Spatial Implications of Minimum Wages

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Abstract:

This paper addresses possible consequences of a minimum wage in a spatial context. An empirical analysis utilizing German data shows that a significant spatial wage structure exists and that, as a consequence, the share of workers earning wages below a minimum wage will be particularly high in rural counties even if we control for educational and occupational differences. A theoretical analysis discusses the implications for the spatial structure of the economy and shows that while the wages in the countryside will be affected positively, wages will decline in the city, where employment and population rise. Workers in the city will further suffer from an increase in housing costs. This supports concerns that urban poverty might increase as a result of the introduction of a minimum wage.

Keywords: Minimum Wages; Urban Poverty; Spatial Wage Structure; Mobility; Economies of Agglomeration;

JEL Classification: J6; R12; J3

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1 Introduction

For the policy maker minimum wages are an attractive policy tool. Minimum wages are apparently targeted at the heart of the poverty problem, the motivation to fight poverty earns public respect, and the direct costs involved seem low. In fact, the evidence suggests that minimum wages do have an impact on the wage distribution raising the earnings of those that are at the bottom of the wage distribution. Opponents argue that minimum wages also have important adverse effects on employment. Thus, a controversial debate about the adverse consequences of minimum wages on employment consumes a lot of space in an empirical literature that employs sophisticated micro-level datasets and advanced econometric techniques to show that minimum wages have or have not adverse effects on employment (e.g. see Card and Krueger 1994, Card and Krueger 2000, Neumark and Wascher 2000, and Brown 1999).

In this paper we argue that it is generally overlooked that wage increases and adverse employment effects resulting from minimum wages are systematically different for different groups of workers. This is already indicated by the experience with minimum wages in Germany. While the minimum wage in the construction sector shows quite limited effects in the western part of the country it exerts rather strong adverse effects in the eastern part (*e.g.*, Moeller and Koenig, 2008a). Moreover, given the wage differential between East and West, Ragnitz and Thum (2007) show that a federal minimum wage would mainly be binding in the eastern part of the country.

It is important to note that these asymmetries are built in, however, by the same striking simplicity of the concept that so much appeals to the policy maker: the minimum wage simply disregards all sorts of wage structures that may exist, including not only wage differences associated with skills, occupation, experience, and sex, but also differences with regard to industry, firm-size, and region. While the ignorance of these differences seems to be a necessary consequence of a social policy that is committed to combat poverty, all of these differences play a role in the economic consequences of minimum wages and, hence, are important for the effectiveness of minimum wages in reducing poverty.

An important dimension of the wage structure in this regard is the spatial wage structure that shows up in higher wages in urban agglomerations as compared to rural areas. This paper argues that if there is a uniform minimum wage imposed on cities and rural towns alike, we can expect that the minimum wage is much more restrictive in the countryside but might be rather ineffective for people working in the cities. Hence, the wages of workers that live in the cities might not benefit much from minimum wages. In fact, using the German example, we present some empirical evidence below showing that the share of workers earning wages below a minimum wage would be much higher in rural as compared to urban areas. While this difference might be explained by the different composition of the work force, we provide further evidence that the regional differences in the incidence of minimum wages are mainly driven by a spatial wage structure that is associated with differences in density even if we control for differences in education and occupation.

Based on these empirical findings we explore the consequences of an introduction of a uniform minimum wage in a stylized theoretical model that derives a spatial wage distribution in a migration equilibrium setting with productivity differences and housing costs. The analysis shows that imposing uniform minimum wages exerts distortive effects on the spatial structure of the economy. More specifically, we find that employment and population will rise in the more densely populated regions implying that wages of the working population in the cities might even fall. Moreover, the city population would also suffer from an increase in housing costs. This asymmetric impact is important since there is a close association between poverty and urbanization.[3] Thus, our findings support concerns that urban poverty might increase as a result of the introduction of a uniform minimum wage.

The paper is organized as follows. The first part is concerned with spatial differences in the extent to which the minimum wage is binding. Section 2 provides some basic empirical evidence about these spatial differences in the incidence of minimum wages in Germany. Section 3 provides some further evidence about the spatial wage structure that gives rise to these systematic differences. The second part of the paper provides a theoretical analysis of the consequences of these spatial differences in the incidence of minimum wages. Section 4 first lays out a stylized theoretical model that shows how a spatial wage distribution emerges in the migration equilibrium setting with productivity differences and housing costs. Subsequently, minimum wages are introduced and we discuss the consequences. Section 5 provides our conclusions.

2 Spatial Differences in the Incidence of Minimum Wages

There is an ongoing political debate in Germany about the economy-wide introduction of minimum wages. In 1997 a minimum wage of DM 16 (€ 8.18) for West Germany (DM 15.14 (€ 7.74) for East Germany) has been introduced in the construction sector

[3] In the German case the poverty rate in the cities is almost twice as large as the poverty rate of rural counties: in 2004, the poverty rate in core cities has been 5.11% compared with a figure of rural counties of 2.89% (Source: German States' Statistical Offices).

(see König and Möller 2008b). Current political proposals for the uniform minimum wage by some of the unions and by the Social-Democratic Party point at levels of € 6.50 or even € 7.50. In the following, we investigate the spatial patterns of the incidence of an introduction of corresponding minimum wages for the case of Germany.

We make use of the regional sample of employees (*Beschäftigtenstichprobe*) of the Institute for Employment Research (IAB), which constitutes a two percent random sample of all German employees subject to social security contributions and provides figures on employment status, wages, and personal characteristics like age, education, and profession of the sampled individuals (for a detailed description of the data see Drews, 2008). Since the data refer to the place of work at the county level,[4] this dataset is well suited to provide evidence on the spatial structure of wages in Germany. For our purpose of illustrating possible spatial consequences of minimum wages we focus only on the latest year available, 2004. Furthermore, we include only full-time employed individuals aged between 16 and 62.[5]

Figure 1 illustrates the spatial differences in the minimum wage incidence, *i.e.* the average percentage of employees affected by a minimum wage at the level of counties and cities for West Germany and East Germany, respectively. Note that we include the top-coded observations when drawing percentiles from the wage distribution. As our data refer to daily wages but not to hourly wages and no information is provided about hours of work, we

[4]For reasons of privacy protection, some counties are aggregated into a region.

