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Mathias Moser & Matthias Schnetzer

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The income–inequality nexus in a developed country: small-scale regional evidence from Austria

Mathias Moser[a] and Matthias Schnetzer[b]

ABSTRACT
The income–inequality nexus in a developed country: small-scale regional evidence from Austria. *Regional Studies*. This paper analyses the relationship between regional inequality and average income in a small-scale framework for Austria. The empirical findings are based on a novel inequality database generated from individual wage tax information at the municipality level. This study researches the magnitude of regional spillovers of income and inequality using spatial econometric methods. The results show a pronounced positive relation between regional income levels and inequality, where especially high-income municipalities exhibit a large spread in the income distribution. Furthermore, it shows that higher levels of inequality are associated with income gains at the top of the distribution.

KEYWORDS
income inequality; regional inequality; spatial dependence; spatial autoregressive model

摘要
已开发国家的所得—不均轴线：来自奥地利的小规模区域证据. *区域研究*。本文分析奥地利一个小规模架构中的区域不均和平均所得之间的关係。本研究的经验发现，是根据市政层级的个人所得税信息所产生的崭新不均数据集。本研究运用空间计量经济模型，探索所得与不均的区域外溢量。研究结果显示，区域所得层级与不均之间具有显着的正相关，而高所得的行政区特别在所得分佈上呈现出大幅扩散。此外本研究显示，较高度的不均，与所得分佈的项层之收入有关。

关键词
所得不均; 区域不均; 空间依赖; 空间自迴归模型

RÉSUMÉ
Le lien entre le revenu et l'inégalité dans un pays développé: des résultats régionaux à petite échelle provenant de l'Autriche. *Regional Studies*. Ce présent article cherche à analyser à petite échelle régionale le rapport entre l'inégalité et le revenu moyen pour l'Autriche. Les résultats empiriques sont fondés sur une base de données originale provenant des renseignements quant à l'impôt sur les salaires des individus au niveau municipal. À partir des modèles économétriques spatiaux, cette étude recherche l'importance des retombées du revenu et de l'inégalité régionales. Les résultats montrent un rapport positif marqué entre les niveaux des revenus et de l'inégalité régionaux, où notamment les municipalités à hauts revenus font preuve d'une importante répartition de la distribution des revenus. Qui plus est, les niveaux d'inégalité plus élevés s'expliquent par des gains de revenu au sommet de la distribution.

MOTS-CLÉS
inégalité des revenus; inégalité régionale; dépendance spatiale; modèle spatial autorégressif

CONTACT
[a] **(Corresponding author)** matmoser@wu.ac.at
Department of Economics, Vienna University of Economics and Business, Vienna, Austria.
[b] matthias.schnetzer@akwien.at
Department of Economics, Vienna Chamber of Labour, Vienna, Austria.

ZUSAMMENFASSUNG

Der Zusammenhang zwischen Einkommen und Ungleichheit in einem Industrieland: Kleinräumige Evidenz für Österreich. *Regional Studies*. In diesem Beitrag wird das Verhältnis zwischen regionaler Ungleichheit und Durchschnittseinkommen im kleinen Maßstab für Österreich untersucht. Die empirischen Ergebnisse beruhen auf einer neuartigen Ungleichheitsdatenbank, die anhand von Informationen über die individuelle Einkommenssteuer auf Gemeindeebene erstellt wurde. Mithilfe von räumlichen ökonometrischen Methoden untersuchen wir den Umfang der regionalen Übertragungen von Einkommen und Ungleichheit. Die Ergebnisse lassen auf eine ausgeprägte positive Beziehung zwischen dem regionalen Einkommensniveau und der Ungleichheit schließen, wobei vor allem einkommensstarke Gemeinden ein breites Spektrum von Einkommensverteilung aufweisen. Darüber hinaus zeigt sich, dass ein höheres Maß an Ungleichheit mit Einkommenssteigerungen am oberen Ende des Spektrums einhergeht.

SCHLÜSSELWÖRTER

Einkommensungleichheit; Regionale Ungleichheit; Räumliche Dependenz; Räumliches autoregressives Modell

RESUMEN

Vínculo entre ingresos y desigualdades en un país desarrollado: ejemplo regional a pequeña escala en Austria. *Regional Studies*. En este artículo analizamos la relación entre las desigualdades regionales y los ingresos medios a pequeña escala para Austria. Los resultados empíricos se basan en un nueva base de datos sobre las desigualdades generada a partir de información del impuesto sobre el salario en un ámbito municipal. Mediante métodos econométricos espaciales investigamos la magnitud de los efectos indirectos regionales de los ingresos y las desigualdades. Los resultados indican una profunda relación positiva entre los niveles de ingresos y las desigualdades regionales, especialmente en los municipios con altos ingresos que muestran una amplia dispersión en la distribución de los ingresos. Asimismo mostramos que los niveles más altos de desigualdades están vinculados a ganancias de ingresos en la parte superior de la distribución.

PALABRAS CLAVES

desigualdad de ingresos; desigualdades regionales; dependencia espacial; modelo autorregresivo espacial

JEL C21, D31, J31
HISTORY Received May 2015; in revised form September 2015

INTRODUCTION

The distribution of income and its nexus to a wide range of social, political and economic aspects has generated a tremendous body of literature. One strand of literature connects income inequality to multiple social phenomena, like health conditions, crime rates, voter participation, political power or social cohesion. Other authors emphasize the link between income inequality and macroeconomic parameters, like economic growth or productivity. The pioneering work in this realm is Simon Kuznets's seminal article in which the relation between economic development, measured as per capita income, and income inequality is described as an inverted 'U'-shape (Kuznets, 1955). Following this argument, the concentration of income-generating wealth is supposed to be a precondition for industrialization in early stages of economic development, since the accumulation of capital incites and requires investment respectively. According to Kuznets, the benefits of economic growth will gradually trickle down to all members of society by increasing low wages and subsequently narrowing the income gap. Thus, personal income inequality should increase at first and in further consequence decline in the course of economic development.

