demographic structure.

[3] One reason for why a physician's income may increase in the number of competitors may relate to a severe under-supply of physicians due to which practitioners face an excessive workload. If this workload is not appropriately compensated for by the reimbursement system, physicians may actually attain a higher income when treating fewer patients.

Consider for the moment the following effects of variations in the demographic and/or regional make-up

$$\begin{aligned}
\frac{\partial V\left(n_i, \ell_i, \lambda_i, k_i, \tau_i\right)}{\partial \ell_i} &= \frac{\partial Y\left(\cdot\right)}{\partial \ell_i} + U_\ell, \\
\frac{\partial V\left(n_i, \ell_i, \lambda_i, k_i, \tau_i\right)}{\partial \lambda_i} &= \frac{\partial Y\left(\cdot\right)}{\partial \lambda_i} + U_\lambda \\
\frac{\partial V\left(n_i, \ell_i, \lambda_i, k_i, \tau_i\right)}{\partial k_i} &= \frac{\partial Y\left(\cdot\right)}{\partial k_i} + U_k
\end{aligned}$$

all of which affect a physician's utility both through changes in income Y and the physician's utility from residence, U. Of course, it is difficult to disentangle the effects of demographic and geographic structure at this level of generality. Some leeway may be gained when assuming that physicians may have pronounced preferences over a regions characteristics, i.e. U_k significantly different from zero, but generally have only weak preferences over the population structure as such, i.e. $\left|U_\ell\right|, \left|U_\lambda\right| \to 0$. In this case, the impact of a region's demographic make-up on the physician's utility from opening practice in the region is predominantly driven by its impact on practice income, $\frac{\partial Y(\cdot)}{\partial \ell_i}$ and $\frac{\partial Y(\cdot)}{\partial \lambda_i}$, respectively. Thus, demographic change, i.e. ageing and shrinking of the population, would *unambiguously* render a region less attractive from a physician's perspective (or alternatively: regions with older and/or smaller populations would be less attractive for physicians) if practice income increases in population size and decreases in the share of the elderly, i.e. if $\frac{\partial Y(\cdot)}{\partial \ell_i} > 0$ and $\frac{\partial Y(\cdot)}{\partial \lambda_i} < 0$.

In our empirical analysis we will also examine whether and how the role of population for the supply of physicians (and implicitly for the physician's income) depends on the degree of rurality. This is captured by the cross effects $\frac{\partial Y(\cdot)}{\partial \ell_i \partial k_i}$ and $\frac{\partial Y(\cdot)}{\partial \lambda_i \partial k_i}$. Again, it is difficult to place a priori signs on these derivatives. To the extent that the treatment of older patient populations is less profitable in rural regions, one would expect that $\frac{\partial Y(\cdot)}{\partial \lambda_i \partial k_i} < 0$. This is plausible in particular for general practitioners: Rurality implies that potentially long distances need to be travelled. On the one hand, this implies that sick patients will increasingly need to be attended by way of home visits (which are more costly for the physician). On the other hand, the very cost of home visits is higher in rural areas due to the long travel times. The negative cross effect between the share of old patients, λ, and the degree of rurality, k, then arises as the share of sick patients and thus the incidence of home visits is higher among old patients.

Generally, the opening of a physician practice can be viewed as a long-term decision. Indeed, there is empirical evidence pointing to a very low geographical mobility of practitioners once they have settled within a particular region (Kopetsch and Munz, 2007). In this case, it is plausible to assume that over their working lives physicians experience demographic change in terms of a changing size and age-structure of their patient population. A (young) physician who considers opening practice in a region i would then seek to make predictions not only about the current demand (depending on current population size and age-structure) but also about future demand. In a simple way this can be captured by considering a set-up, where physicians practice for two-periods with distinct population structure. Thus, for any two subsequent periods t and $t+1$ we can write a physician's full utility as the sum of her utilities within the two periods

$$V_i = V\left(n_{it}, \ell_{it}, \lambda_{it}, k_{it}, \tau_{it}, t\right) + \delta V\left(n_{it+1}, \ell_{it+1}, \lambda_{it+1}, k_{it+1}, \tau_{it+1}, t+1\right),$$

where the second period utility is discounted by a factor δ. In the following we are interested in particular in the development of the population from which the physician recruits her patients. Assuming that individuals live for two periods, in which they are old and young, respectively, and suppressing the regional index i for convenience, we denote by

$$\ell_t^o = \lambda_t \ell_t; \quad \ell_t^y = \left(1 - \lambda_t\right) \ell_t,$$

the number of old and young persons (within a region) and at time t, respectively. The development of the population can be described by the following two equations

$$\begin{aligned} \ell_{t+1}^o &= \left(1 + m_t\right) \ell_t^y, \\ \ell_{t+1}^y &= \left(1 + m_t\right) v_t \ell_t^y, \end{aligned}$$

where m_t and $v_t \geq 0$ denote the rate of net-migration and of reproduction, respectively.[4] Here, we are assuming for simplicity that both migration and reproduction occur during the transition from young to old. Furthermore, we make the simplifying assumption that immigrants experience the same fertility as the native population. We can then express the size and age-structure of the population in period $t+1$ entirely in terms of the demographic parameters of period t

$$\begin{aligned} \ell_{t+1} &= \ell_{t+1}^o + \ell_{t+1}^y = \left(1 + m_t\right)\left(1 + v_t\right) \ell_t^y = \left(1 + m_t\right)\left(1 + v_t\right)\left(1 - \lambda_t\right) \ell_t \\ \lambda_{t+1} &= \frac{\ell_{t+1}^o}{\ell_{t+1}} = \frac{1}{1 + v_t}. \end{aligned}$$

Thus, we can derive the following effects of the demographic parameters

[4] Thus, $m_t < (>) \, 0$ would capture out- (im-)migration and $v_t > (<) \, 1$ above (below) replacement fertility.