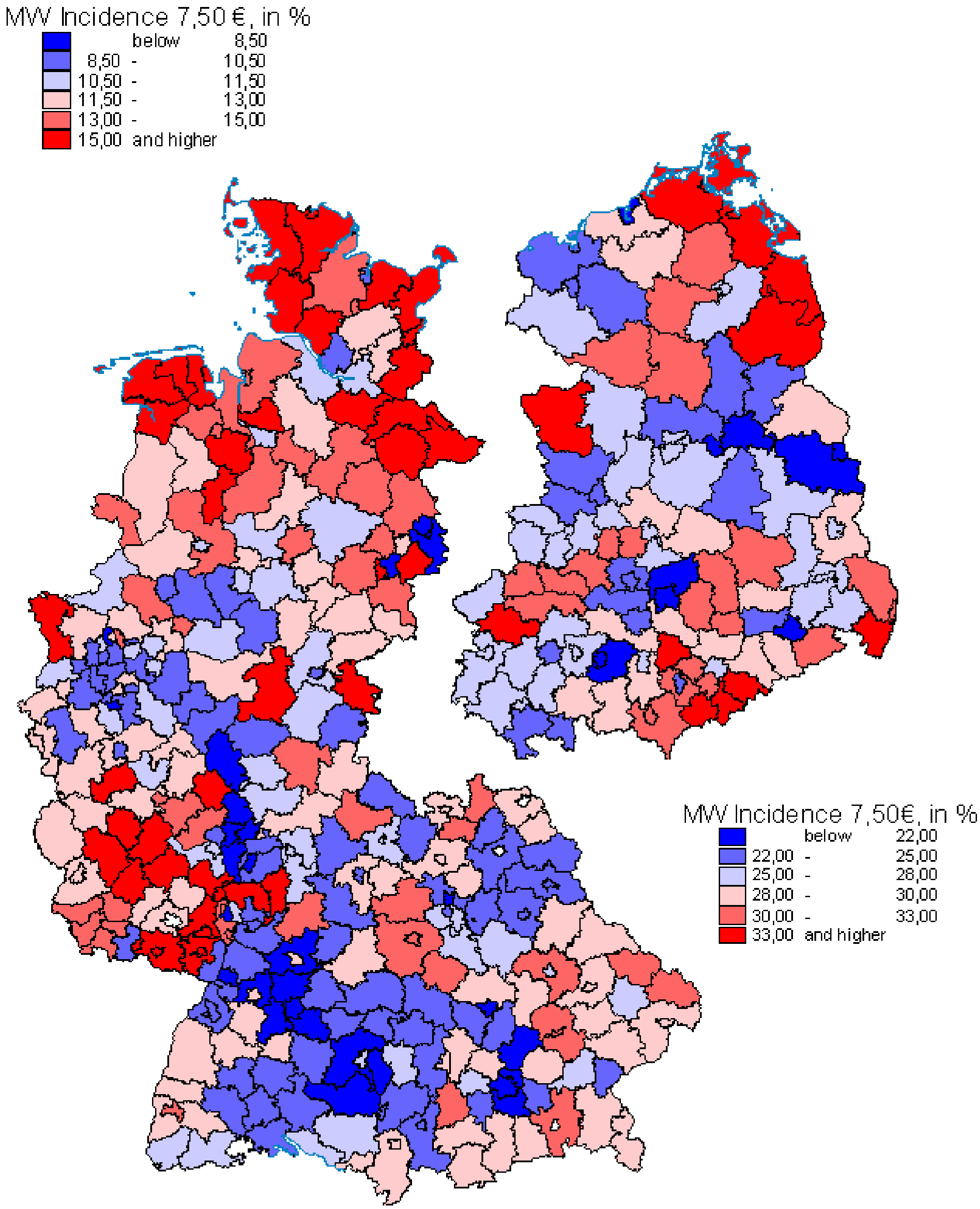
[5]Due to changes in individual employment status, employer, etc., for some of the sampled individuals several, possibly also simultaneous, spells are reported within one year, with the wage level possibly differing among different spells. In order not to overstate the incidence of a minimum wage in Germany, we include the highest respective wage reported for each individual worker in our analysis. To check for possible problems with simultaneous spells we conducted alternative analyses excluding all observations with a daily wage below € 40 to ensure that the results are not driven by such possibly defective observations. However, all results are unaffected qualitatively, and even quantitatively only minor changes were found.

rely on a percentile of the wage distribution for full employed workers rather than directly applying a minimum wage. More specifically we rely on the analysis of Ragnitz and Thum (2007) who found that a minimum wage of € 6.50 (7.50) corresponds to the 8.50 (11.30) percentile of the wage distribution in West Germany and to the 18.10 (26.00) percentile in East Germany. Ragnitz and Thum are using microdata from the survey on the salary and wage structure in the manufacturing and service sectors that have been issued by Federal Statistical Office in 2007. While this data refers to 2001 our analysis focuses on 2004. Since the wage distribution might have changed over time, more recent data might result in different percentiles. However, our focus is not so much on the actual share of workers with wages below a minimum wage of € 6.50 or €7.50. Rather we are interested in the spatial differences in the minimum wage incidence, regardless of the actual level.

A first inspection seems to confirm that some of the cities, like Hamburg, Berlin, Cologne, or Munich, are visibly less affected by a minimum wage of € 7.50 than their less densely populated neighbor regions. Further visualization of the spatial dimension of the minimum wage incidence is provided by Figure 2 which shows the average population density and the average percentage of employees affected by a minimum wage for five county types. The classification of county types is based on the typology given by the Federal Bureau of Regional Planning (*Bundesamt für Bauwesen und Raumordnung*).[6] Clearly, the share of employees that earn less than the minimum wage is higher, the less densely populated the respective county is. The highest share is found for rural counties where more than 20 %

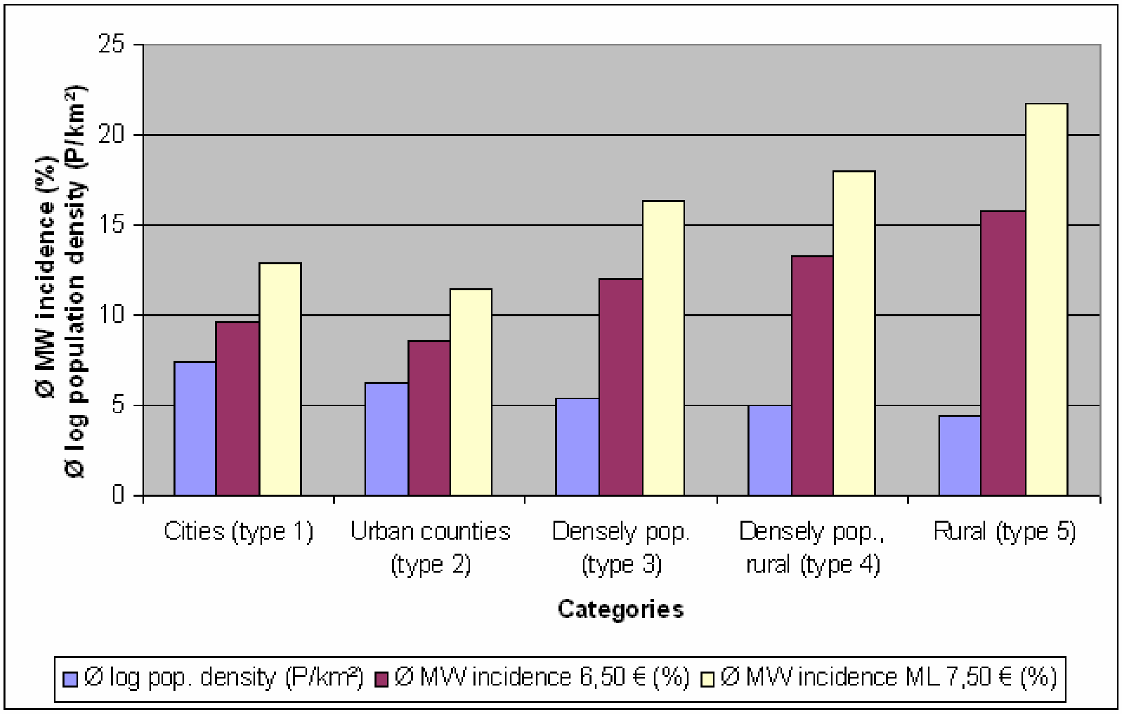
[6]We modify the existing classification such that counties are classified according to their own characteristics, ignoring the dimension of the general level of agglomeration of their surrounding area, that is contained in the original classification. More precisely, our county type 1 comprises cities with more than 100 000 inhabitants, county type 2 captures all counties with density above 300 inhabitants per sqkm. County type 3 refers to all counties with density above 150 but below 300 inhabitants per sqkm. County type 4 refers to all counties with density below 150 inhabitants per sqkm. County type 5 finally captures rural counties with density below 100 inhabitants per sqkm.