Kuznets's argument was guided by inter-sectoral transitions in agriculture and the manufacturing industry, and hence inequality was seen as a result of the structural composition of the economy. However, as noted by Galbraith (2012), wealthy states may be in a more complex form of inter-sectoral transition towards technology, finance and services, which complicates the nexus between the rise of income and the change in inequality. For instance, economic prosperity boosts earnings in high-income sectors, particularly in technology and finance, and thus inequality in industrial countries, whereas strong growth tends to reduce inequality in emerging markets. To be more precise, Galbraith accentuates that wealthy countries show again an upward-sloping Kuznets curve. Hence, rising income levels are associated with higher income inequality. Piketty (2014) provides rich empirical evidence for this argument. He shows that the development of income inequality was in fact 'U'-shaped in most wealthy countries in the 20th century and consequently rejects the theoretical foundations of the Kuznets hypothesis. Piketty argues that the reduction in inequality observed by Kuznets in rich countries between 1914 and 1945 was not due to a tranquil process of inter-sectoral mobility but rather caused by violent economic and political shocks. According to Piketty, most developed countries experienced a remarkable trend reversal of rising inequality, particularly since the 1980s. While this development is far more pronounced in the United States, European countries also exhibit a rise in income disparities.

The link between regional income and the degree of income inequality has also received widespread attention in the field of spatial economics, where recent research acknowledges the risk of disregarding small-scale geographic specifics and potential spatial patterns at subnational levels. The growing body of the empirical literature on the spatial dimension of income inequality confirms that earnings disparities are not only a sectoral (as argued in the original Kuznets contribution) but also a regional phenomenon (Fan & Casetti, 1994; Rey & Montouri, 1999; Beblo & Knaus, 2001; Akita, 2003; Hoffmeister, 2009). Some studies even focus on much smaller regional scales and address income inequality in the neighbourhood context (Watson, 2009; Bailey, Gannon, Kearns, Livingston, & Leyland, 2013). This leads to the argument that the spatial distribution of regional incomes and the degree of inequality should be considered jointly, since the magnitude of social tensions triggered by inequality may be correlated with the geographic segregation of certain social groups (Rey, 2004).

This paper explores the nexus between income levels and regional inequality for Austria and investigates which parts of the income distribution affect this relationship. More specifically, this contribution makes use of the vivid genesis of register-based statistics that in many ways impels empirical research. The analysis is thus not confined to per capita gross domestic product (GDP) or average national income based on national accounts but uses an administrative data source on Austrian individual tax records providing annual gross earnings. While it is not possible to analyse long-term developments based on these data, individual geographical identifiers permit a thorough investigation of income and inequality on the small-scale municipality level for the years 2009–11. Descriptive analyses show that earnings and inequality seem to exhibit positive correlation and strong regional clustering. Based on these findings, the relation between average income and inequality is investigated for Austria using spatial econometric methods. The results suggest a significant positive relationship between income levels and inequality, particularly due to a lift-off at the top tail of the distribution. In contrast, the results do not indicate a similarly strong effect between changes at the bottom and average income levels.

The article is structured as follows. The second section provides an overview of related studies on the spatial distribution of income and inequality. The third section introduces the dataset based on tax data and census information and motivates the need for a spatial analysis. The fourth section describes the instruments used to detect spatial clustering, the estimation strategy and the treatment of spatial effects. Subsequently, the results from the econometric exercise and the main findings are presented. Finally, the last section concludes.

AVERAGE INCOME, INEQUALITY AND SPATIAL EFFECTS

The traditional empirical literature investigating the Kuznets hypothesis has dealt with national- or state-level per capita income as a measure of economic development and its relation to inequality. Recent studies rely either on cross-country collections of inequality measures (Barro, 2000, 2008) or on the availability of long-term income tax data to analyse the shape of the inequality–income nexus by country over time (Piketty & Saez, 2003). Despite the longstanding and extensive research to test the Kuznets hypothesis at the (sub-)national level, these contemporary studies are discordant. Barro (2008), for instance, finds evidence for the presence of the Kuznets curve in a cross-country study for the 1960s to the 2000s. However, there is growing indication that changes in income inequality continue after the last stages of the inverted 'U'-shaped model, which does not predict increases in inequality after regional convergence at advanced stages of development (Fan & Casetti, 1994). Most prominently, the work of Piketty and Saez (2003) shows impressively that inequality in the United States has actually followed a 'U'-shape over the last century. The authors state that a pure Kuznets mechanism cannot fully account for these facts.

This paper is not concerned with research on the Kuznets hypothesis itself, since the small-scale data on a comparatively short period are inconvenient for explaining long-term regional developments. However, it focuses on the same structural relation underlying the Kuznets hypothesis, that is, the association between income and inequality. Contrary to Kuznets's theory, the literature provides various arguments to explain the simultaneous increase of average incomes and income inequality. These arguments include the role of welfare regimes (Gottschalk & Smeeding, 1997; Beblo & Knaus, 2001; Hoffmeister, 2009), skill-biased technological change (Acemoglu, 1998), unevenly distributed productivity gains (Dew-Becker & Gordon, 2005), the economics of superstars (Rosen, 1981) and the exceptional surge of top wage earners (Piketty & Saez, 2003). However, the major part of this literature observes income inequality at very aggregated regional levels. In contrast, the data used in this paper entail the possibility to observe small-scale inequality measures at the municipality level. The small-scale analysis implies that macroeconomic parameters cannot serve as an exhaustive explanation for the differences in inequality measures and need to be complemented by spatial and neighbourhood characteristics.

The literature provides multiple rationales for the joint analysis of income and inequality on extremely disaggregated regional levels, most prominently neighbourhood effects. One strand of the literature links the income–inequality nexus to spatial segregation. The underlying argument is concerned with rising housing market segregation, since higher income groups may outbid lower income groups in the competition for better neighbourhoods (Banzhaf & Walsh, 2008). This could lead to positive feedback effects to the extent that richer families might produce positive neighbourhood externalities which raise the relative price of high-income neighbourhoods even further (Watson, 2009; Bailey et al., 2013). Thus, a positive relationship between income inequality and average earnings may arise from displacement processes in the residential environment. While the canonical model of Meltzer and Richard (1981) predicts that higher inequality leads to more redistribution, empirical evidence suggests that increasing spatial segregation and rising income disparities between regions worsen social cohesion and limit the success of redistribution policies. For instance, Bailey et al. (2013) argue that if growing segregation undermines the bonds of solidarity between the rich and the poor, support for redistributive policies weakens, which further fuels rising inequality. A theoretical explanation for this vicious circle is given by the belief that attitudes are not based on knowledge about one's absolute economic position, but rather on a comparison with a reference group or the immediate social network. Hence, the neighbourhood context causes social contagion and shapes attitudes about redistribution policies which may boost income inequality.