$\{\ell_t, \lambda_t, v_t, m_t\}$ on a physician's (expected) utility

$$\begin{aligned}
\frac{\partial V}{\partial \ell_t} &= \frac{\partial V(\cdot,t)}{\partial \ell} + \delta \frac{\partial V(\cdot,t+1)}{\partial \ell}\frac{d\ell_{t+1}}{d\ell_t} \\
&= \frac{\partial V(\cdot,t)}{\partial \ell} + \delta (1+m_t)(1+v_t)(1-\lambda_t)\frac{\partial V(\cdot,t+1)}{\partial \ell} \\
\frac{\partial V}{\partial \lambda_t} &= \frac{\partial V(\cdot,t)}{\partial \lambda} + \delta \frac{\partial V(\cdot,t+1)}{\partial \ell}\frac{d\ell_{t+1}}{d\lambda_t} \\
&= \frac{\partial V(\cdot,t)}{\partial \lambda} - \delta (1+m_t)(1+v_t)\ell_t \frac{\partial V(\cdot,t+1)}{\partial \ell} \\
\frac{\partial V}{\partial v_t} &= \delta \left[\frac{\partial V(\cdot,t+1)}{\partial \ell}\frac{d\ell_{t+1}}{dv_t} + \frac{\partial V(\cdot,t+1)}{\partial \lambda}\frac{d\lambda_{t+1}}{dv_t}\right] \\
&= \delta \left[(1+m_t)(1-\lambda_t)\ell_t \frac{\partial V(\cdot,t+1)}{\partial \ell} - \frac{\lambda_{t+1}}{1+v_t}\frac{\partial V(\cdot,t+1)}{\partial \lambda}\right] \\
\frac{\partial V}{\partial m_t} &= \delta \frac{\partial V(\cdot,t+1)}{\partial \ell}\frac{d\ell_{t+1}}{dm_t} \\
&= \delta (1+v_t)(1-\lambda_t)\ell_t \frac{\partial V(\cdot,t+1)}{\partial \ell},
\end{aligned}$$

.It is plausible under most circumstances that larger populations will generally ceteris paribus will allow physicians to obtain a higher practice income.[5] In such a case, $\frac{\partial V(\cdot)}{\partial \ell} = \frac{\partial Y(\cdot)}{\partial \ell} \geq 0$. In such a case it is unambiguously true hat $\frac{\partial V}{\partial \ell_t} > 0$ and $\frac{\partial V}{\partial m_t} > 0$. A larger population in period t increases physician's income in the current period t and leads the physician to expect a larger population in the following period $t+1$. Note that the expectation about future income is moderated, however, by migration, fertility and, importantly, the age-structure. By construction net migration does not affect the physician's current income, as it only occurs in the transition from the first to second period Nevertheless, it still lead to the expectation of a higher second-period patient population and income. Thus, regions suffering from out-migration exhibit disincentives for physician's location choices. These disincentives are particularly strong if migration is not only reducing the number individuals, currently alive but also the number of potential new births. The effects of current age-structure, $\frac{\partial V}{\partial \lambda_t}$, and of current fertility, $\frac{\partial V}{\partial v_t}$, are a priori ambiguous. Consider the following two cases: $\frac{\partial V(\cdot)}{\partial \lambda} = \frac{\partial Y(\cdot)}{\partial \lambda} > 0$, i.e. old patients are more profitable than young patients. Remarkably, the effect of the age-share on the physician's utility/income is, $\frac{\partial V}{\partial \lambda_t}$, is nevertheless ambiguous. On the one hand, a high age-share implies high current profits, on the other hand, it implies that the second period population will decrease significantly, leading to the expectation of low future profits. Thus, even if old patients are profitable to serve, it is by no means certain that

[5]The exception would be a setting where physicians are forced by regulatory, professional or ethical codes to serve an excess demand even when it is unprofitable to do so. Such an instance may (only) occur in regions with a severe under-supply of physicians.

their presence renders a region attractive from the physician's perspective. The effect of current fertility on the physician's utility/income, $\frac{\partial V}{\partial v_t}$, is driven by the expectation of a larger population on the one hand, and a lower age-share, on the other. This leads to an ambiguous effect if old patients are relatively profitable. Now, consider a set-up, where old patients are relatively less profitable to serve, $\frac{\partial V(\cdot)}{\partial \lambda} = \frac{\partial Y(\cdot)}{\partial \lambda} < 0$. In this case, the impact of current age-share (fertility) on physician income is unambiguously, negative (positive): $\frac{\partial V}{\partial \lambda_t} < 0$ ($\frac{\partial V}{\partial v_t} > 0$). As it turns out the net effect of ageing on regional attractiveness for physicians may well depend on the degree of rurality. Assuming $\frac{\partial Y(\cdot)}{\partial \lambda \partial k} < 0$, it is clear that ageing is more likely to render rural regions unattractive than urban regions. However, the expectation of lower future practice income may imply that ageing triggers a disincentive to locate even within urban regions, within which it is a priori profitable to serve an elderly population.