Figure 1: Incidence of Minimum Wages



Percentage of employment spells with a wage below € 7.50 in East and West Germany.

Figure 2: Incidence of Minimum Wages by County Type



Percentage of employment spells affected by a minimum wage of € 6.50 (€ 7.50) and log of density by county type.

of employees would be subject to a minimum wage of € 7.50.

The visual impression is further underpinned by means of regression analysis, where we estimate the relationship between the local minimum wage incidence and the degree of agglomeration. More precisely, the regressions take the form

$$MW_j = \beta_0 + \beta_1 Z_j + \varepsilon_j,$$

where MW_j denotes the percentage of employees affected by the respective minimum wage at location j, and Z_j is a vector of attributes reflecting the degree of agglomeration of region j.

Summary statistics of all variables employed in this study are reported in Table 1. Table 2

Table 1: Descriptive Statistics

Variable	Obs.	Mean	Std.Dev.	Min	Max
	Individual Data				
Daily wage	327130	83.1	33.7	1	167
Sex (is 1 for male)	353047	.641	.480	0	1
Age	353047	40.3	10.6	16	62
Edu.: No	353047	.131	.338	0	1
Edu.: Elementary school	353047	.687	.464	0	1
Edu.: High school	353047	.011	.103	0	1
Edu.: High school w. prof. training	353047	.053	.224	0	1
Edu.: College degree	353047	.045	.207	0	1
Edu.: University degree	353047	.074	.262	0	1
Prof. status: Simple Laborer	353047	.202	.402	0	1
Prof. status: Skilled	353047	.239	.427	0	1
Prof. status: Foreman	353047	.017	.128	0	1
Prof. status: Employee	353047	.543	.498	0	1
Prof. status: Home worker	353047	.000	.019	0	1
	Regional Data				
East	435	.257	.438	0	1
Population density	435	502.4	654.1	40.0	4010
MW incidence in %, € 6.50	435	12.1	6.62	4.08	56.1
MW incidence in %, € 7.50	435	16.4	8.61	5.08	61.3
Cty. type 1: Cities	435	.163	.370	0	1
Cty. type 2: Urban	435	.101	.302	0	1
Cty. type 3: Densely	435	.299	.458	0	1
Cty. type 4: Densely, rural	435	.340	.474	0	1
Cty. type 5: Rural	435	.097	.296	0	1

Sources: IAB Beschäftigtenstichprobe 2004, federal and regional statistical offices, and own calculations. All figures for 2004.

reports the results. The first set of regressions, reported in columns (1) and (2), confirms a highly significant negative relationship between the log of the population density and the percentage of workers affected by the minimum wage restriction. Doubling density would be associated with a decrease of the minimum wage incidence by about 1.68 (2.41) percentage points for the € 6.50 (€ 7.50) example. In our second set of regressions (columns (3) and (4)), we replace the density by dummy variables indicating the respective county type. The results clearly show that the minimum wage incidence is higher in less densely populated counties: the rural counties are having the highest coefficient indicating that the share of workers affected by a minimum wage is higher by about 6.19 (8.93) percentage points in rural counties as compared to cities.

Columns (5) and (6) provide results that include a dummy variable for counties in East Germany. It shows a strong positive effect confirming the results by Ragnitz and Thum (2007). Of course, since there is a clear difference in terms of population size and density between regions in East and West this dummy captures some part of the spatial variation in density. This explains why the inclusion of this dummy is associated with smaller density effects. However, the qualitative results prove robust. As compared to the cities the share of employees with wages below the minimum wage is up to 2.7 (3.9) percentage points higher in rural counties.

3 The Spatial Wage Structure in Germany

The descriptive evidence provided so far has not touched upon the issue of what is driving the wage differences that are behind the spatial differences in the incidence of minimum wages. Yet this is important for the economic consequences of minimum wages. If higher

Table 2: Spatial Determinants of the Minimum Wage Incidence

Variable	MW incidence				MW incidence				MW incidence			
	€ 6.50		€ 7.50		€ 6.50		€ 7.50		€ 6.50		€ 7.50	
	(1)		(2)		(3)		(4)		(5)		(6)	
Constant	21.4*	(1.55)	29.9*	(2.00)	9.59*	(.459)	12.8*	(.639)	7.82*	(.245)	10.3*	(.323)
*log*Density	-1.68*	(.260)	-2.41*	(.335)								
Cty. type 2: Urban					-1.09	(.658)	-1.34	(.976)	.205	(.355)	.539	(.498)
Cty. type 3: Densely					2.42*	(.812)	3.56*	(1.05)	2.26*	(.608)	3.32*	(.686)
Cty. type 4: Densely, rural					3.74*	(.714)	5.18*	(.941)	1.76*	(.472)	2.30*	(.550)
Cty. type 5: Rural					6.19*	(1.12)	8.93*	(1.56)	2.71*	(.445)	3.89*	(.603)
East									10.5*	(.428)	15.2*	(.512)
N	435		435		435		435		435		435	
R^2	.074		.091		.095		.111		.535		.658	

Dependent variable: share of employment spells with wages below the minimum wage in %. OLS estimation, heteroskedasticity robust standard errors in parentheses. Omitted category: *County type 1: Cities*. * denotes significance at the 5% level.

wages are the result of a spatial structure in the wages, such that wages in densely populated areas are systematically higher, the imposition of the minimum wage might distort the spatial wage structure with consequences for the spatial allocation of production. If, however, higher wages in the cities simply arise from differences in the composition of the labor force in terms of skill and occupation, the economic consequences might be rather different. Therefore, this section further explores the sources of the observed spatial differences in the wages.