Another recent strand of literature emphasizes the role of small-scale spatial clustering in economic activity. Skilled workers and skill-intensive firms tend to agglomerate in order to benefit from technology or information spillovers (Combes, Lafourcade, Thisse, & Toutain, 2011). Spatial clusters of high-skilled individuals with higher earnings may also affect the relation between regional inequality and income. A similar argument is brought forward by Lee and Rodríguez-Pose (2013) who focus on the role of innovation as a crucial driver of income inequality. For instance, innovative cities and regions tend to grow faster and have higher average wages. Accordingly, innovation creates gains for particular individuals who possess complementary skills or work in innovative sectors. Innovation may also produce knowledge spillovers, which only increase productivity for those who have the capacity to use them. Thus, average earnings and inequality could jointly be linked to the spatial distribution of innovation.

The empirical literature on spatial inequality provides rich evidence of regional patterns and small-scale spillover effects in income inequality. Shorrocks and Wan (2005) give a detailed list of international studies conducting spatial decompositions of inequality measures on various geographic scales. Fan and Casetti (1994) show that the increase in US regional income inequality between the 1950s and the 1980s was mainly due to spatial restructuring of the US economy. Rey and Montouri (1999) find evidence of spatial autocorrelation in US state per capita incomes, which are also strongly associated with the level of income dispersion. Rey (2004) analyses regional income inequality in the United States between 1929 and 2000, and detects a strong positive relationship between measures of inequality in state incomes and the degree of spatial autocorrelation. Numerous studies have also addressed regional income inequality in Europe: Beblo and Knaus (2001) perform a spatial decomposition of the Theil inequality measure to determine the contribution of single European countries to overall inequality in 1995. Novotný (2007) and Hoffmeister (2009) show spatial patterns on different geographical levels using Theil decompositions to assess within and between region inequality in Europe. Ezcurra, Gil, Pascual, and Rapún (2005) and Ezcurra, Pascual, and Rapún (2007) reveal positive spatial dependence in the income distribution in the European Union from 1993 to 2000. Analyses for sub-national regions are often limited by data availability, and hence more scarce. Examples of such applications can be found, amongst other countries, for the UK (Dickey, 2001; Etherington & Jones, 2009) and the United States (Bollens, 1988).

While most of these articles focus on descriptive approaches, such as Theil decompositions, some recent articles apply spatial econometric methods in order to assess the relationship of inequality and several covariates while controlling for spatial spillover effects. For instance, Rodríguez-Pose and Tselios (2009) constitute a positive relationship between per capita income, income inequality and educational levels across European regions using spatial autoregressive and spatial error models. Perugini and Martino (2008) find a positive link between income inequality and regional growth in European countries. However, the relation is less significant when controlling for spatial effects. These results confirm the importance of taking spatial effects into account when analysing the Kuznets relation between income and inequality.

DATA AND DESCRIPTIVE ANALYSIS

This analysis uses a new inequality database based on wage tax data for all Austrian municipalities including the capital Vienna for 2009–11. This dataset includes approximately 6.4 million tax payers, of which roughly 4.1 million are economically active, that is, not retired. These persons can be attributed to 2356 municipalities and the 23 districts of Vienna, which leaves a total of 2379 regional observations. On the whole, Austrian wage tax data cover about 90% of income tax payers, but leaves out self-employed individuals.

A distinct feature of this data source is the availability of various earnings inequality measures on a very disaggregated geographic scale. Empirical studies often rely on one specific inequality measure which is mostly predetermined by data limitations. A more robust approach would target a set of different inequality measures for several reasons. First, prominent measures such as the Gini index can be sensitive to changes in the middle of the distribution, and therefore lead to an under- or overestimation of effects. Second, deviations in such aggregated measures can hardly provide insight into the actual changes in the distribution, that is, which segment of the distribution caused the observed reaction in the measure. The measures applied in the following are the well-known Gini index, the 90/10, 90/median and median/10 ratios. This group of measures is chosen in such a way that it targets different parts of the distribution (overall, upper, middle, lower) to provide a more comprehensive picture of the relationship between average income and inequality. While this paper focuses on the economically active part of the distribution, all variables in use are also available for the retired population. Calculations of these measures are based on the annual gross wages per municipality as reported in the data, which are defined as all earnings received within a year, including supplementary payments and social security contributions.

Table 1. Descriptive statistics for municipality inequality measures, 2009–11.

	Minimum	Mean	Median	Maximum	SD	VC	VC (04–11)
Average wages	21,653	33,256	32,682	67,045	3929	0.118	0.119
Gini	0.21	0.332	0.33	0.515	0.0259	0.0782	0.0791
90/10	2.86	5.34	5.28	11.2	0.712	0.133	0.127
90/50	1.46	1.93	1.92	3.58	0.159	0.0826	0.0825
50/10	1.53	2.77	2.75	5.33	0.298	0.108	0.104

Note: VC, variation coefficient, 2009–11; VC (04–11), variation coefficient for total sample, 2004–11; SD, standard deviation.
Source: Wage tax data, 2004–11.

As can be seen in Table 1, the various inequality measures vary considerably between municipalities for the pooled period of 2009–11. While the Gini index is rather stable in terms of the coefficient of variation, the 90/10 ratio as well as the other ratios prove to be more responsive. This is also shown by the range of the inequality measures. The Gini index ranges from 0.21 for the most equal municipalities to roughly 0.51. Strong deviations are found for the 90/10 ratio, where the income share of the top 10% compared with the bottom 10% varies by a factor of five between the most equal and unequal municipalities (2.86 and 11.2 respectively). Particularly for very small municipalities, some extreme outliers related to high-income individuals moving to (or away from) these regions can be found. The following analysis will therefore use three-year averages to smooth such statistical noise.