The effect of demographic characteristic $x_{it} \in \{\ell_{it}, \lambda_{it}, v_{it}, m_{it}\}$ on the equilibrium number of physicians n_{it}^* can then be found from the following total differential

$$\frac{\partial V_i}{\partial x_{it}} dx_{it} + \frac{\partial Y_i(t)}{\partial n_{it}} dn_{it} + \delta \frac{dY_i(t+1)}{dn_{it+1}} dn_{it+1} - \overline{V}_n = 0.$$

Denoting by $\widehat{n}_{it}$ the number of young physicians who enter region i in period t and given that all physicians continue their practice within the same region for the second period, we have $n_{it} = \widehat{n}_{it} + \widehat{n}_{it-1}$ as the total number of physicians in region i in period t. By construction, we then have $dn_{it} = d\widehat{n}_{it}$. However, as in period t entry has not yet occurred, we have the forward looking expression $dn_{it+1} = d\widehat{n}_{it+1} + d\widehat{n}_{it}$. We then obtain the comparative static derivative

$$\frac{dn_{it}^*}{dx_{it}} = -\left(\frac{\partial V_i}{\partial x_{it}} + \delta \frac{dY_i(t+1)}{dn_{it+1}} \frac{d\widehat{n}_{it+1}}{dx_{it}}\right)\left(\frac{\partial Y_i(t)}{\partial n_{it}} + \delta \frac{dY_i(t+1)}{dn_{it+1}} - \overline{V}_n\right)^{-1},$$

where $\frac{\partial Y_i(t)}{\partial n_{it}} + \delta \frac{dY_i(t+1)}{dn_{it+1}} - \overline{V}_n < 0$ holds within an entry equilibrium. Thus, we have $sgn \frac{dn_{it}^*}{dx_{it}} = sgn\left(\frac{\partial V_i}{\partial x_{it}} + \delta \frac{dY_i(t+1)}{dn_{it+1}} \frac{d\widehat{n}_{it+1}}{dx_{it}}\right)$. The number of physicians is thus determined both by the direct effect of x_{it} on the physician's lifetime utility/income, as was discussed above, and by an effect of the current demographic make-up on second-period income as mediated through changes in future physician supply. This latter effect may well be offsetting, e.g. if current population growth $(1 + m_t) v_t$ triggers future entry into the market, or if current ageing, renders future entry unattractive. While it is thus difficult to assign a sign to the comparative static effect, we may assume that the effects through changes in competition, are of second-order so that the sign of the overall effect is predominantly determined by the sign of $\frac{\partial V_i}{\partial x_{it}}$, as was discussed above. Thus, demographic change, i.e. ageing and shrinking of the population, triggers an *unambiguous* reduction in physician supply (or alternatively: regions with older and/or smaller populations have fewer physicians) if practice income and decreases in the share of the elderly, i.e. if $\frac{dY(\cdot)}{d\ell_i} > 0$ and $\frac{dY(\cdot)}{d\lambda_i} < 0$. At any rate, it was the main purpose of this section merely to set out a framework for analysis and for understanding the empirical results to which we shall now proceed.

4 Data

The data used are taken from the INKAR data set provided by the federal office for civil engineering and regional development (Bundesamt für Bauwesen und Raumordnung). The data are disaggregated to 439 regions at the district level in Germany and cover the period 1995 to 2004. The dependent variable is the number of physicians. In the robustness section we also use the number of physicians per 100,000 population . The latter has frequently been used in analyses similar to ours. However, as we will ague below this variable exhibits to some extent a measurement bias, and for this reason we prefer to use the number of physicians as dependent variable.

As we have outlined in the previous section, demographic change bears on the regional physician supply population by way of two channels: ageing, in the sense of the age-structure shifting towards higher age-groups, and population decline. Changes in the size of the population are captured by the flow variables net migration and the difference between births and deaths (natural balance) in a region. The size of a population increases if both variables are positive. Our main interest, however, is in the effect of a changing age structure. We approximate regional population ageing by the population share of people 60 years and older (share 60plus) and the population share of people 20 years and younger (share 20minus). As pointed out in the theoretical section, it is possible that the effects of ageing on physician supply vary according to the character of the region (urban vs. rural). We control for these effects by interacting the age groups (60plus and 20minus) with an index of rurality, as provided by the federal office for civil engineering and regional development. This index is subaggregated into agglomeration areas, municipalized areas, and rural areas. Within these area groups there are up to four different classes differing in population and population density. Altogether there are nine levels of the index, with higher levels corresponding to a greater degree of 'rurality'. See the Appendix for further details.

In addition, we use a set of control variables in the estimates. First, we control for the regional population density, measured as population per square meter, which will be subdivided into population density in East and West German regions. We do this because a large migration flow from Eastern to Western regions has taken place in the period under consideration. The remaining set of regional control variables comprise: population size, GDP per capita, unemployment rate, employment rate, share of foreigners, share of welfare recipients, population share of people with a university degree, population share of people with at most primary education, share of new houses for up to two families and new flats in the total stock of flats, tourist accommodation per 100,000 population, and cars per 1,000 population. We will discuss the expected effects in the next section when we present the results.