As is discussed in the regional and urban economics literature, differences in productivity give rise to differences in the intensity of land use which is most strikingly reflected in population density. As the largest density is generally observed in urban agglomerations, the discussion about the spatial wage structure is centered around the so-called urban wage premium, *i.e.* the notion that wages tend to be higher in densely populated areas, and, in particular, in the cities. While there is much discussion on the determinants of the urban wage premium, its existence is confirmed by many empirical studies (*e.g.*, Glaeser and Mare, 2001, for Germany see Lehmer and Möller, 2007).

In order to obtain quantitative estimates of the spatial wage structure in Germany, we run regressions relating the log of individual daily earnings to different measures of agglomeration, thereby controlling for individual characteristics. These Mincer-type wage regressions take the form

$$\ln w_{k,j} = \alpha_0 + \alpha_1 X_{k,j} + \alpha_2 Z_j + \varepsilon_{k,j},$$

where $w_{k,j}$ denotes the wage of individual k in location j, $X_{k,j}$ is a vector of personal characteristics of this individual, and Z_j is a vector of regional attributes reflecting the degree of agglomeration of region j.[7]

[7] Note that this wage regression is concerned with the cross-section. As the dataset used is a panel

While the dataset is quite rich, a problem with the data is that the wage figures are top coded at the upper social security threshold. We employ two different estimation strategies to deal with this problem. First, we estimate a tobit model. As is well known, the basic tobit model relies on rather strong assumptions and suffers from inconsistency under conditions of heteroskedasticity. However, with increasing age the individual wages might well display a larger variance, since the job experience and the employment record will be more different within groups of older workers. Similarly, workers with higher levels of education might display a larger variance in wages (*e.g.*, Martinsa and Pereira, 2004). We, therefore, employ a heteroskedastic tobit-model where we associate differences in the conditional variance of wages with the age and education level of the individuals.

In a second approach we focus on the median of wages which is less affected by the top-coding of the wages. We adopt a two-step procedure to censored quantile regressions suggested by Chamberlain (1994) and applied to regional data by Buettner and Fitzenberger (2001). In a first step, we group the data by cells of workers with the same education and the same age, and where employment takes place in the same district. For each cell the median wage is determined. In a second step, all uncensored cell medians are regressed on cell characteristics such as the population density.

Table 3 reports the results of different specifications using the Tobit approach to the mean wage.[8] In column (1), we report a very basic regression of the log of daily earnings, controlling only for gender and age structure. The inclusion of the log of population density in column (2) yields an increase in the goodness of fit and the significant coefficient

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dataset that provides information also about earlier years, one might control for all individual differences using panel data techniques. Since we are concerned with a cross-sectional issue, this would require to focus on workers that have moved between counties of different types. An analysis along these lines is, however, beyond the scope of the current paper.

[8] For reasons of comparison, we report the equivalent OLS estimates in Table A.1 in the appendix.

Table 3: Urban Wage Premium: Tobit Regression Results

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sex	.283*(.006)	.293*(.005)	.289*(.005)	.483*(.007)	.478*(.005)	.475*(.006)	.450*(.006)
Age	.073*(.002)	.071*(.002)	.071*(.002)	.061*(.002)	.060*(.002)	.060*(.002)	.061*(.002)
Age squared	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)
Edu.: Elementary school				.118*(.009)	.131*(.010)	.133*(.010)	.164*(.007)
Edu.: High school				.143*(.033)	.122*(.032)	.133*(.032)	.149*(.031)
Edu.: High school w. prof. training				.414*(.021)	.402*(.021)	.409*(.020)	.435*(.020)
Edu.: College degree				.851*(.035)	.850*(.034)	.855*(.034)	.892*(.031)
Edu.: University degree				1.22*(.056)	1.20*(.053)	1.21*(.053)	1.25*(.052)
Prof. status: Skilled				.030*(.008)	.036*(.007)	.038*(.007)	.070*(.005)
Prof. status: Foreman				.429*(.013)	.426*(.013)	.427*(.013)	.421*(.013)
Prof. status: Employee				.464*(.013)	.444*(.010)	.449*(.011)	.439*(.011)
Prof. status: Home worker				-.474*(.082)	-.456*(.080)	-.467*(.080)	-.483*(.082)
*log*Density		.087*(.014)			.060*(.012)		
Cty. type 2: Urban			-.007 (.036)			.045 (.031)	.015 (.029)
Cty. type 3: Densely			-.148*(.033)			-.079*(.028)	-.070* (.024)
Cty. type 4: Densely, rural			-.229*(.033)			-.158*(.029)	-.092* (.022)
Cty. type 5: Rural			-.312*(.048)			-.232*(.047)	-.100* (.027)
East							-.334* (.011)
N	353047	353047	353047	353047	353047	353047	353047
Log pseudolikelihood	-388120.33	-383360.89	-383802.88	-353845.33	-351272.78	-350995.53	-344669.53

Dependent variable: *log* of daily wage. ML estimation, 327130 obs. uncensored, and 25917 obs. right-censored. Standard errors in parentheses are heteroskedasticity robust and clustered at the regional level. Omitted categories are: *Edu.: No*, *Prof. status: Simple Laborer*, and *County type 1: Cities*. * denotes significance at the 5% level.

confirms a positive relationship between wage level and agglomeration. To be precise, we find that doubling population density is associated with a 8.7 percentage increase in wages. In column (3) we replace the density variable by several dummy variables capturing the county type of the individual's working place. The results confirm a spatial structure and show that the wage in rural counties is lower by about 31.2 percent.

In columns (4) to (7) we include controls for education and occupation. All coefficients on individual attributes are statistically highly significant and show the expected signs, except for the indicator of high-school graduation that does not seem to provide much information once it is controlled for high-school graduates with further professional education. Column (5) includes the log of population density. With all other coefficients remaining remarkably constant, the density again shows a significant positive association with the wage level. Note, however, that the coefficient obtained after controlling for skill and occupation is slightly smaller, indicating that a part of the density effect is captured by the composition of the labor force. In column (6) we again replace the density by dummy variables for the county type. While the urban counties are statistically not distinguishable from the omitted category (cities), the other three indicators of county categories are each significantly and inversely associated with the wage level. Note that when ignoring cities, a category that is based on the administrative status and the population size, the size of coefficients decreases with the density, confirming a monotonous relationship between density and the level of earnings. For rural counties we find that wages tend to be lower by 23.2 percent.

As reported in column (7), when accounting for structural differences between eastern and western Germany by means of a dummy variable we get similar results. While the size of the effects are smaller, the qualitative results prove robust: for rural counties we still find that wages are lower on average by about 10 percent.