While the wage tax data are available from 2004 to 2011, the time horizon of this analysis is limited due to the availability of socio-economic characteristics. Even though the period 2009–11 can be considered special in terms of the economic environment, for Austria this is hardly measurable in the data. The coefficient of variation is rather low for all variables in Table 1 both for the period 2009–11 as well as for the full sample ranging from 2004 to 2011. Accordingly, the variables are very stable over time and an impact of the economic crisis is hardly noticeable in the data. This observation can be explained by the fact that Austria was, along with Germany, largely unaffected by the crisis in terms of unemployment until 2011. Especially, the strict laws on job protection and possibilities for working time adaption (reduced working hours) contributed to these exceptional circumstances.

Figure 1 depicts the dispersion of average earnings and inequality measures by the nine Austrian federal states. In both graphs, some states show a substantial heterogeneity in the measures, particularly Vienna and Lower Austria (the north-eastern part of Austria), while some states, like Vorarlberg (in the west, on the Swiss border) and Burgenland (the easternmost state on the Hungarian border), are comparatively homogeneous. While the dispersion of average income is larger than that of the Gini in terms of the coefficient of variation in Table 1, the visual impression indicates more outliers for the inequality measure.

The econometric exercise below controls for structural and institutional factors together with a variety of socio-demographic variables. The literature has a set of recurring variables that may have an effect on the level of income inequality, for example, education (Rodríguez-Pose & Tselios, 2009), ethnicity (Borjas & Ramey, 1994; Watson, 2009), labour market parameters (Fortin & Lemieux, 1997), and the structure of the population in general (Perugini & Martino, 2008; Baum-Snow & Pavan, 2013; Behrens & Robert-Nicoud, 2014). The covariates in the regression analysis are mostly drawn from the register-based labour market statistics for 2009 and 2010, which are the predecessor of the Austrian register-based census conducted in 2011. These sources provide detailed information on the socio-economic characteristics for the economically active population of Austrian municipalities. For the estimations, a number of relevant variables such as the population density of a region, which serves as a proxy for urbanization, are used. Other potential determinants of income inequality are adopted from the literature mentioned above and include the share of native-born individuals and information on ongoing and attained education. With the exception of population density and average wages, all variables are defined as shares relative to the total population of a municipality. Further included are the share of women to control for wage-gap and part-time effects which could affect regional inequality measures. The proportion of commuters may be an indicator for income transfers from high-income regions to rural areas, even if average education levels remain low (Tinbergen, 1972). Finally, and most importantly, the logarithm of average earnings is included to evaluate the relationship between regional income levels and inequality. The sign of this relationship is, however, theoretically ambiguous: earnings losses for lower incomes could increase inequality, while income gains for top income groups could also trigger this change. Table A1 in Appendix A in the supplemental data online provides a detailed overview of the variables in use and their sources.

Spatial dependence in income-related statistics is often measured via Moran's I, which is used to test the null hypothesis that spatial autocorrelation of a variable is zero (Rey, 2004; Ord & Getis, 1995). Since Moran's I is a global indicator and assumes homogeneity across the spatial sample, local measures are more powerful to reveal spatial non-stationarity. Anselin (1995) designs a class of local indicators of spatial association (LISA) like local Moran's I, which can distinguish between clusters (that is, regions with similar neighbours), on the one hand, and dispersion, on the other. Ord and Getis (1995) developed a local spatial autocorrelation measure, the G-statistic, that

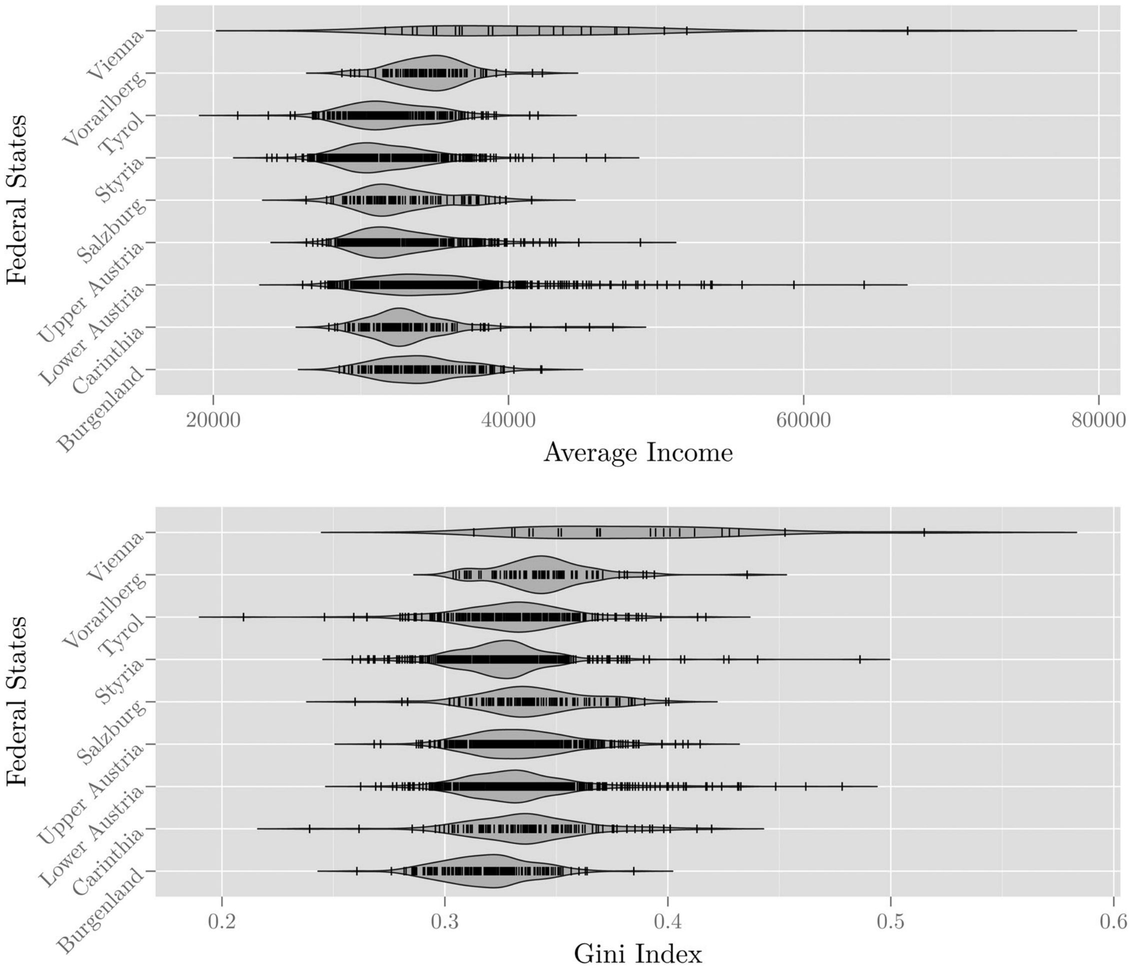

Figure 1. Bean plots for municipality earnings and inequality aggregated by federal states, mean 2009–11.

