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ABSTRACT

This paper analyses the impact of urban agglomeration on the wages of Hungarian workers. Using micro data from the Hungarian Wage Surveys for the years 2008–2012, we investigate whether average wages vary with urban scale. According to our results wages are 12% higher in the metropolitan area of Budapest than outside of it after controlling for the characteristics of labour supply, demand as well as unemployment. Wage premium cannot be observed in smaller urban areas, which indicates that the impact of urban size on wages is non-linear. We also find that working in Budapest affects returns to labour market experience and it also increases returns to education. For college-educated workers the effect is 22%, while for those with primary education it is only 5%.

Keywords: Wages, Agglomeration economics, Productivity, Self-selection

JEL codes: R23, J24 , J31

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INTRODUCTION

Analysing the wage inequalities in late 19th-century Prussia, Weber (1899, [1967]) found that average urban wages considerably exceed average wages offered in the countryside. More recent empirical studies carried out for a wide cross-section of countries confirm the century-old observation that firms continue to pay significantly higher wages in large urban areas. This raises the question as to why firms are willing to pay their workers more and why they do not flee these high-wage areas. One explanation for the continuing presence of firms in large urban agglomerations is that firms are compensated for higher wages by higher labour productivity.[1]

Duranton and Puga (2004) mentioned three broad mechanisms through which the geographical concentration of economic activity positively impacts labour productivity. These are *input sharing, matching and learning*.[2] Spatial clustering permits firms to share indivisibilities like large high fixed-cost facilities and the local base of specified suppliers. The opportunity of sharing and reducing fixed costs prompts firms to locate close to each other. Sharing specialised suppliers triggers the same behaviour through the reducing costs of purchasing factor inputs (Abdel-Rahman – Fujita 1990, Henderson – Becker 2000). Moreover, sharing local labour force helps firms smooth out idiosyncratic demand shocks (Krugman 2003, Overman – Puga 2010). The second agglomeration mechanism prevails through improved matching between firms and employees. In thicker urban labour markets, the probability of signing new employment contracts in a certain period of time is higher, and the quality of matching is better, as employers find workers meeting their skill requirements more easily. Thus, firms operating in cities are expected to face lower search and adjustment costs. From the workers perspective it is also important to note that better matching reduces the average time period of transitioning from one job to another (Helsley – Strange 1990, Kim 1990, Combes – Duranton 2006). Finally, cities provide exclusive opportunities for learning and transmitting any kinds of knowledge (Glaeser 1999, Storper – Venables 2004, Charlot – Duranton 2006). Since learning is not a solitary, but rather

[1] Focusing on U.S metropolitan areas with more than 1 million inhabitants Glaeser and Maré (2001) found that average nominal wages are 36% higher than outside these areas. Later, Yankow (2006) repeated Glaeser's calculations for CPI-deflated real wages and found that the wage gap between metropolitan areas and the rest of the U.S. is lower by nearly 50% but remains highly significant. For France Combes et al (2008) showed that average wages in Paris are 15% higher than in other French cities and 60% higher than in rural areas. Similar results are available – among others – for Japan (Tabuchi – Yoshida 2000), Germany (Haas – Möller 2003, Lehmer – Möller 2010) and also for Italy (Di Addario – Patacchini 2008, Matano – Naticchioni 2013).

[2] Agglomeration economies can, of course, be classified in several other ways. See, for example Parr (2002).

a social activity requiring personal contact, large agglomerations provide more advantageous conditions for learning and gaining experience. In urban areas the frequency of personal interactions is higher, which equally facilitates learning by imitation, and innovation based on the re-thinking of old ideas (Glaeser 1999, Jovanovich – Rob 1989). These mechanisms positively affect labour productivity, which might also be reflected in the higher urban wages. All of these mechanisms predict that labour productivity is higher in cities, which explains why firms continue to operate in cities despite the high wages.

However, higher productivity stemming from agglomeration is not the only factor behind the urban-rural wage gap. Differences in the composition of the local labour supply also play an important role in determining regional wage inequalities. Considering free labour mobility, rational individuals choose their geographical location by the return to schooling and experience. Thus, there are systematic differences in the educational composition of the labour force in urban areas and outside of them. The same might also be true for unobservable skills. If the return to these skills and traits are higher in densely populated areas, the appearance of more able workers will be more probable in urban locations. Besides, workers with higher social and cognitive skills might also move to cities, specifically to benefit from learning (Bacolod et al 2009). Since these hypotheses on spatial sorting suggest that there might be substantial differences in the skill composition of the labour supply, raw urban-rural wage differences cannot be attributed to agglomeration economies alone.