Table 4: Urban Wage Premium: Median Regression Results

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sex	.210*(.009)	.211*(.009)	.210*(.009)	.326*(.013)	.315*(.013)	.317*(.013)	.294* (.012)
Age	.285*(.014)	.279*(.014)	.280*(.014)	.132*(.015)	.125*(.015)	.125*(.015)	.084* (.014)
Age squared	-.004*(.000)	-.003*(.000)	-.003*(.000)	-.002*(.000)	-.001*(.000)	-.001*(.000)	-.001* (.000)
Edu.: Elementary school				.112*(.043)	.124*(.042)	.119*(.042)	.038 (.039)
Edu.: High school				.023 (.047)	.047 (.046)	.041 (.046)	.034 (.043)
Edu.: High school w. prof. training				.167*(.052)	.207*(.051)	.197*(.051)	.189* (.048)
Edu.: College degree				.311*(.051)	.353*(.050)	.340*(.050)	.325* (.047)
Edu.: University degree				.415*(.051)	.462*(.050)	.449*(.050)	.445* (.048)
Prof. status: Skilled				-.227*(.077)	-.191 (.075)	-.196 (.076)	.098 (.068)
Prof. status: Foreman				.036 (.175)	.076 (.171)	.088 (.175)	.245 (.144)
Prof. status: Employee				.330*(.071)	.285*(.070)	.300*(.070)	.378* (.065)
Prof. status: Home worker				-.126 (.561)	-.247 (.613)	-.199 (.604)	-.070 (.280)
*log*Density		.065*(.006)			.065*(.007)		
Cty. type 2: Urban			-.002 (.021)			.021 (.022)	-.015 (.016)
Cty. type 3: Densely			-.080*(.019)			-.067*(.021)	-.067* (.013)
Cty. type 4: Densely, rural			-.136*(.019)			-.129*(.021)	-.082* (.013)
Cty. type 5: Rural			-.220*(.039)			-.205*(.040)	-.118* (.023)
East							-.308* (.013)
N	3863	3863	3863	3863	3863	3863	3863
R^2	.286	.345	.310	.596	.623	.619	.694

Dependent variable: *log* of daily wage. OLS estimation, standard errors in parentheses are heteroskedasticity robust and clustered at the regional level. Omitted categories are: *Edu.: No*, *Prof. status: Simple Laborer*, and *County type 1: Cities*. * denotes significance at the 5% level.

Table 4 provides results for the median wage among the cells of workers with the same education, age, and district. We obtain a number of 3863 uncensored cells with an average cell size of about 88 observations. At least when considering specifications that include controls for skills and occupation (column (4) to (7)) the results with regard to density and county type are remarkably similar to the above Tobit results. The wage differential between cities and rural counties is estimated to be on average 20.5 or 11.8 percent depending on whether a dummy for the eastern part of Germany is included.

Having shown that not only the absolute wage distribution shows marked spatial differences but also the conditional wage distribution obtained after controlling for skills and occupation, let us come back to the question of the spatial incidence of the minimum wage. The significance of the density variable or the county types in a wage regression that includes controls for education and occupation, indicates that there is a spatial structure that is not simply driven by composition effects: the same worker tends to earn more if employed in a more urbanized region. As a consequence, the probability to earn a wage rate that is below the minimum wage will be significantly higher in rural regions. To get an impression of the empirical magnitudes involved, we can use our estimates to obtain a statistical analogue to the minimum wage incidence derived in Section 2 above.

Based on the results presented in column (6) of Table 3, assuming a log-normal wage distribution for a simple laborer without completed schooling and with mean age,[9] we obtain an estimate of the probability to earn a wage below a minimum wage of € 6.50 of 34 %. According to column (6), the wage differential between a city and a rural county is about -.232 percent. Given this substantial rural-urban wage gap, in a rural county the probability for the same type of worker to earn a wage below the minimum wage of € 6.50

[9]The associated standard deviation of the log of the wages is estimated with $\sigma = .537$.

is estimated to be no less than 51%. Accordingly, the probability to earn a wage below the minimum wage is larger in a rural county by 17 percentage points for this unskilled type of worker. However, column (7) which includes a dummy for East Germany obtains a smaller urban-rural wage gap of about -.100. Doing the same calculation for this specification, [10] we find that the probability to earn a wage below the minimum wage is larger in a rural county by 7.2 percentage points.

While controlling for composition effects, these estimates point at even stronger differences in the minimum wage incidence between urban and rural counties. Thus, the inverse relationship between urbanization and minimum wage incidence is confirmed.

4 Minimum Wages in Spatial Equilibrium

In order to discuss the consequences of minimum wages in the presence of a spatial wage structure, we start with outlining a theoretical model of the spatial equilibrium without minimum wages. We, then, introduce a minimum wage into this setting, and, finally, discuss the associated welfare implications.

4.1 A Basic Model of the Spatial Equilibrium

Consider an economy with M regions, $i = 1, 2, ..., N$. Region i hosts n_i identical households. Each of these households supplies one unit of (homogenous) labor and, thus, the total labor supply in region i is equal to the population size n_i. All labor is employed by

[10] The associated standard deviation of the log of the wages is estimated with $\sigma = .528$.

local firms according to a production function $F_i(n_i)$, with $\frac{\partial F_i}{\partial n_i} > 0$ and $\frac{\partial^2 F_i}{\partial n_i^2} < 0$. Note that the production function is indexed with i in order to allow for possible differences in productivity. Denoting the wage rate in region i with w_i optimal employment obeys

$$F_{in}(n_i) = w_i.$$

To derive labor supply in spatial equilibrium, let us assume that the representative worker household in region i enjoys utility from the consumption of a private good in the amount of x_i and of housing space in the amount of q_i:

$$u_i = \tilde{u}(x_i, q_i).$$

To keep the analysis simple let us assume that each household consumes a fixed amount of housing $q_i = 1$ and we can simplify the utility function

$$u_i = \tilde{u}(x_i, 1) = u(x_i).$$

Each region hosts one city that serves as center of production and is the place of residence for the mobile population. Let us employ a standard monocentric city model (see Fujita, 1989). Production takes place in the central business district, which is surrounded by the residential district. Consider a household located at the urban fringe which is in distance b to the city center. This household has commuting costs of kb and direct housing costs corresponding to the opportunity cost of land ρ. Since differences in the direct cost of housing within the city would only capture differences in the commuting costs, we know that the total cost of housing, *i.e.* direct housing costs plus commuting costs, is equal within the city. However, the total cost of housing might vary across cities if the population size differs. To see this, note that we have the following equilibrium condition for the housing market:

$$n_i = \int_0^{b_i} T_i(\delta)\, d\delta,$$

where $T_i(\delta)$ captures the available housing space at distance δ from the city center. Hence, the distance from the urban fringe to the city center is an increasing function of the total population size $b_i = b(n_i)$ with some positive elasticity.[11] As a consequence, the total cost of housing in the city is

$$h_i \equiv h(n_i) = \rho + kb(n_i),$$

which is increasing in population size.