provides more comprehensive information on regional clustering, that is, the differentiation between clusters of high and low values ('hot spots' or 'cold spots'). The diagnostic tool applied in this paper is the Z-score of the Getis–Ord G-statistic which denotes:

$$G_i(d) = \frac{\sum_j w_{ij}(d)y_j - W_i\bar{y}(i)}{s(i)\{[(n-1)S_{1i} - W_i^2]/(n-2)\}^{1/2}}, \quad i \neq j \qquad (1)$$

where y is the variable under consideration; n is the number of observations; and w_{ij} is a so-called spatial weights matrix, which is an indicator for the adjacency of regions i and j. The sum of weights is written as:

$$W_i = \sum_{i \neq j} w_{ij}(d)$$

and

$$S_{1i} = \sum_j w_{ij}^2.$$

$\bar{y}$ and s^2 are the usual sample mean and variance. The spatial weights matrix incorporates spatial relationships via multiple weighting possibilities (e.g. inverse distance, fixed distance, k nearest neighbours, contiguity). In the reference specification the concept of first-order contiguity with row-standardization is applied throughout this paper, but additional robustness checks using other weighting strategies are conducted as well. Positive values of G_i indicate local pockets of high values of y, while negative values signal a concentration of low y values.

Figure 2(a) shows the results for the local spatial association of average earnings, while Figure 2(b) presents the same map for the Gini index. Areas coloured in light grey represent regions considered as 'cold spots' of income or inequality, whereas darker shaded regions imply spatial patterns of high values ('hots pots'). For Austria, the cluster map of average earnings shows strong positive spatial patterns for urban areas, specifically in the eastern part of the country. High wages are especially concentrated in Vienna and its suburbs, which reach far into the neighbouring state of Lower Austria.

To a certain extent, the spatial patterns for income inequality and average earnings are very similar. High levels of inequality are concentrated around the major cities, where, again, Vienna leads the ranking (Figure 2(b)). This evidence mirrors the findings of Baum-Snow and Pavan (2013), who uncover a positive relationship between wage inequality and city size in the United States. However, the spillover effects for the Gini index seem to be more dispersed compared with income, so that new hotspots emerge in this figure. For instance, strong spatial autocorrelation of high inequality is evident in large parts

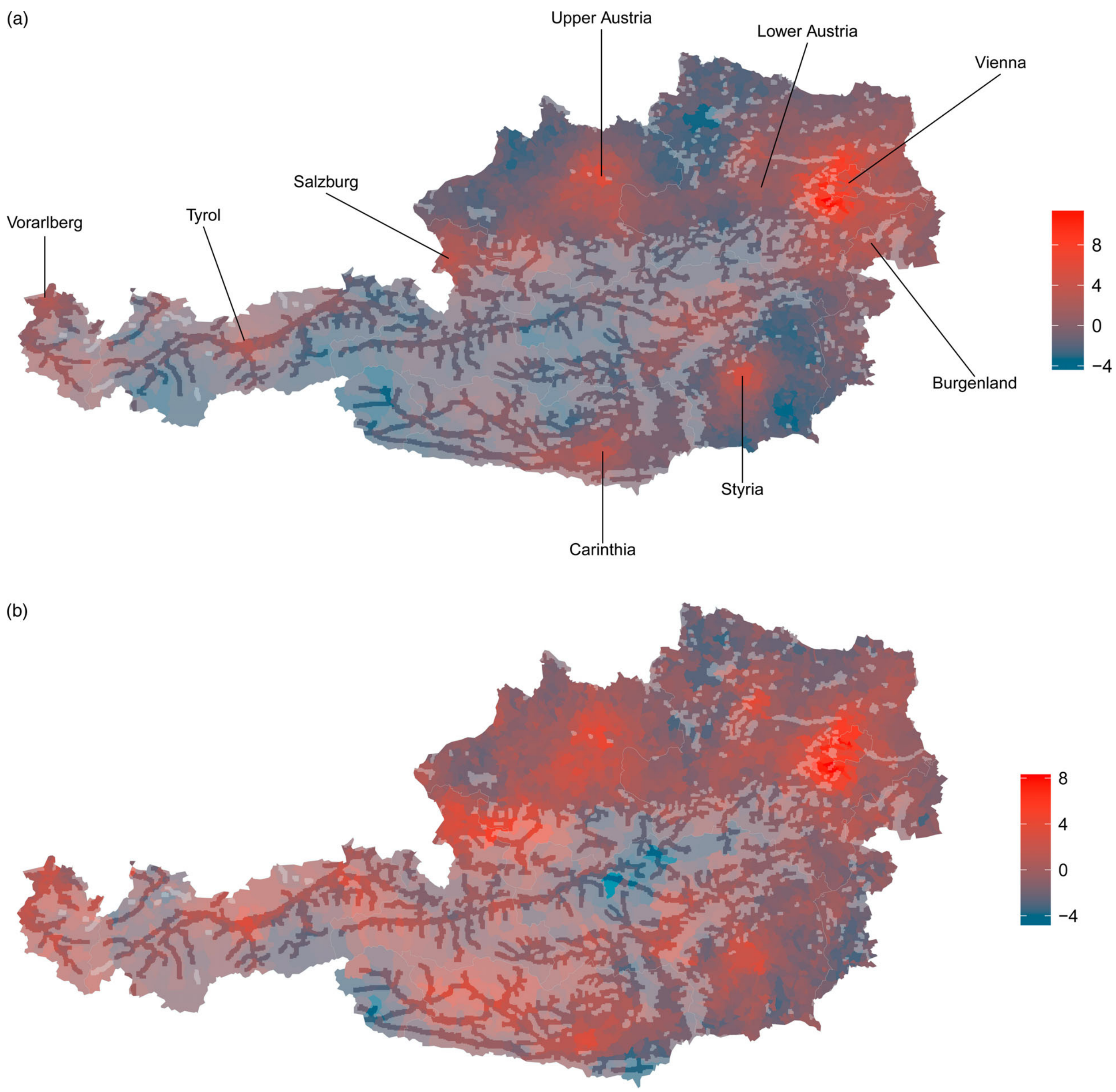

Figure 2. Getis–Ord *G*-statistic for (a) wages and (b) inequality in Austria.

of the west (Vorarlberg) and in the south (Carinthia). The cold spots are found in regions like northern Styria, southern Burgenland as well as in northern Lower Austria, which are less developed regions in terms of industrial density, for instance. In general, this visual evidence suggests a link between both inequality and average earnings.