The challenge of decomposing urban-rural differences inspired many urban economists in the last two decades; however, despite the growing number of empirical studies, there is still a substantial empirical gap concerning the extent of agglomeration economies in CEE countries. The main objective of this paper is to fill this gap by analysing micro data on individual workers from Hungary. We estimate *Mincerian* wage equations to relate spatial wage differences to observed worker characteristics and city-specific effects and endowments. The results show that after controlling for labour supply and demand characteristics, a wage premium related to local productivity effects is roughly 12-13% for the urban agglomeration of Budapest. For the lower levels of the Hungarian urban hierarchy, such urban wage premium disappears after controlling for the observable worker characteristics. The wage premium of Budapest seems to be heterogeneous across educational groups. Moreover, predictive margins show that wages grow faster in the urban agglomeration of Budapest than outside of it. This pattern of results holds even when we re-estimate the wage equation on a quasi-panel to control for unobserved heterogeneity among workers.

The upcoming sections of the paper are organized as follows. The second section provides a simple equilibrium model on spatial wage inequalities. The third section lays down some facts about the Hungarian urban structure, then the fourth and fifth sections introduce the estimation method and describe data. The results and their implications are presented in the fifth section. The last section concludes the study.

A SIMPLE MODEL ON SPATIAL WAGE DISPARITIES

Our empirical analysis builds on a simplified version of the general equilibrium model of Roback (1982), which assumes that each location is a competitive economy provided that the migration of workers and firms is costless between them. For the sake of simplicity every worker resides at the location of the work-place and intra-city commuting is not considered. Assume that each individual gains utility by consuming traded (C_T) and non-traded goods (C_N), where the price of the traded good is fixed in the national market and set to unity.[3] Each individual (indexed i) is endowed with a certain amount of efficiency units of labour (h_i). Wage per efficiency unit in the j^{th} location is ω_j, thus the wage received by individual i in location j is equal to $\omega_j h_{ij}$. Assuming Cobb-Douglas preferences, the utility-maximization problem of the individual is

$$\max C_T^{\alpha} C_N^{1-\alpha} \quad s.t. \quad \omega_j h_{ij} \geq C_T + p_j C_N$$

where p_j denotes the price of the non-traded good in location k. Solving this problem the indirect utility of the individual is

$$\alpha^{\alpha}(1-\alpha)^{\alpha}\omega_j h_{ij} p_j^{\alpha-1} \tag{1}$$

which must be equal for all locations in spatial equilibrium by the assumption of identical and homothetic preferences. Therefore, the difference in average wages between location 1 and 2 is given by

$$W_1 - W_2 = \tilde{h}_1 - \tilde{h}_2 + (1-\alpha)\log\left(\frac{p_1}{p_2}\right) \tag{2}$$

where W_j and $\tilde{hj}$ are the logarithms of the geometric mean of wages and the efficiency units of labour in location j=1,2. According to Equation (2), spatial wage differences are due to the differences of average skill levels and the prices of the non-tradable good. Even if prices are equal across locations, the skill composition of workers might still cause substantial wage differences. Similar conclusion can be drawn from the side of labour demand. The production of traded goods operates under constant returns to scale and use labour (H) expressed in efficiency units and capital (K) as factor inputs. The profit (π) of the representative firm in location j is

$$\pi_j = A_j H_j^{\sigma} K_j^{1-\sigma} - \omega_j H_j - r_j K_j$$

where A_j denotes location-specific productivity, σ is the output elasticity on labour $(0 < \sigma \leq 1)$ and r_j is the rental rate of capital. Product and factor markets are perfectly competitive, which implies that efficiency units of labour are paid by their marginal product. Thus, the wage of worker i endowed with h_i amount of efficiency units is

$$\omega_j = \sigma(1-\sigma)^{\frac{(1-\sigma)}{\sigma}} A_j^{\frac{1}{\sigma}} r_j^{-\frac{1-\sigma}{\sigma}} \tag{3}$$

Again, the difference in average wages between two locations is given by

$$W_1 - W_2 = \tilde{h}_1 - \tilde{h}_2 + \frac{1}{\sigma}\log\left(\frac{A_1}{A_2}\right) - \frac{1-\sigma}{\sigma}\log\left(\frac{r_1}{r_2}\right) \tag{4}.$$

[3] Following Henderson (1988) we use the simplifying assumption that the providers of non-traded goods do not reside in either of the locations.