Note that a larger population size implies a larger city, and, hence, the higher total housing costs reflect a larger location rent in the city center. As the urban area in the region increases we can also say that density is increasing with population size.[12]

Under conditions of household mobility, utility is equalized across locations such that the level of consumption is the same

$$u(x_i) = u(x).$$

For simplicity, we abstract from other sources of income and assume that mobile households only earn income from labor. Thus, we assume that households derive income from supplying one unit of labor to local production at a competitively determined wage. Since, however, housing costs may differ between cities, we can derive a labor supply function indicating the number of people that are willing to work and live in the city at a specific

[11] A positive elasticity is obtained, for instance, in the simple case of a circular city with $T_i(\delta) = 2\pi\delta$. In this case the elasticity of b_i with respect to n_i is 0.5.

[12] Of course, a more elaborate model of the spatial structure would include investment in structures such that density even increases within the city.

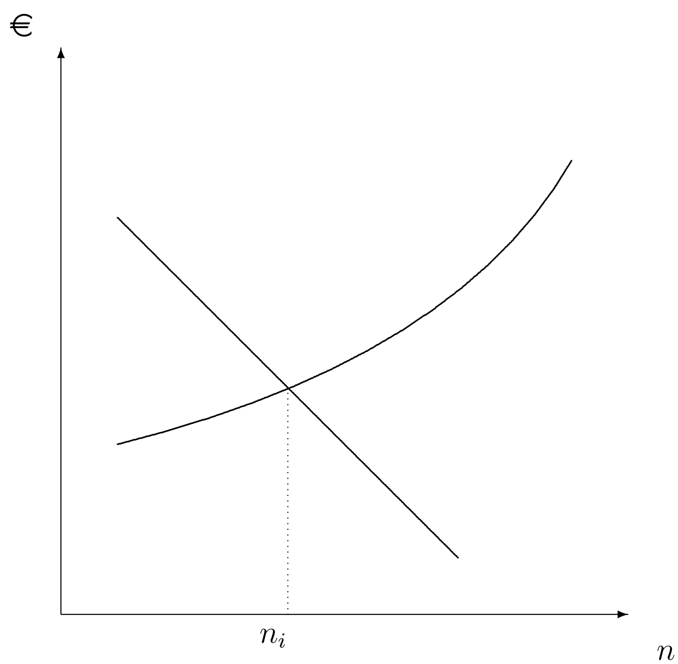
wage rate:

$$w_i = x + h(n_i)$$

Given the properties of the total housing cost function, note that the equilibrium wage rate is increasing in population size.

Labor market equilibrium in region i is graphically depicted in Figure 3. The labor supply

Figure 3: Labor Market Equilibrium in Region i



curve shows a positive slope that, as we have seen, results from the increase in the total housing costs. Note that the position of the labor supply curve depends on the level of consumption x_i. At higher levels of consumption and, thus, at higher levels of utility, the supply curve shifts upward. The labor demand curve, however, shows the usual negative slope. At the intersection point labor demand is consistent with the supply decision of the households and we obtain the equilibrium level of the corresponding wage rate and of employment which is equivalent to population in our model.

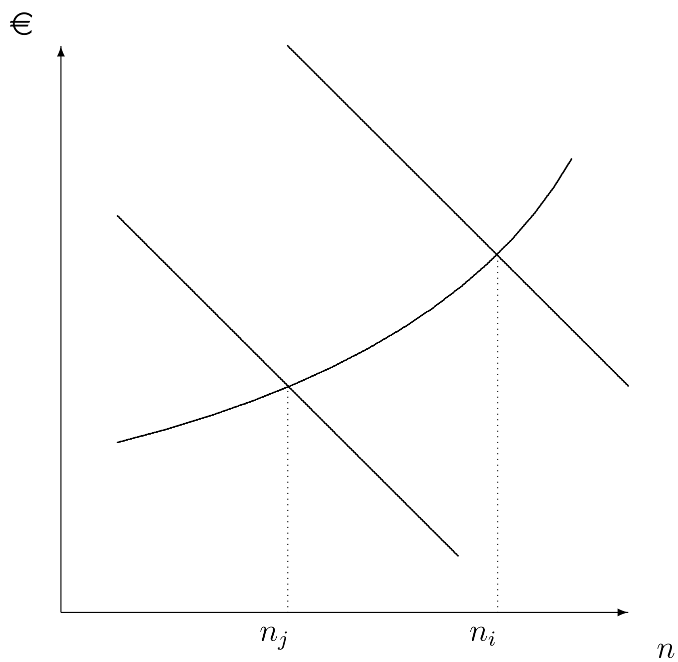
Suppose that total factor productivity is subject to region-specific productivity differences, and let us introduce a parameter γ_i that shifts productivity according to $F_i(n_i) = \gamma_i \tilde{F}(n_i)$. If $\gamma_i > \gamma_j$, region i has a higher productivity such that $F_{in} > F_{jn}$ at the same level of population. As a consequence, the population in i will be higher $(n_i > n_j)$. To see why, note that if population would be the same $(n_j = n_i)$ also housing costs would be equal. Hence, private consumption would have to be higher $x_i > x_j$. With more consumption x_i and the same housing costs, however, utility would be higher in i such that the migration equilibrium is disturbed. Hence, the population size in region i would have to be larger. The additional labor supply would result in a decline in the marginal productivity of labor and in higher total cost of housing until utility is equalized across regions. Since housing costs are increasing with population size, and since wages will compensate cost differences between regions, wages will differ in spatial equilibrium $w_i > w_j$.

Thus, we can state the following lemma:

Lemma 1 (City Size and Spatial Wage Structure)
In the migration equilibrium where utility is equal across regions, locations with higher productivity display a larger population size, a larger urban area, and higher wages.

Graphically, as displayed in Figure 4 an increase in productivity in region i relative to region j will result in a different labor demand curve that shows higher wages at the same level of employment. Since in the spatial equilibrium utility and, thus, consumption is equalized across regions, both regions face the same supply curve. As a consequence, the high productivity region will be larger in terms of population and display a higher wage rate than the other.