In essence, the analysis of LISA shows distinct hotspots of high inequality or high average wages in urban areas whereas cold spots can be mainly found in rural regions.

ECONOMETRIC ANALYSIS OF REGIONAL INEQUALITY DETERMINANTS

The individual wage tax data permit the estimation of specifications using the 2009–11 averages of four inequality measures (Gini index, 90/10, 90/median and median/10 point ratios) as endogenous variables. The explanatory variables comprise the 2009 levels of the census variables described above and are listed in Table A1 in Appendix A. Estimating such a specification through standard ordinary least squares (OLS) may not be appropriate if the spatial structure of the model causes correlation in the error term. However, alternative estimation strategies allow the incorporation of spatial autocorrelation to some extent.

An appropriate estimation method may focus on two competing model types: the spatial lag model and the spatial error model. While the former implies a direct ‘lag’ of the neighbouring observations of the endogenous variable, the error model assumes spatial dependence in the disturbances.

Spatially lagged models incorporate spatial structure through an endogenous lag in the specification, and can be written as:

$$y_i = \alpha + \rho W y_i + X\beta + \epsilon_i \quad (2)$$

where $\epsilon\, N(0, \sigma^2)$; W is an $N \times N$ spatial weights matrix; and X is a set of explanatory variables. This specification directly captures neighbourhood spillover effects so that the spatially weighted inequality of neighbouring municipalities is assumed to be an explanatory factor for local inequality. Estimation of this model needs to be based on, for example, maximum likelihood or generalized method of moments (GMM) methods, since the endogenous specification causes OLS estimates to be potentially biased and inconsistent.

In case spatial dependence does not directly affect the endogenous variable but is present through unobserved factors, a spatial error model is typically estimated. This approach assumes that the error term follows a spatial structure:

$$y_i = \alpha + X\beta + \nu_i \quad \nu_i = \lambda W \nu_i + \epsilon_i \quad (3)$$

so that unobserved spatial factors are accounted for in the error term. Since the spatial structure only targets the error term, OLS estimates would be unbiased but still inefficient.

The choice of the most appropriate spatial specification is often based on Lagrange multiplier (LM) tests, which check for error dependence and a missing spatial lag respectively (Anselin, Bera, Florax, & Yoon, 1996). The estimation approach of both specifications in this paper closely follows LeSage and Pace (2009), where the estimation of both the error and lag model is separated into two steps: first, the spatial parameter is found by maximum likelihood optimization and then used for generalized least squares (GLS) estimation of the rest of the model.

Similarly to the descriptive analysis, the weights matrix is a non-negative matrix used to describe the strength of the spatial interaction for cross-sectional units. Since the weights depend on the properties of the data as well as on theoretical considerations, their specification needs to be addressed carefully. The main results will be consistently based on the first-order Queen contiguity weights, but have been made robust by considering multiple spatial weights specifications. Apart from Queen-style contiguity, where neighbours share a common border or corner, alternatives such as k-nearest-neighbour weights of different order did not change the quality of the results and are therefore not shown here.

For the econometric exercise, the average earnings and further controls mentioned in the third section are regressed on three-year averages of the Gini index. In a further step, the specification incorporates other inequality measures, namely the 90/10, 90/median and median/10 ratios, into the analysis. In a framework where it is assumed that within-municipality inequality is positively related to average earnings, this strategy allows it to be investigated which part of the income distribution drives the effect. This approach thus tests whether changes in inequality are related to changes in average income and, if so, to which *parts of the distribution*. If, for example, average income and inequality seem to be positively related, this would give a rough picture of the relationship, but it would leave the specific distributional effects aside. Suppose the relationship in this scenario is caused by the concentration of high incomes, then one would additionally expect a strong effect on ratios that include the 90th percentile point. On the other hand, one would expect no effect on the median/10 ratio. A similar argument can be made for the case where changes in the distribution would be associated with income losses at the bottom of the distribution.

Controlling for other covariates, it can be hypothesized that a high share of Austrian citizens in a municipality decrease inequality due to the income gap between natives and immigrants. Furthermore, a considerable proportion of marginal and part-time employment should increase inequality since these jobs are typically associated with lower wages. This effect should be visible in the inequality measures that capture the bottom of the distribution. The effect of the average education level is theoretically ambiguous since it may lead to a higher wage segregation between high and low education levels. However, rising educational attainments could reduce the income gap in regions where inequality is already high.

For all specifications, LM test statistics are presented in the OLS column of the results. In general, both standard tests to distinguish lag and error specifications are highly significant with a preference for the error specification in all models except for the 50/10 ratio (see the first columns in Tables 2 and 3). In cases where both tests are equally significant, robust versions of these LM tests (RLM) fortify the preference for the error model – again with the exception of the 50/10 ratio. Accordingly, both error and lag models are presented with a focus on the interpretation of the former. Yet, the two models imply different spatial transmission channels for inequality. For the 50/10 ratio, the LM tests suggest a direct spillover effect of inequality between neighbouring municipalities through a spatial lag. Thus, for this variable, the detachment of poorer income groups from the middle class can be explained through spatial structure. This may be due to agglomeration effects of nearby large cities or the limited mobility of low-income groups, which can only migrate into municipalities close by and, accordingly, cause inequality to increase. Alternatively, the error specification, relevant for the other measures, implies that inequality in a certain region is affected by underlying spatial structures that are captured in the error term. Such unobserved effects in the present model can be driven by a number of factors like segregation in the housing market, neighbourhood preferences or productivity spillovers.