Equation (4) suggests that higher wages are due to higher average skill levels, higher location-specific productivity, or lower costs of physical capital. This paper focuses on productivity differences between urban and rural areas stemming from agglomeration externalities; therefore,, in the following sections we take a closer look at the demand side of the labour market. However, equation (3) implies that productivity effects of agglomeration and the effects of lower capital prices in cities are difficult to be identified separately. Thus, one can only identify the overall effect of city characteristics.[4] Throughout the subsequent analysis when the term agglomeration effects is used, it means the net effects.

AGGLOMERATION PATTERNS IN HUNGARY

Before turning to data description, it is important to lay down some basic facts about the Hungarian urban hierarchy and explain the contextual basis of the urban-rural distinction used throughout the analysis. Recently, several papers have been concerned with the contemporary changes of the Hungarian urban system (e.g. Enyedi 1998, Beluszky – Győri 2005, Bajmócy – Hegedűs 2008, Brown et al 2009, Csomós 2015); therefore, the argument of this section is only limited to the basic patterns, which led to the current urban structure.

Considering its long-standing structural rigidities and stability, Beluszky and Győri (2005) aptly referred to the Hungarian urban network as a 'slow response system'. Although it was exposed to the direct impacts of the political and economic transition, the majority of urban areas have recovered from the immediate dislocations of the regime change, returned to their growth trajectories, and restored their leading positions in the urban network. Large cities remained the motor of economic development after the regime change as they could adapt to the new economic conditions the earliest, and their purchasing power, accessibility and supply of high-skilled workers made them the primary destination of FDI at the end of the nineties (Kukely 2006). However, in earlier stages of the transition process, massive labour displacement in large urban areas resulted in both suburbanisation as well as net movement to villages, especially villages that are located relatively close to cities. Post-socialist population de-concentration extended urban labour markets as movers continued to reside in nearby villages and preferred to commute even after the economic recovery of urban cores (Brown et al 2008). Suburban areas of large cities are still characterised by positive net migration, what is more, in some instances the overall population growth of urban areas can be attributed to the growth of suburban settlements and not the centres. The reason why suburbs grow faster in terms of population is that settling down outside the city and commuting to work is more affordable for those arriving from rural hinterlands, where property prices are much lower (Bajmócy – Hegedűs 2008).

Since commuters constitute a substantial (and growing) share of the urban labour supply, agglomerations

[4] See Duranton and Puga (2004) and Combes et al (2008) for further discussion of this issue.

should be conceptualised as areas that are comprised of both a densely populated urban core and its surrounding settlements, where workers commute from.[5] For this reason we used the agglomeration delimitation of the Hungarian Central Statistical Office, which is based on several development indicators and also the recent commuting patterns of the workforce (HCSO 2014). According to economic density and the degree of interconnections among settlements involved, the HCSO distinguishes between 3 types of urban areas: *urban agglomerations, agglomerating urban areas and urban settlement groups*. Only one modification was made in this classification: the metropolitan area of Budapest was pulled out from the category of urban agglomerations. Population statistics on the HCSO urban categories are summarised in Table 1 (see Table A1 in the Appendix for detailed statistics). According to the latest Census of 2011, the metropolitan area of Budapest is home to 2.5 million people, 25% of the whole population. The second category consisting of three urban agglomerations (*Győr, Pécs, Miskolc*) comprises only 7 % of the population. The third broad urban category labelled as *'agglomerating urban areas'* involves urban settlement groups, where certain processes of agglomeration, such as the growth of the population and the dwelling stock, the rapid expansion of the built-up area and commuting are all recognisable, but the overall population is still low. This category consists of 4 urban areas (*Szombathely, Zalaegerszeg, Eger, and the region of Lake Balaton*), from which the largest one is home to only 147 thousand people. The last urban category giving 17% of the population consists of 15 urban settlement groups. Although some of these areas are larger than those classified into the category of agglomerating urban areas, urban settlement groups are at the beginning of the urban growth process, as the intensity of interconnections among the urban centre and its surrounding settlements is relatively low.