Figure 4: Regional Productivity Differences with Labor Mobility

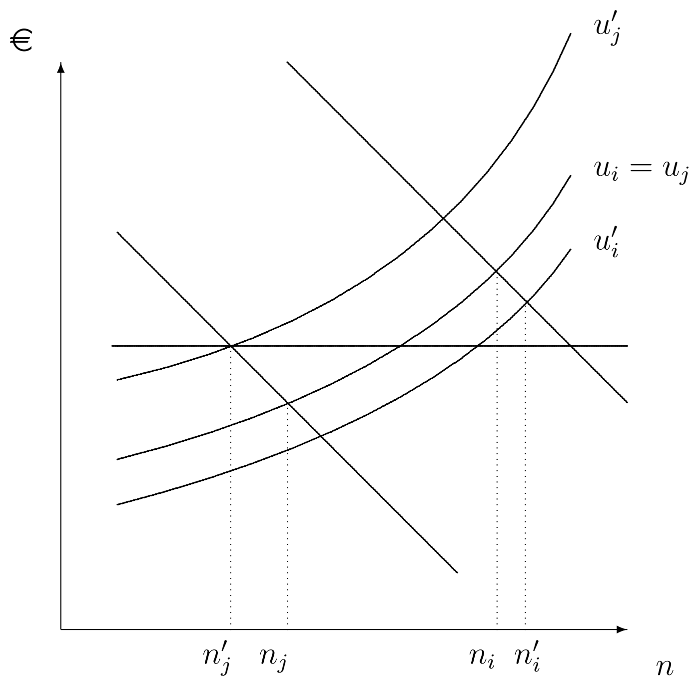


4.2 Introducing a Minimum Wage

Now let us consider an economy with several regions, which differ in productivity. Let us rank regions by size $n_1 > n_2 > .... > n_M$. Our analysis implies, so far, that the wage rate will differ in the sense that the region with the higher productivity displays a higher wage rate such that $w_1 > w_2 > .... > w_M$. Let us introduce a minimum wage $\overline{w}$ such that the wage rate of, say, region i is higher, whereas the wage rate in region $j = i+1$ is lower. To see how this affects the spatial distribution of activities, consider first the lower-productivity region where $\overline{w} > w_j$. We can see immediately, that for the marginal product of labor to rise, employment will have to decline. Without mobility we would obtain unemployment. With mobility, however, labor will move to more productive regions where the minimum wage is not binding and, hence, employment can be increased. As a consequence, both employment and population decline in the low productivity region.

The consequences of the introduction of a uniform minimum wage are illustrated in Figure 5. The initial equilibrium is characterized by levels of employment n_i and n_j and in both

Figure 5: Spatial Effects of the Minimum Wage



regions utility is at the same level.

With the introduction of the minimum wage, labor market equilibrium in region j requires a decline in employment to a level n'_j, and with higher wages and smaller housing costs there is an increase of utility in the low productivity region. The high productivity region experiences an increase in employment as well as a decline in wages as marginal productivity declines, and hence, utility decreases. However, migration cannot restore equilibrium since employment cannot be increased at the minimum wage in the low productivity region.

Also for the more general case with M regions we can establish the following proposition:

Proposition 1 (Agglomeration Effect of the Minimum Wage)
Imposing a minimum wage that is binding somewhere within the spatial wage distribution distorts the locational equilibrium such that the population of densely populated regions rises whereas the population of sparsely populated regions declines.

Proof: Given labor mobility the consumption level earned by workers in different regions is equalized. Taking account of the labor demand equation this implies

$$F_{in}(n_i) - h(n_i) = F_{jn}(n_j) - h(n_j).$$

Suppose that region j is less productive such that $n_j < n_i$. Imposing a minimum wage that is binding in region j but not in region i implies that

$$\overline{w} = F_{jn}\left(n_j'\right).$$

With this constraint the model is overdetermined and, hence, the population size of region j is no longer determined by the above spatial equilibrium. However, in all regions where the minimum wage is binding, labor productivity is forced to rise implying that labor demand declines. With the total population size given, employment and population size in the unconstrained regions will expand. ■

Further results can be obtained with regard to spatial price differences. First consider wages. Intuitively, the spatial wage distribution is compressed. To see this, recall that the minimum wage is more likely to bind in the low productivity regions that display lower wages. At the same time, however, the wage level in the more productive regions declines since employment is increased.

Proposition 2 (Spatial Wage Distribution Effect of the Minimum Wage) *Imposing a minimum wage that is binding somewhere within the spatial wage distribution tends to compress the spatial wage structure.*

Proof: We know from Proposition 1, that all regions where the minimum wage is not binding face an employment increase. All regions where the minimum wage is binding experience a decline in employment. Hence, the marginal productivity is increasing in all regions where the wage rate is below the minimum wage, whereas it declines in all regions above the minimum wage. As a consequence, wages in the latter group decline, whereas wages in the former group increase. ■

With regard to housing costs a different result is obtained. Due to the agglomeration effect, we have a larger demand for space in the large regions that are unconstrained and a reduction of the demand for space in the smaller, constrained regions. Let us state this as our third proposition.

Proposition 3 (Location Rent Effect of the Minimum Wage) *Imposing a minimum wage that is binding somewhere within the spatial wage distribution tends to raise total housing costs and location rent in the more densely populated regions and to reduce total housing costs and location rent in the less densely populated regions.*

Proof: We know from Proposition 1, that all regions where the minimum wage is not binding face an increase in population. All regions where the minimum wage is binding, experience a decline in population. Hence, the total housing costs are increasing in the first group but decreasing in the latter. ■

4.3 Welfare Implications

It is tempting to consider welfare implications. We have one group of workers that experience higher wages at lower housing costs. For this group utility rises. A second group of workers in the high productivity regions experience a utility decline since wages fall and housing costs rise. A third group of workers that leave region $j, ..., M$ and move to regions $1, ..., i$ also experience a decline in utility. In fact, since utility is equalized across regions in the initial equilibrium, and will still be equalized across regions $1, ..., i$ where wages are above the minimum wage, the decline in utility experienced by the second and third groups of workers will be the same. Can we say that the gain of the one group with an increase in utility outweigh the losses of the other two groups? In order to address this question it is useful to discuss the efficiency properties of the spatial equilibrium with and without minimum wages. A standard way to approach this issue is to invoke a central planner that aims at maximizing the utility of a representative worker household in jurisdiction i under the spatial equilibrium constraint that worker utility is equalized across jurisdictions.

$$
\begin{aligned}
\mathcal{L}^{cp} = u\left(x_i\right) + \sum_{j\neq i}^{M} \nu_j [u(x_j) - u(x_i)] \\
+\mu \sum_{j=1}^{M} \left[F_j - \left(x_j + h\left(n_j\right)\right) n_j\right] \\
+\varphi \left[N - \sum_{j=1}^{M} n_i\right].
\end{aligned}
$$

The first set of constraints require that worker utility is equalized across regions – they may be referred to as mobility constraints. The second set of constraints capture the budget constraints for the households requiring that the sum of a region's households' consumption and total housing costs is equal to the total income in this region. The last constraint simply states that the total population is fixed. The efficient spatial allocation of labor is obtained from the first order condition with regard to the population size.

$$\frac{\partial \mathcal{L}^{cp}}{\partial n_i} = \mu \left(F_{in} - x_i - h_i - h_{in} n_i \right) - \varphi = 0.$$

Taking account of the mobility constraints we derive the locational efficiency condition (Wildasin, 1986)

$$F_{in}\left(n_i\right) - h\left(n_i\right) - h_n\left(n_i\right) n_i = F_{jn}\left(n_j\right) - h\left(n_j\right) - h_n\left(n_j\right) n_j,$$

implying that a reallocation of labor cannot increase output net of housing costs.