The first three columns in Table 2 report results for the Gini coefficient as a dependent variable using OLS, the spatial error and the spatial lag approach. These results are based on the municipality dataset and use first-order Queen-style contiguity weights, consistent with the descriptive analysis. Both the λ and ρ parameters capture a spatial effect in the error and lag specification, respectively. Their signs are positive and diminishing as expected, pointing to

Table 2. Regression results for Gini and 90/10 ratio, 2009–11.

	Gini			90/10		
	OLS	**Spatial error**	**Spatial lag**	**OLS**	**Spatial error**	**Spatial lag**
Constant	−0.97***	−1.12***	−0.94***	−10.92***	−15.59***	−11.81***
	(0.055)	(0.059)	(0.055)	(1.774)	(1.879)	(1.683)
Average Income (ln)	0.13***	0.15***	0.12***	2.04***	2.39***	1.83***
	(0.005)	(0.006)	(0.005)	(0.168)	(0.182)	(0.163)
Share Female	−0.09***	−0.06**	−0.08***	−5.40***	−3.23***	−4.25***
	(0.021)	(0.021)	(0.020)	(0.665)	(0.652)	(0.630)
Secondary Education	−0.01	−0.03**	−0.02	−0.38	−0.53	−0.42
	(0.010)	(0.012)	(0.010)	(0.324)	(0.374)	(0.307)
Tertiary Education	0.08***	0.04*	0.06***	3.69***	2.90***	2.75***
	(0.015)	(0.016)	(0.015)	(0.491)	(0.521)	(0.467)
Secondary Sector	−0.05***	−0.06***	−0.04***	−2.74***	−3.14***	−2.48***
	(0.008)	(0.009)	(0.008)	(0.260)	(0.283)	(0.249)
Tertiary Sector	−0.03***	−0.04***	−0.03***	−2.37***	−2.67***	−2.02***
	(0.007)	(0.008)	(0.007)	(0.236)	(0.259)	(0.227)
Population Density	0.00	−0.01	−0.00	0.13	−0.47	−0.33
	(0.012)	(0.014)	(0.011)	(0.376)	(0.449)	(0.356)
Austrian Citizen	−0.08***	−0.08***	−0.06***	−2.06***	−1.45***	−1.32***
	(0.012)	(0.013)	(0.011)	(0.373)	(0.408)	(0.356)
City Commuters	−0.02***	−0.02***	−0.02***	−0.77***	−0.74***	−0.70***
	(0.004)	(0.005)	(0.004)	(0.115)	(0.158)	(0.110)
Marginal Employment	0.24***	0.20***	0.20***	12.65***	11.24***	9.98***
	(0.032)	(0.033)	(0.031)	(1.023)	(1.052)	(0.984)
Part-time	0.22***	0.22***	0.21***	5.55***	5.63***	4.95***
	(0.012)	(0.012)	(0.012)	(0.379)	(0.389)	(0.364)
λ		0.42***			0.45***	
		(0.027)			(0.026)	
ρ			0.25***			0.35***
			(0.024)			(0.024)
LM error	225.78			289.86		
	(0.00)			(0.00)		
LM lag	118.36			240.75		
	(0.00)			(0.00)		
Robust LM error	109			52.74		
	(0.00)			(0.00)		
Robust LM lag	1.58			3.64		
	(0.21)			(0.06)		
Observations	2379	2379	2379	2379	2379	2379

Notes: LM, Lagrange multiplier; OLS, ordinary least squares.
***Significant at 0.1%; **significant at 1%; *significant at 5%.

the assumed neighbourhood effects. These significant effects are therefore another indication that the estimation of this regional inequality model should control for spatial spillover effects to avoid biased results. The following interpretation of the results will therefore focus on the spatial error model.

With regard to the hypotheses, a high share of natives is correlated with reduced inequality within a municipality, which is most likely an income effect of social stratification. Both indicators for atypical employment (part-time work and marginal employment) exhibit strong correlation with the inequality measures. The two covariates show a large and significant relationship with the inequality measures that are more sensitive at the bottom tail of the distribution. However, both working conditions are increasingly present in the Austrian labour market and therefore even affect the Gini, which is more sensitive to

Table 3. Regression results for 90/50 and 50/10 ratio, 2009–11.

	90/50			50/10		
	OLS	**Spatial error**	**Spatial lag**	**OLS**	**Spatial error**	**Spatial lag**
Constant	−3.18***	−3.72***	−3.06***	4.43***	3.71***	2.59**
	(0.352)	(0.376)	(0.343)	(0.964)	(1.029)	(0.924)
Average Income (ln)	0.53***	0.60***	0.46***	0.06	0.05	0.09
	(0.033)	(0.036)	(0.034)	(0.092)	(0.099)	(0.087)
Share Female	−0.09	−0.01	−0.06	−3.06***	−2.01***	−2.40***
	(0.132)	(0.132)	(0.128)	(0.361)	(0.362)	(0.344)
Secondary Education	−0.03	−0.11	−0.08	0.03	0.06	0.06
	(0.064)	(0.074)	(0.062)	(0.176)	(0.202)	(0.168)
Tertiary Education	0.90***	0.69***	0.75***	0.72**	0.69*	0.51*
	(0.098)	(0.104)	(0.095)	(0.267)	(0.285)	(0.255)
Secondary Sector	−0.18***	−0.28***	−0.17***	−1.27***	−1.33***	−1.14***
	(0.052)	(0.056)	(0.050)	(0.141)	(0.154)	(0.135)
Tertiary Sector	−0.06	−0.13*	−0.06	−1.16***	−1.19***	−0.96***
	(0.047)	(0.052)	(0.045)	(0.128)	(0.141)	(0.124)
Population Density	−0.20**	−0.24**	−0.24***	0.09	0.01	0.00
	(0.075)	(0.088)	(0.072)	(0.204)	(0.240)	(0.194)
Austrian Citizen	−0.50***	−0.57***	−0.40***	−0.63**	−0.22	−0.40*
	(0.074)	(0.081)	(0.073)	(0.203)	(0.222)	(0.193)
City Commuters	0.05*	0.03	−0.01	−0.42***	−0.38***	−0.27***
	(0.023)	(0.030)	(0.023)	(0.063)	(0.082)	(0.061)
Marginal Employment	0.28	0.39	0.21	5.96***	4.93***	4.58***
	(0.203)	(0.211)	(0.197)	(0.556)	(0.579)	(0.535)
Part-time	0.65***	0.70***	0.62***	2.11***	2.10***	1.86***
	(0.075)	(0.078)	(0.073)	(0.206)	(0.214)	(0.198)
λ		0.39***			0.37***	
		(0.028)			(0.028)	
ρ			0.28***			0.35***
			(0.025)			(0.026)
LM error	198.39			165.95		
	(0.00)			(0.00)		
LM lag	137.07			201.03		
	(0.00)			(0.00)		
Robust LM error	61.32			0.57		
	(0.00)			(0.45)		
Robust LM lag	0			35.64		
	(0.99)			(0.00)		
Observations	2379	2379	2379	2379	2379	2379

Notes: LM, Lagrange multiplier; OLS, ordinary least squares.
***Significant at 0.1%; **significant at 1%; *significant at 5%.

changes in the middle of the distribution. In fact, in some municipalities the share of part-time employment makes up one-third of all employees.