Table 1. Statistics on urban areas in Hungary

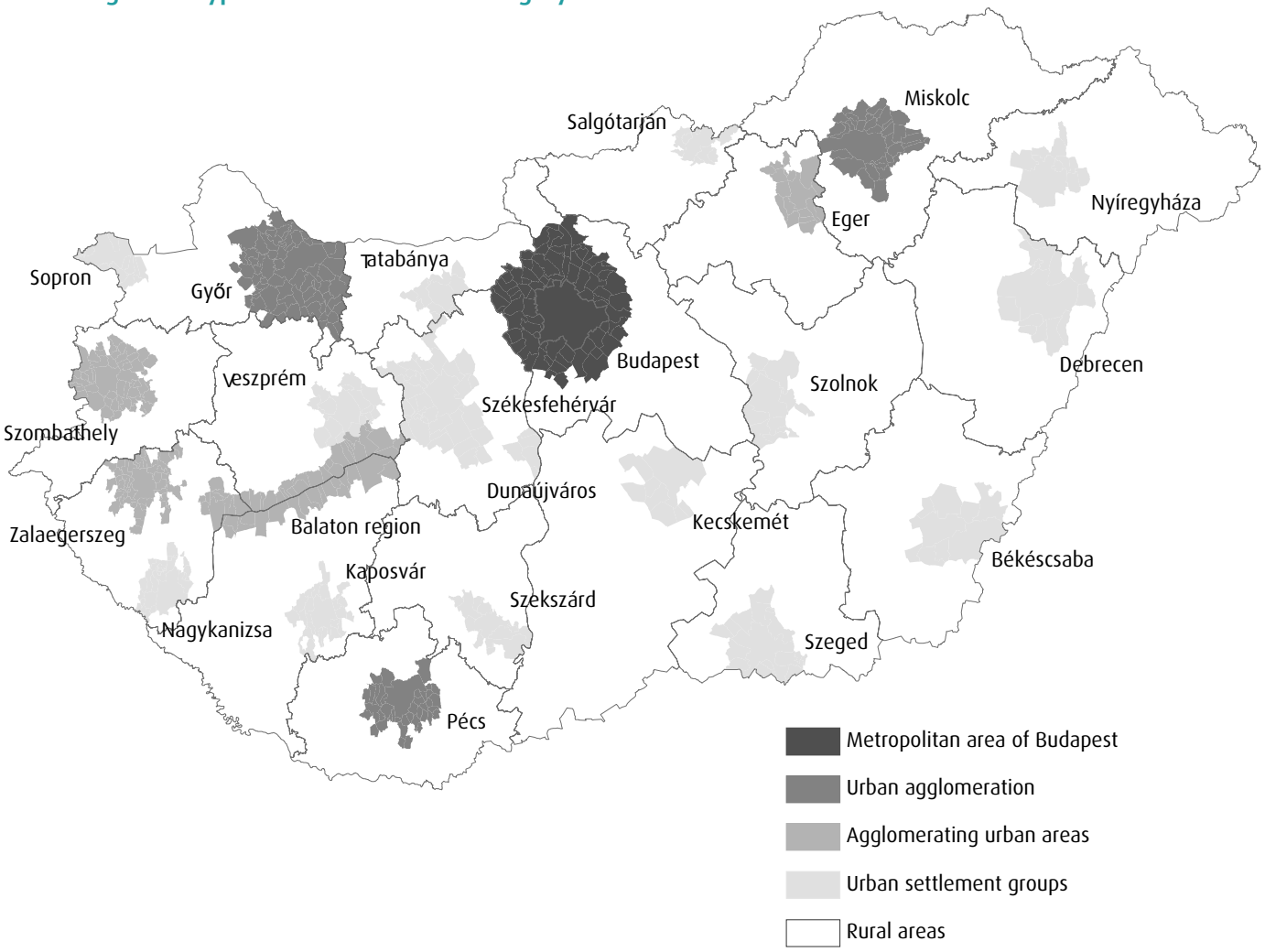
Type of urban area	Population (in thousand persons)	Population (% of total)	Mean population (in thousand persons)	Min	Max	Number of urban areas
Metropolitan area of Budapest	2558	26	2558	2558	2558	1
Urban agglomerations	685	7	228	193	261	3
Agglomerating urban areas	438	4	110	79	147	4
Urban settlement groups	1744	17	116	48	271	15
All type of urban areas	5425	54	235	48	2558	23

Notes: The source of the population data is Census 2011 (HCSO).