5 Estimation and Results

In this section we analyze empirically the effects of regional population ageing and population decline on the regional supply of physicians. In particular, we examine whether the share of older people in the population (60plus) has a different impact on the supply of physicians in rural regions as opposed to more urban settings.

At the macro level physician supply is usually measured in per capita terms, i.e. by physician density. However, if ageing at the regional level is intensified by interregional migration, this measure could comprise a measurement error. This is possible if, for example, younger and older people differ in their geographical mobility. It is observed empirically that younger people leave rural areas more often than older people. Outmigration on the part of the young has two distinct implications for a region. On the one hand, the corresponding decline in population implies that the physician density increases for a given number of physicians. At the same time the share of older people increases, generating a positive, yet spurious, correlation with physician density. According to our data physician density is correlated negatively with the population share 20minus (-0.57) and positively with the population share 60plus (0.26). Given that physician location choices are made long term, physician density then comprises a measurement error.

To make this more clear we decompose the physician density (D) into the real term that is based on decisions of physicians (Y) and a measurement error due to interregional migration (ϵ). The regression that should approximate the true model $D = Y + \epsilon = \alpha + \beta X + u + \epsilon$ (with u as idiosyncratic error term) yields a biased parameter β if X and ϵ are correlated. For example, population density and the population share 60plus are correlated positively (0.13). Since a declining population increases (at least in the short run) the physician density, we can conclude that the parameter that corresponds to the share of 60plus is biased negatively. Therefore, in this section we use only the number of physicians as dependent variable. In the robustness section we run additional regressions with the physician density as dependent variable, conditional on the same set of covariates, to account for this bias.

In the theoretical section we have argued that physician supply is, among other things, related to net migration flow (which increases in the net migration rate), natural balance (which increase in the fertility rate), and the age structure of the population in a region. We first seek to establish whether the underlying relationships can be estimated even if we do not control for other observed or unobserved influencing factors. We then extend the specification by different possibilities to account for unobserved heterogeneity. Hence, we will start with the following specification:

$$\begin{aligned} S_{it} &= \beta_0 + \beta_1 old_{it} + \beta_2 young_{it} + \beta_3 migration_{it} + \beta_4 natural_{it} \\ &\quad + \gamma_i + \eta_t + \delta_{jt} + \epsilon \end{aligned} \quad (1)$$

where S is the number of physicians, *old* is the population share 60plus, *young* is the population share 20minus, *migration* is the net migration flow *natural* is the natural balance, i.e. birth minus deaths. γ_i and η_t are individual and time fixed effects, δ_{jt} are state level time fixed effects, and ϵ is an error term. Note that German states (Bundeslaender) comprise of a whole number of regions (Kreise).

Table 1: Demographic Change and the number of Physicians - Basis Specification

	(1)	(2)	(3)
share 60plus	-32.730‡	-6.582‡	-5.570‡
	(5.787)	(1.611)	(1.470)
share of 20minus	-79.004‡	12.106‡	6.649†
	(7.813)	(1.681)	(2.805)
net migration	1.148	2.185‡	1.755‡
	(0.769)	(0.240)	(0.225)
natural balance	18.082‡	16.634‡	12.509‡
	(2.714)	(2.014)	(1.517)
R^2	0.101	0.233	0.699
regional FE		✓	✓
time FE		✓	
state level time FE			✓

Notes: Dependent variable: number of physicians; number of observations 3951; robust standard errors in parenthesis; ‡ 1% significance level; † 5% significance level.

The results are provided in table 1. Regressions (1)-(3) involve increasingly more controls for unobserved heterogeneity, where regression (1) contains no controls at all, regression (2) controls for regional and period fixed effects, and regression (3) controls in addition for fixed effects at state level. We consistently find that physician supply decreases in the share 60plus and increases in net migration and the natural balance. This corresponds well with our model, according to which population growth, fertility or migration driven, will generally increase the physician's future demand and, thus, provide incentives to locate within this region. A higher current share of older people, certainly leads to the expectation of lower future demand, a disincentive for location. Whether or not the treatment of older patients is relatively profitable or not cannot be inferred, only that possible current profits from treating older patients would be overcompensated by the expectation of future losses in demand and income. The effect of the age share 20minus is not robust with respect to changes in specification and changes sign from negative to positive once unobserved heterogeneity is controlled for. From the more reliable estimations (2) and (3) it follows that young populations provide a positive stimulus for physician supply. This may be for young patients being relatively profitable, but it also embraces the expectation that currently young populations guarantee a high demand well into the future. From these simple regressions it follows that both channels of demographic change, namely ageing and population decline, affects physician decisions negatively.

In the following we add to elements to our estimation. Firstly, we now include a number of control variables to analyze if the estimated effects of the demographic change remain significant, if other determinants of physician supply are considered. In table 1 we provide standard errors that are robust to heteroskedasticity and autocorrelation. We now calculate standard errors that are robust to heteroskedasticity and autocorrelation and additionally robust to contemporaneous cross-sectional correlations in the error terms following Driscoll and Kraay (1998). According to Driscoll and Kraay spatial correlations among cross-sections may arise for a number of reasons, ranging from observed common shocks such as terms of trade oil shocks, to unobserved contagion or neighborhood effects.[6]

Secondly, we examine in greater detail the relationship between the demographic and geographic make-up of a region. We have argued before, that in particular the effect of age structure on physicians' location incentives may importantly be shaped by the degree of rurality. Therefore we additionally include interactions of the age groups with our proxy for rurality discussed in the data section.