Secondary education is consistently high for most Austrian municipalities and does not exhibit drastic correlations with inequality, which can partly explain why the coefficient is low and significant only in the Gini specification. This differs notably for tertiary education, since this variable is more volatile from a regional perspective. Tertiary education positively and consistently correlates with inequality for all evaluated inequality measures. Furthermore, commuters are a large and very heterogeneous group of the working population in rural areas. The results suggest that a large share of commuters in a municipality appears to be connected to lower inequality. This could theoretically be linked to less developed or suburban regions where a large share of employees are forced to commute to nearby cities.

Most importantly the relation between average earnings and observed inequality measures has to be stressed. The data support the view that the two factors are positively correlated, as can be seen in the regression on the overall inequality, measured via the Gini index. This setup in itself, however, does not reveal the full picture. In fact, there appear to be differences between changes in inequality that are generated at the top versus the bottom half of the distribution. If the wages of all residents within a municipality would rise exactly by the same percentage, rising average wages would be observed, but common inequality measures like the Gini index or percentile ratios should not be affected. However, rising inequality could be traced back to two major reasons. First, there may be a widening gap between low-income earners and the rest of the population. In this case, many individuals witness rising income levels, while a subgroup does not, which would consequently result in rising inequality while average earnings also increase. Another explanation could be that average wage levels are driven by exorbitant income gains for the upper tail of the distribution, which would be reflected by the mean but not the median. In such a world, most of the population would receive below-average incomes vis-à-vis a small lifted-off elite.

To test for these effects, the specification is adapted to include the other three income distribution measures introduced earlier as dependent variables. The results for the 90/10 ratio are reported in columns 4–6 of Table 2. The regressions results highlight that the changes in inequality seem to be related to the tails of the distribution. A further extension is made in Table 3, where results for the inequality measures that include the median are presented. The 90/50 ratio indicates that the inequality of the top to the median is larger for higher mean wage levels. As a counterfactual, the analysis regarding the 50/10 measure – which does not capture changes in the top – remains insignificant for average earnings. This additionally strengthens the hypothesis that inequality within municipalities is mainly driven by top incomes.

The overall picture suggests that there exist spatial spillover effects in the small-scale inequality data. These effects have to be addressed in the estimation procedure. Therefore, spatial econometric techniques are needed to control for possible biases in an OLS specification. The signs of the OLS estimates do not differ in the spatial error and spatial lag models, whereas the levels of the coefficients vary. This analysis also highlights the differences in the relationship between earnings, inequality and additional socio-economic covariates by using alternative measures of inequality. The data reveal a positive nexus between average earnings and inequality largely due to a lift-off of high incomes – even when controlling for neighbourhood effects.

The present findings entail important policy implications. The development of rising spatial inequality may cause externalities in the housing market to the disfavour of the local population. There is evidence of feedback effects since richer families entail positive neighbourhood externalities that drive housing prices, and vice versa (Watson, 2009). At worst, this leads to segregation and social separation between income groups. A further consequence is that spatial segregation may erode the social basis for redistribution policies, illustrating the path-dependent nature of welfare regimes (Bailey et al., 2013). The related question of the nexus between regional inequality and housing prices is still an open task for Austria. Especially in suburbs, the influx of high-income commuters and displacement processes due to house price surges may endanger the continuity of established municipal structures like educational institutions, public infrastructure, volunteer work and vivid private associations that contribute to high living standards. Increased mobility and the ease of communication have undoubtedly created more complex spatial patterns, but the neighbourhood context and small-scale social interactions are still important reference points for economic analyses.

CONCLUSIONS

Based on the large body of literature dealing with the relationship between average income and inequality, this paper provides a new empirical perspective with novel register-based statistics for Austria. Although the general idea is similar to the controversial Kuznets hypothesis, the approach taken in this paper follows a spatially disaggregated analysis in order to investigate the non-linear connection between inequality and income in a small-scale framework. The main focus therefore lies on neighbourhood effects rather than on inter-sectoral shifts due to economic development.

This study uses individual wage tax data to investigate geographically disaggregated wage inequality. A descriptive analysis indicates strong spatial patterns for the inequality measures for roughly 2380 Austrian municipalities, especially in cities and suburban areas. Given these findings, an econometric assessment of the relationship between inequality, average earnings and important socio-economic characteristics is at risk of being biased if it neglects spatial spillover effects. Therefore, the econometric approach applies spatial regressions to inequality measures, derived from the rich register-based dataset on a municipality level. By means of local spatial autocorrelation statistics, distinct patterns in urban and rural areas have been identified. The joint observation of wage inequality and average wages indicates a strong positive correlation between the two parameters.

The econometric exercise reveals small-scale relationships that have not yet been investigated for Austria. The inclusion of spatial effects provides additional insights into the dynamics of income inequality. The results suggest that regionally specific characteristics such as the magnitude of marginal employment, part-time jobs and tertiary education go along with rising inequality. Spatial patterns of inequality are particularly distinct in urban areas and suburbs since there are significant disparities between locals and highly qualified top earners moving to suburban regions.

From a policy perspective, it is argued here that spatial income inequality on a regionally disaggregated scale has important implications, especially concerning externalities in the housing market. The results suggest that high average incomes in municipalities are often associated with pronounced inequality at the top of the distribution. Given these findings, spatial segregation may be intensified if housing prices are driven by wealthy families and lower income groups are displaced. This development potentially entails social and economic consequences that are generally perceived as undesirable.

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