[5] Conceptualising urban agglomeration in such a way might also be desirable for practical reasons. As Briant et al (2010) illustrate, the outcome of empirical investigations in economic geography might vary depending on the choice of district boundaries. The ponderousness of this issue known as the modifiable areal unit problem (MAUP) is the lowest, when the applied zonal system follows the spatial reach of labour markets.

Figure 1 shows the location of urban areas by categories. The 23 urban areas cover the country evenly; however, it is important to note that most of the elements in the second and third categories are likely to be located in Western-Hungary, while in the Great Plain urban settlement groups are prevailing. Though some of these urban settlement groups are highly populated (e.g. Debrecen, Szeged or Nyíregyháza), they are on a much slower growth path than urban areas in Transdanubia. Considering the substantial heterogeneity of urban areas, all types are included into the analysis to get a more comprehensive picture on the distribution of agglomeration wage premium in Hungary.

Figure 1. Types of urban areas in Hungary



ECONOMETRIC APPROACH TO ESTIMATE URBAN PRODUCTIVITY EFFECTS

As discussed in Section 2, there are at least three broad explanations for spatial wage disparities. Since we are ultimately interested in the differences of local productivity term, only the demand side of labour is considered, where wages are related to urban labour supply, productivity, and the price of physical capital. A method that is often used to analyse wage differences is the *Mincerian* wage regression (Combes – Gobillon 2015). The estimation of the *Mincer* equation relates the wage earned to a series of factors, starting with individual characteristics, but also firm and industrial characteristics as controls for the labour demand. To estimate the effects of agglomeration on wages, dummy variables for all urban categories are also included. The reason why we estimate the effects of working in urban areas of different sizes rather than the effect of size or density is that urban theory relates agglomeration economies to large agglomerations, which suggests some threshold effects.

To control for observable characteristics of the labour supply, variables on gender, individual education, experience and occupation types are added to the regressions. It is, however, possible that individuals might also self-select into regions according to unobservables, such as abilities, ambition, or dedication to work. If there is substantial spatial sorting according to non-observed characteristics, it might explain a part of the relationship between urban status and wages. One straightforward way to deal this problem is the inclusion of a wide range of control variables relating to the composition of labour demand (Duranton – Monastiriotis 2002). If skilled workers tend to sort themselves into high-productivity firms, which are also more likely to cluster in large urban agglomerations, firm-level characteristics determining productivity and offered wages might help reduce the upward bias caused by spatial sorting. By the same token it is also reasonable to include industry dummies (Bartel – Sicherman 1999). Thus, the wage regression equation takes the following general form:

$$\log w_{i,j,t} = \mathbf{X}'_{i,j,t}\boldsymbol{\beta} + \mathbf{Z}'_{i,j,t}\boldsymbol{\delta} + \sum \varphi_u D^u_{i,j,t} + t + \varepsilon_{i,j,t} \qquad (5)$$

where $w_{i,j,t}$ represents the wage of individual i working in settlement j, $\mathbf{X}$ and $\mathbf{Z}$ are vectors of individual and employer characteristics, $D^u_{i,j,t}$ are dummies indicating whether the workplace of the individual locates in urban area type u, and t denotes year-specific fixed effects. From the regression parameters, we are interested in φ_u, which reflect the overall productivity effects in each type of urban areas. The reliability of the estimates on productivity obviously hinges on what extent additional variables on occupation types and labour demand are able to capture the effects of unobserved individual characteristics. Although the omitted variable is proved to be an important issue in the case of the U.S. and other Western-European countries, it is unlikely to be a prominent concern in Hungary after controlling for such a large number of

wage-determining factors. The reason is that Hungarian labour markets are characterised by relatively low geographical mobility (Cseres-Gergely 2004), caused by imperfections of the residential real estate market and high moving costs, which reduce the property owners' propensity to migrate. Since in Hungary the share of owner-occupied properties is disproportionally large, these factors affect a large proportion of households.

Consequently, introducing a large set of controls might be able to reduce estimation bias caused by spatial sorting to a negligible level. However, the problem of omitted regional level variables might still be an issue. One such variable is the unemployment rate. Efficiency wage and bargaining theories predict negative correlation between wages and local unemployment, an empirical law called the 'wage curve' relationship (Blanchflower – Oswald 1995). Since unemployment is prone to be lower in urban areas, it is important to include it in some of the specifications, otherwise the coefficients of urban dummies might also capture the effects of labour market adjustment mechanisms.