One argument is, that it is more difficult for rural areas to attract or

[6] According to Driscoll and Kraay (1998) the presence of such spatial correlations in residuals complicates standard inference procedures that combine time-series and cross-sectional data since these techniques typically require the assumption that the cross-sectional units are independent. When this assumption is violated, estimates of standard errors are inconsistent, and hence are not useful for inference.

retain young people or those in the working age population. Hence, if ageing happens in these regions it seems to be obvious that this process is not easily reversed. Furthermore, we have argued in the theoretical section that the degree of rurality may affect the relative profitability of treating different age-groups. In particular, we have conjectured that the treatment of old - and similarly perhaps for very young - patients within a rural context arguably involves a larger share of provision by way of house visits. In particular in rural areas these are likely to be costly for physician due to long travelling times.

We now estimate

$$\begin{aligned} S_{it} = & \beta_0 + \beta_1 old_{it} + \beta_2 old_{it} \times rurality_i \\ & + \beta_3 young_{it} + \beta_4 young_{it} \times rurality_i \\ & + \beta_5 migration_{it} + \beta_6 natural_{it} + \alpha' X_{it} + \gamma_i + \delta_{jt} + \epsilon \end{aligned} \quad (2)$$

where, in addition to specification (1), we have included the interaction of population share 60plus with the rurality variable ($old_{it} \times rurality_i$), the interaction of population share 20minus with the rurality variable ($young_{it} \times rurality_i$), and a vector of control variables, X_{it}.

The models presented in table 2 differ with respect to the restriction $\beta_2 = \beta_4 = 0$ in the regression (1). The omission of the interaction terms within this regression renders the results more comparable with the estimates provided in table 1. According to regression (1) ageing affects physician supply negatively, which is accordance with the results presented in table 1. The additional interaction with rurality in regression (2) shows that the negative effect of the population 60plus on physician supply is particularly pronounced for rural areas. In fact, within an urban context the reverse may well be true, as the pure effect of the share 60plus is now positive, albeit insignificant. As the (negative) effect of ageing on the expected future demand should not vary too much with the regional context, this strongly hints at the fact that rurality reduces the relative profitability of treating old patients. As is well known from the empirical literature, older patients (60plus) exhibit far higher consultation rates and, thus, generate a higher demand for physicians (see e.g. Pohlmeier and Ulrich 1995, Dusheiko et al. 2002, Dormont et al. 2006, Juerges 2007). Whereas meeting this demand appears to be relatively profitable within an urban context, it is unprofitable within rural settings.

When taken across all regions alike, the share of the young population 20minus does not have a significant effect on physician supply (see regression (1)). However, if we consider in addition the interaction with rurality, we find that a high share of the young is most attractive in urban regions: whereas the direct effect of the share of 20minus is significantly positive, the interaction with rurality is significantly negative. The positive direct effect is consistent with a young population being a good indicator for a high future demand. The fact that the attractiveness of young patients weakens within rural areas either hints at the fact that treating the higher demand from young ages within a rural context exposes the physician again to additional costs.[7] Alternatively, it may hint at the expectation that young populations may not stay within rural areas but rather migrate elsewhere. Net migration and natural balance are significant positive in both specifications. These two variables being proxies for the expected future demand, confirms once more that physician supply is driven not only by the size and age-structure of the current population but also by the expectations about future population structure.

table 2 about here

The main reason for why we can interpret the two population flow effects in terms of expectations is that population size has a significant positive effect in of itself. As such, this is not surprising since the number of physicians is related to the number of inhabitants in the region. But to the extent that changes in population over time are measured directly, a the population balance would suggest that one of the three determinates - population size, net migration or natural balance - should turn out to be insignificant. The fact that all three variables are significant then hints at the additional role of expectation over and above the mere population accounting. In the subsequent section on robustness (section 6) we apply a dynamic model that allows us to conclude whether this effect is important even in the short run. In this case, we argue, that expectations play only a minor role. Furthermore, we check in section 6 if the flow effects disappear, if we choose the physician density as dependent variable.

We divide the population density effect into West and East because the net migration flow between the two subregions is unilateral in the period considered in the estimates. Between 1990 and 2004 the East German population has decreased by about 7.5%, while the West German population has increased by almost 7%. Hence, within Germany there is East-to-West migration, a process which has intensified in the middle of the 1990s. According to the literature the effect of population density is positive, because higher densities indicate on average, a lower need for travelling either by patients or by physicians and thus a higher demand and/or greater profitability of provision. One explanation for why the West German effect is not significant is that we control for the share of the elderly in the population, which are less mobile. With respect to the significant negative effect for East Germany we argue that the population density decreases in nearly all regions.

[7] The studies on the intensity of use of physician services by Pohlmeier and Ulrich (1995), Dusheiko et al. (2002), Dormont et al. (2006) and Juerges (2007) consistently reveal a U shaped age-pattern, thus suggesting a relatively high demand for physician services both for the old and youngest ages.

At face value, this may seem to be a good message, as it would imply that the physician density (with reference to population) increases. However, this is simply an artificial effect as long as physicians do not abandon their practice promptly. Moreover, since the location choice is a long-run decision, in most cases they persevere until they retire. Hence, the results are driven by a restructuring process.