Note that there is a discrepancy between the central planner's allocation and the above migration equilibrium even without the imposition of minimum wages. This is caused by the crowding effect that arises through the impact of population changes on the total housing costs. Intuitively, when moving from one region to the other the household ignores the crowding effect. Therefore, the *laissez faire* migration equilibrium turns out to be not efficient in our model. However, the imposition of the minimum wage does not improve this situation.

To see this, consider the crowding effect $h_n\left(n_i\right) n_i$ and note that it is positive and increasing in n_i. Hence, this term tends to be larger in the larger region. Compared with the basic spatial equilibrium, the marginal productivity in the larger region is too low - in the smaller region it is too high. Therefore, we know that the efficient allocation of labor and population would be such that employment and population are smaller in region i. Thus, denoting the efficient population size with a star we get

$$n_i > n_i^{\star} > n_j^{\star} > n_j.$$

However, with minimum wages, we know that we have an increase in agglomeration relative to the spatial equilibrium distribution, $\overline{n}_i > n_i$ and $\overline{n}_j < n_j$. Hence

$$\overline{n}_i > n_i > n_i^\star > n_j^\star > n_j > \overline{n}_j.$$

Thus, we can say that if there is an inefficient spatial equilibrium with excessive agglomeration, due to crowding effects, the imposition of minimum wages would give a further push towards excessive agglomeration.

Therefore, there is no possibility for a Pareto improvement, the group of workers that benefits from minimum wages cannot compensate the others.

5 Conclusions

In this paper we have discussed consequences of uniform minimum wages for the spatial structure of the economy. The starting point is the notion that a minimum wage is much more restrictive in the countryside but might be rather ineffective for people working in the cities.

An empirical analysis exploiting German data shows that a uniform minimum wage would affect the regional labor markets quite differently. In particular, we find that the share of workers that will be directly affected by the minimum wage is higher in rural counties as compared to cities and urban counties. While this supports concerns that the minimum wage is more effective in the rural as compared to urban areas, the economic consequences depend on the nature of the urban-rural wage differences. A further empirical analysis, however, shows that the wage differences are mainly associated with systematic spatial differences in the wages. Thus, the differences in the incidence of the minimum wage are driven by the spatial wage structure. According to our estimates, and based on some simplifying assumptions, for a simple laborer without completed schooling and with mean age the probability to earn a wage below the minimum wage is larger in a rural county by 17 percentage points as compared to a city or urban county.

To explore the consequences of the spatial differences in the incidence of minimum wages, we present a spatial equilibrium model of the labor market, where wage differences occur due to productivity differences and housing costs. Imposing uniform minimum wages in this setting exerts some distortive effects on the spatial structure of the economy. While the wages in the countryside will tend to rise, wages would decline in the city, where employment and population increase. Workers in cities will further suffer from an increase in housing costs. Thus, a federal minimum wage will tend to spur rural-urban migration and might raise rather than reduce urban poverty.

Having discussed the spatial implications of minimum wages in a rather straightforward model of the spatial equilibrium, let us briefly talk about possible limitations and extensions. A first issue is the possible existence of federal welfare programs. Such programmes would exert similar effects as minimum wages if they define a uniform reservation wage. Whether or not this is the case in Germany is not obvious, however. While the subsidies according to SGB II are, in fact, uniform, the large housing subsidy programme categorizes the cities and municipalities and assigns higher subsidies to households in urban agglomerations.

A second important issue is the role of wage bargaining. In Germany wage bargaining leads to sector-specific agreements defining wage floors that are uniform across several regions. This kind of agreements may exert similar effects on the spatial wage structure.

However, wage bargaining is much less restrictive as it does not apply to all firms and shows some limited regional differences (Buettner, 1999). Nevertheless, our analysis suggests that these agreements might have already contributed to some excess agglomeration effect in Germany.

Finally, we should note that the spatial wage structure is only one example of wage structures that are disregarded by a uniform minimum wage. With other types of systematic wage differences such as the firm-size wage distribution, similar problems will arise. Since a uniform minimum wage is more binding for smaller firms, it would distort the firm-size distribution, and in a competitive setting would benefit capital owners of larger firms, in the same way as the distortion of the spatial wage structure emphasized in this paper benefits land owners in cities.

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Table A.1: Urban Wage Premium: OLS Estimates

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sex	.383*(.009)	.389*(.008)	.386*(.009)	.543*(.009)	.535*(.006)	.533*(.007)	.506*(.007)
Age	.089*(.003)	.087*(.003)	.087*(.003)	.064*(.002)	.064*(.002)	.063*(.002)	.064*(.002)
Age squared	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)	-.001*(.000)
Edu.: Elementary school				.070*(.009)	.085*(.008)	.088*(.008)	.121*(.006)
Edu.: High school				.133*(.029)	.108*(.027)	.120*(.027)	.141*(.027)
Edu.: High school w. prof. training				.349*(.018)	.339*(.017)	.345*(.016)	.376*(.015)
Edu.: College degree				.644*(.021)	.646*(.020)	.651*(.020)	.698*(.018)
Edu.: University degree				.875*(.026)	.862*(.024)	.873*(.023)	.924*(.024)
Prof. status: Skilled				.029*(.008)	.035*(.007)	.038*(.007)	.071*(.005)
Prof. status: Foreman				.407*(.013)	.404*(.013)	.405*(.012)	.402*(.012)
Prof. status: Employee				.526*(.015)	.500*(.011)	.506*(.012)	.498*(.011)
Prof. status: Home worker				-.456*(.071)	-.437*(.070)	-.444*(.069)	-.467*(.072)
*log*Density		.127*(.018)			.068*(.014)		
Cty. type 2: Urban			-.061 (.048)			.037 (.035)	.006 (.034)
Cty. type 3: Densely			-.252*(.043)			-.100*(.032)	-.089*(.028)
Cty. type 4: Densely, rural			-.350*(.042)			-.185*(.033)	-.112*(.026)
Cty. type 5: Rural			-.438*(.052)			-.259*(.047)	-.116*(.029)
East							-.339*(.014)
N	353047	353047	353047	353047	353047	353047	353047
R^2	.110	.149	.145	.355	.365	.366	.386

Dependent variable: *log* of daily wage. OLS estimation, standard errors in parentheses are heteroskedasticity robust and clustered at the regional level. Omitted categories are: *Edu.: No*, *Prof. status: Simple Laborer*, and *County type 1: Cities*. * denotes significance at the 5% level.