DATA AND DESCRIPTIVE STATISTICS

DATA SOURCES

The data needed for the analysis are from two distinct sources. Individual data are from the 2008-2012 waves of the *Hungarian Wage Survey* (HWS), which contains the wages and other individual characteristics of approximately 200,000 individuals in each year. The survey carried out by the *National Employment Office* has maintained the same structure since 2002. It covers the entire public sector: all firms employing more than 20 workers as well as a 20% random sample of firms employing fewer than 20 workers are included in the survey sample. The public sector and firms employing fewer than 50 employees provide data on all workers, while larger firms report a 10% random sample of their workers.

For the purpose of the present analysis two individual databases are built. The first one is a pooled cross-sectional database, which contains 637,436 observations after the exclusion of the entire public sector, part-time workers[6] and observations with missing data. The second one is a quasi-panel of 58,159 individuals (number of observations: 130,811). Despite the fact that in the absence of any individual identifiers the HWS is not capable to build a panel database, by using the prime number of firms, time-invariant individual characteristics such as gender, date of birth, schooling and occupation, a quasi-panel including every individual observed for at least two subsequent years at the same firm can be construed. Since after a job change individuals cannot be followed any more, the panel only contains non-movers. While the pooled cross-sectional sample is used to estimate the productivity effects of agglomeration, and to decompose the agglomeration wage premium, the quasi-panel is used to check for robustness.

[6] Those working fewer than 36 hours per week were considered as part-time workers.

Individual data on wages, gender, schooling, experience, occupation and firm-level data such as firm-size, ownership, industry, and the existence of any collective bargaining agreements are extracted from HWS. Wages are defined as the log of average gross monthly wages expressed in 2008 HUF.[7] Following Kertesi and Varga (2005), a four-category classification of education is used: (i) primary education or less, (ii) vocational and technical school, (iii) secondary schools with final examination, and (iv) higher education or more. In terms of the OECD classification, category (i) corresponds to primary education or less (ISCED 0 and 1), category (ii) roughly covers lower secondary education (ISCED 2), category (iii) refers to upper secondary education (ISCED 3), and finally category (iv) covers tertiary education or more (ISCED 5 and 6). Throughout the paper we use the ISCED terminology. Labour market experience is approximated by the difference between age and the school leaving age minus six. To distinguish between occupations three broad occupational types (manual, professional, managerial) were created by aggregating the detailed classes of HWS along the hierarchy specified in Order No. 6/1992 of the Minister of Labour on the Inter-Sectoral Classification System of Employees.[8] Firms are classified into seven categories according to their number of employees (up to 5; from 5 to 10; from 11 to 20; from 21 to 50; from 51 to 300; from 301 to 1000; and 1001 or more). To catch the proprietorial structure of firms, two sets of dummies showing the share of state and foreign ownership. Each set includes 4-4 dummies (0%; minority; majority and 100%). Another dummy indicating whether the employees of the firm are covered by a collective bargaining agreement is also generated while industry dummies follow the NACE Rev. 2. classification at the 2-digit level. Finally, unemployment rates at the settlement (LAU-2) level are extracted from the HCSO T-STAR database. Since the number of economically active persons is only available at the county (NUTS-3) level, we used the indicator of active aged population to calculate local unemployment rates.

DESCRIPTIVE STATISTICS

Average wages calculated for urban and rural areas are summarised in Table 1. Remarkable wage differences can be observed between Budapest and other parts of the country. On average, wages offered in the metropolitan areas of Budapest are significantly higher than elsewhere in the country. Simply averaging all observations using sampling weights, the average real monthly wage is 191,100 HUF, while in Budapest the average is 244,700 HUF. This value is approximately 80,000 HUF higher in other urban agglomerations and 90,000 higher than in the rural hinterlands. Substantial differences between smaller urban areas cannot be observed.

[7] In the absence of regional price indices nominal wages were deflated to 2008 prices by the national CPI.
[8] See Table A2 in the Appendix for the details of the aggregation.