For the GDP per capita and the employment rate we argue that they are a proxy for the standard of living and the sound condition of the labor market. In contrast to this, and in accordance with the literature, the unemployment rate and the share of welfare recipients are proxies for morbidity.[8]. Hence, the effects are expected to be positive. For the share of foreigners we find no significant effect, nor for the share of academics. As expected, the share of those without a formal education affect the number of physicians in a region negatively. In as far as this hints at a relatively poor educational environment, it would reduce the residential utility of physicians who care for the development of their own children. The two variables that measure the development of new buildings for living should capture the attractiveness of regions. The share of new houses is related only to one and two family houses and is therefore directly related to an increase in the number of families. The share of new flats in the stock of flats measures the general activities of housebuildung. In as far as such construction activities hint at the simultaneous development of a regional infrastructure (schools, shopping, etc) they provide an additional measure of a region's attractiveness. In a far as development is in particular directed at families, this may provide an additional hint that such a region may be particularly attractive for young physicians (upon the point of their location choice). The capacity of tourist accommodation hints at the attractiveness of such a region both in general and for holiday makers. The effect on physician supply can be expected to be positive, both because the region is attractive and because of the additional demand generated by holiday makers. Finally, cars per 1000 population acts as a measure of geographical mobility. On the one hand, mobility should have a positive effect on physician supply: potential patients find it easier to visit the physician and, thus, exhibit a greater (expected) contact frequency. On the other hand, given that we control for the population size and density as well as for the age structure this variable measures the possibility to consult physician outside the region, e.g. in order to visit a specialist within a city rather than the local general practitioner. In this case the expected effect is negative, and this is what we measure.

[8] See Stewart (2001) for a relatively recent survey on the positive correlation between unemployment and morbidity. The fact that direction of causality remains unresolved is immaterial for our purposes.

6 Robustness Check

As mentioned in the previous section, in this section we provide two further models that should help to assess the robustness of our results. In the first case we estimate the specifications of equation (2), but with physician density as dependent variable. As mentioned in the data section, it is rather common in the literature is to use this variable as a dependent instead of the number of physicians . The subsequent analysis thus makes our results more comparable with other studies and allows to analyse if our general conclusions will change. In the second case we estimate a dynamic spatial panel data model. This allows to consider both short-term effects of the demographic change in the local area and effects of the market for physicians in the surrounding regions.

table 3 about here

Using the physician density as dependent variable in equation (2) yields the results displayed in table 3. With respect to the effects of the population age structure we get comparable results. However, the share of the young population is no longer significant in regression (2). The population flow variables, net migration and natural balance, are still significant, although the population size is not considered on the right hand side of the equation. Hence, the general conclusions based on the results presented in table 2 do not change. In addition, we can conclude that the measurement bias in the dependent variable is apparently not large enough to affect our results.

We now turn to the spatial and time dynamic model. In order to generate spatially lagged counterparts of the dependent variable, we construct a spatial weight matrix indicating the contiguity of regions. We define contiguity between two regions as regions sharing a common border. The corresponding spatial weight matrix W is therefore a symmetric 439×439 matrix. W is row normalized, which ensures that all weights are between 0 and 1, and weighting operations can be interpreted as an average of the neighboring values.

Although we are principally interested in long run effects, we consider this alternative approach, because it allows us to differentiate between expectations concerning the future and short-term utility/profit maximisation. Put differently, we argue that only the latter effect should remain in this specification. Usual fixed effects estimators that include spatial and time dynamic effects of the dependent variable are biased.[9] Hence, we use a spatial and time dynamic data approach with both regional and time fixed effects as suggested by Lee and Yu (2007) and Yu et al. (2008). In this

[9] See, for example, Nickell (1981) with respect to the asymptotic bias of OLS estimation using the time lagged effect and, for example, Kelejian and Prucha (1998) for biased OLS estimates when spatial lagged effects are considered.

case, the parameters for the time lagged and spatial lagged values of the dependent variables will be estimated using a quasi-maximum likelihood estimator that is extended by a bias correction. To avoid biased estimates for the lagged effects of the dependent variables, Lee and Yu (2007) developed a data transformation approach that has the same asymptotic efficiency as the quasi-maximum likelihood estimator when n is not relatively smaller than T.

table 4 about here

We apply this estimation technique to equation (2) and choose the number of physicians as well as the physician density as dependent variables. Although we only show the results for the important variables, the specification with respect to the remaining control variables has not changed. With respect to the spatial lagged effect of the dependent variable we find a significant positive effect. This means that the propensity to locate in a particular region is positively related to the physician density in neighboring districts. This is because high densities of physicians in neighboring regions are likely to be associated with strong competition there. In turn, this would imply a greater relative attractiveness for the local region under consideration.

With respect to the age effects we can conclude that the young as well as the old are negatively associated with rural areas. That is, the higher the rurality level is the more profitable is the working age population. This is consistent with our previous findings. The main difference to the results in table 2 is, that the share of young is no longer significant in regression (2). Hence, this effect is driven by expectation about future income. For net migration and natural balance we find that the estimated effects are not significant or at least have a lower significance level. According to tables 2 and 3, it follows that the population flows thus measure in fact mainly expectations.

7 Conclusions

Population ageing is widely expected to come with an increased per capita demand for (ambulatory) physician services. Everything else equal regions with high population shares of old persons should then be particularly attractive on economic grounds for the location of physician practices and should therefore exhibit high physician to population ratios.

At the regional level in Germany, ageing is not only shaped by low or declining fertility rates but also by outmigration. This is because younger people exhibit a higher regional mobility than older people. Hence, ageing may be accelerated by outmigration in particular as it becomes progressively more difficult to attract young people into regions in which the average

age is increasing towards (or at) high levels. According to our data the largest population share of the age cohort 60plus in 2004 lives in the region Hoyerswerda (33.4%) followed by the region Görlitz (32.9%); two regions in East Germany. Between 1995 and 2004 the share of 60plus has increased by 89% in Hoyerswerda and 41% in Görlitz. However, there are other regions, in particular in the Eastern part of Germany, that experience ageing in a similar manner. According to the results, physician supply is negatively related to the population share of 60+ within rural areas, while it is not significantly related to the share within urban regions. Hence, many rural regions with a high share of the elderly population are in particular danger of being under-doctored in the future, if the identified effects in our regressions are in fact a causal.

Additionally, we adopt the hypothesis that demographic and geographic characteristics do not determine in isolation the attractiveness of a region from a physician's perspective but interact in a particular way. More specifically, we posit that the high demand for services by elderly patients may be less attractive for a physician if it has to be served within a rural context. Long travel times and poor availability of public transport deter frail elderly patients from attending the physician's practice, implying a high demand for home visits as compared to an urban context. Furthermore, due to the long travel times the provision of home visits is more costly for the physician in rural areas. Thus, a high demand from old populations may be served at a relatively low cost within an urban region but only at a high cost within a rural context. Given that the interaction of age-related population shares and the rurality variable (in nine levels) is adequate to measure this effect, we find that the share of the elderly has an increasing negative effect on physician supply, the higher the level of rurality.

At regional level, demographic developments and geographical location imply a framework with both an intertemporal and a spatial dimension. Given that physicians' location choices are mostly long-term decisions, the intertemporal aspect implies that not only the current population structure will matter but also the expected population. In fact, we find that net population growth (births – deaths) and net migration to constitute significant determinants for physician supply besides the population and its age structure in of themselves. Furthermore, spatial interactions in terms of physician density are important. More specifically, the econometric results confirm our hypothesis whereby the propensity to locate in a particular region is positively related to the physician density in neighbouring districts. This is because high densities of physicians in neighbouring regions are likely to be associated with strong competition. In turn, this would implies a greater relative attractiveness for the region under consideration.

Unlike the East-West migration ageing did not start in Germany in the early 1990s but in West Germany has been in effect from the second half of the 1970s onwards. We can therefore assume that the estimated effects of regional population ageing are robust for Western German regions. However, the East German population density effect on physician supply is underestimated. In 2007 the share of 50plus among the physicians is 37.7%, while it was 30.3% in 1997. Hence, ageing happens to physicians, too. From this it follows that a large number of physicians will retire in the next 15 years and this will touch the medical provision particularly in the eastern part of Germany. According to the German Medical Association about 13% of the East German regions are medically "underprovided" in 2007. In addition, more than half of the hospitals in East Germany have problems to fill vacancies in medical employment.

The important problem for the future lies in attracting new and young physicians to these regions, as it is known from statistical projections that population decline in many East German regions will go on for the next 20 years. Since the speed of population ageing is much faster in rural regions, policy should provide incentives to move into these regions not only on equity grounds but also because a worsening provision of basic goods and services, such as health care, may reduce even further the development prospects (e.g. by way of job creation) for such regions. In addition, many rural regions in East Germany have a rural contiguity neighbor, which means that the positive spatial effect disappears here.

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9 Appendix

Table 2: Demographic Change and the Number of Physicians

	(1)		(2)	
share 60plus	-8.157‡	(1.747)	1.247	(1.219)
share 60plus×rurality			-2.267‡	(0.241)
share of 20minus	2.124	(2.612)	17.32‡	(4.269)
share of 20minus×rurality			-3.506‡	(0.328)
net migration	1.073‡	(0.081)	1.154‡	(0.077)
natural balance	8.626‡	(2.631)	7.596‡	(2.377)
population size	0.002‡	(0.0002)	0.002‡	(0.0002)
population density West	0.237	(0.177)	0.206	(0.171)
population density East	-0.473‡	(0.148)	-0.515‡	(0.143)
GDP per capita	1.045‡	(0.324)	0.802‡	(0.299)
employment rate	2.413‡	(0.511)	2.051‡	(0.473)
unemployment rate	1.186‡	(0.256)	1.081‡	(0.179)
share of welfare recipients	0.767‡	(0.124)	0.704‡	(0.113)
share of foreigners	-1.198	(0.891)	-0.526	(0.811)
high school leavers	-0.324	(0.215)	-0.456	(0.249)
no formal education	-1.071‡	(0.222)	-1.064‡	(0.241)
share of new houses	1.316‡	(0.182)	1.227‡	(0.178)
new flats	0.608‡	(0.196)	0.450‡	(0.169)
tourist accommodation	0.136‡	(0.011)	0.114‡	(0.013)
cars per habitants	-0.079‡	(0.021)	-0.071‡	(0.017)
R^2	0.735		0.741	
individual FE	✓		✓	
state level time FE	✓		✓	

Notes: Dependent variable: number of physicians; number of observations 3951; Driscoll & Kraay robust standard errors in parenthesis; ‡ 1% significance level; † 5% significance level.

Table 3: Demographic Change and Physician Density

	(1)		(2)	
share 60plus	-1.483‡	(0.496)	-0.472	(0.322)
share 60plus×rurality			-0.257‡	(0.066)
share of 20minus	-0.935	(1.600)	2.391	(1.522)
share of 20minus×rurality			-0.629‡	(0.094)
net migration	0.373‡	(0.036)	0.389‡	(0.035)
natural balance	2.736‡	(0.779)	2.698‡	(0.773)
population density West	0.011	(0.028)	0.007	(0.028)
population density East	-0.178‡	(0.025)	-0.188‡	(0.023)
GDP per capita	0.620‡	(0.151)	0.606‡	(0.157)
employment rate	0.277$^{\sharp}$	(0.164)	0.220	(0.163)
unemployment rate	0.421‡	(0.090)	0.364‡	(0.079)
share of welfare recipients	0.078†	(0.038)	0.072†	(0.038)
share of foreigners	1.092‡	(0.178)	1.181‡	(0.190)
high school leavers	0.076	(0.094)	0.070	(0.098)
no formal education	-0.050	(0.070)	-0.049	(0.072)
share of new houses	0.447‡	(0.039)	0.446‡	(0.039)
new flats	0.222‡	(0.069)	0.191‡	(0.065)
tourist accommodation	0.082‡	(0.006)	0.079‡	(0.005)
cars per habitants	-0.044‡	(0.010)	-0.042‡	(0.009)
R^2	0.702		0.704	
regional FE	✓		✓	
state level time FE	✓		✓	

Notes: Dependent variable: physician density; number of observations 3951; Driscoll & Kraay robust standard errors in parenthesis; ‡ 1% significance level; † 5% significance level.

Table 4: Spatial and Time Dynamic Model

dependent variable	physicians		physician density	
	(1)	(2)	(3)	(4)
time lagged dep. var.	0.983‡	0.965‡	0.873‡	0.871‡
	(0.012)	(0.012)	(0.013)	(0.013)
spatial lagged dep. var.	0.054‡	0.036♯	0.110‡	0.099‡
	(0.021)	(0.021)	(0.022)	(0.022)
share 60plus	-1.425	2.211♯	-0.305	0.691♯
	(1.045)	(1.293)	(0.301)	(0.371)
share 60plus×rurality		-0.849‡		-0.235‡
		(0.175)		(0.051)
share of 20minus	-1.340	3.623	-0.847♯	0.907
	(1.716)	(2.409)	(0.492)	(0.705)
share of 20minus×rurality		-1.134‡		-0.378‡
		(0.306)		(0.089)
net migration	0.223†	0.267‡	-0.028	-0.022
	(0.099)	(0.099)	(0.029)	(0.024)
natural balance	0.566	0.352	0.507†	0.419†
	(0.747)	(0.749)	(0.217)	(0.219)
additional controls	✓	✓	✓	✓
regional FE	✓	✓	✓	✓
state level time FE	✓	✓	✓	✓

Notes: Number of observations 3951; standard errors in parenthesis; ‡ 1% significance level; † 5% significance level; ♯ 10% significance level.

Table 5: Summary Statistics

	Mean	Std. Dev.	Min	Max
physicians	271.53	433.10	51	7894
physician density	141.96	47.54	68	391
share 60plus	23.44	2.72	13.8	33.4
share 60plus×rurality	126.24	61.68	18.5	271.8
share of 20minus	21.38	2.32	15	29
share of 20minus×rurality	116.89	57.84	15	239.4
net migration	2.16	7.66	-43.1	57.2
natural balance	-1.63	2.66	-10.2	7.1
population size	186160.3	214296.7	35499	3471418
population density	509.49	656.79	40	4024
GDP per capita	22.77	9.32	10.1	85.4
employment rate	48.11	15.29	20.9	139.1
unemployment rate	11.66	5.34	3.0	31.4
share of welfare recipients	28.45	16.41	3.4	138
share of foreigners	6.95	4.85	0.1	28.9
high school leavers	22.22	7.94	0	52.2
no formal education	9.28	2.70	1.4	26
share of new houses	88.80	9.81	29.2	100
new flats	12.31	7.42	0	69.3
tourist accommodation	36.38	49.71	0.6	581.1
cars per habitants	528.09	51.65	350	959
rurality	5.39	2.52	1	9

Notes: Number of observations 3951.

Table 6: Rurality

Type I: Agglomeration Regions
1 Independent Cities with more than 100,000 inhabitants
2 Districts with at least 300 inhabitants per square kilometer
3 Districts with at least 150 inhabitants per square kilometer
4 Districts with less than 150 inhabitants per square kilometer
Type II: Urbanised Regions
5 Independent Cities with more than 100,000 inhabitants
6 Districts with at least 150 inhabitants per square kilometer
7 Districts with less than 150 inhabitants per square kilometer
Type III: Rural Areas
8 Districts with at least 100 inhabitants per square kilometer
9 Districts with less than 100 inhabitants per square kilometer

Notes: The criteria for Type I regions is that they have a concentrated hinterland. Type III regions are defined by a low number of inhabitants per square kilometer. The remaining regions are merged to Type II areas. In contrast to the Type III regions they have a higher urbanisation degree, a rudimental metropolitan centre, and a higher density.