Table 2. Average wages in urban and rural areas

	Metropolitan area of Budapest	Urban agglomeration	Agglomerating urban areas	Urban settlement groups	Rural areas
Gross monthly wage (1000 HUF)	244.7	163.8	162.2	162.1	154.4
Individual characteristics					
By gender:					
Male	219.8	174.1	173.5	173.6	164,7
Female	263.4	146.5	143.5	143.4	137,1
By level of schooling:					
Primary	122.1	112.0	109.5	111.8	111,3
lower secondary	145.1	128.3	132.5	130.5	126,4
upper secondary	197.9	158.8	158.6	158.0	162,0
Tertiary	444.8	297.9	286.4	289.4	327,5
By type of occupation:					
Manual	141.2	127.7	131.9	129.1	125,9
Professional	290.6	203.2	197.6	201.5	203,5
Manager	607.4	349.1	342.4	368.1	392,1
Firm characteristics					
By level of state ownership					
100%	260.7	193.2	184.3	201.0	190,5
Majority	274.7	189.9	166.0	195.2	164,0
Minority	423.8	251.2	199.7	251.8	217,6
0%	234.8	155.4	158.7	153.3	148,6
By level of foreign ownership					
100%	334.3	203.0	197.2	207.4	189,3
majority	367.9	225.9	209.8	234.5	242,7
minority	313.6	219.9	209.3	193.7	185,1
0%	272.7	151.9	148.5	148.8	139,9
By having a collective agreement					
Yes	299.1	200.3	199.5	193.2	164,2
No	226.1	150.7	146.6	149.7	138,8
By size of firm (in terms of employment)					
0-5	209.6	129.2	184.8	122.0	127,7
5-10	179.8	131.0	124.5	123.9	115,1
11-20	194.6	132.0	124.0	126.2	122,2

21-50	222.0	147.3	137.8	135.4	136,2
51-300	286.0	164.6	156.4	163.2	154,4
301-1000	275.1	207.9	185.1	193.4	179,3
1001-3000	293.0	190.1	233.2	204.8	216,6
3000+	278.3	207.1	211.0	227.1	209,1
Experience (years)	23.9	21.3	23.1	23.0	22.7
Unemployment rate (%)	3.8	7.8	5.8	7.30	8.76
Number of observations	242,718	44,671	20,142	105,457	224,448

Source: Hungarian Wage Survey, National Employment Office.

To investigate the possible sources of this remarkable difference between the capital city and the rest of the country, average real wages were also calculated along several dimensions that are usually considered as important factors of wage determination. With respect to individual schooling, the sample indicates that wages increase with the level of schooling. Those working in Budapest earn more, regardless of their educational attainment. However, for the less educated workers the difference is much smaller in magnitude. For the primary and lower secondary levels, the wage gap is about 6-10% of the national average real wage, 12% for the upper secondary level and 15% for tertiary education. The same is true for occupation types. Real wages are significantly higher in Budapest in each occupational category, but the gap gets wider as we move up the occupational hierarchy. Again, the data do not show any significant differences between rural and smaller urban areas.

Experience is also an important source of wage determination. As this variable is not discretized, the average years of labour market experience is calculated for both subsamples. On average, experience is only 1-2 years higher in Budapest than in rural and smaller urban areas. Although the impact of experience on wages is not linear, it is highly plausible to assume that this difference is not enough to counterweight the gap in average wages. Overall, the sample suggests that even though significant wage difference exists between the largest urban agglomeration and the rest of the country, *its size is not homogeneous across different groups of workers.*

Similar conclusions can be drawn from firm-specific characteristics. As profitability is highly different across industries, a large inter-sector wage difference can be observed in the sample. The proprietorial structure also seems to be important, and a collective agreement on general tends to increase the average wage level. The expected spatial patterns continue to hold for these variables, too. Firms operating in Budapest tend to pay significantly higher wages.

Finally, in accordance with the wage-curve literature (Blanchflower – Oswald 1995), average wages tend to be higher, where the unemployment rate is lower. In the Hungarian case, unemployment in rural

areas is almost twice as high as in the agglomeration of Budapest, but surprisingly only 1-3 percentage points higher than in other urban areas. These enormous differences draw attention to the importance of controlling on local unemployment when identifying agglomeration effects.

ESTIMATION RESULTS

AGGLOMERATION WAGE PREMIUM

Results are reported in Table 3. The baseline model in column 1 establishes the relationship between wages and the urban status. It shows that average wages are significantly higher in every urban type than in the rural hinterland. On average, wages are 33% higher in the Metropolitan area of Budapest than in rural areas, which is the half of the raw wage difference observed between Paris and the rural hinterland in France (Combes et al 2008), but similar to the wage difference between metropolitan areas with more than 1 million inhabitants and the rest of the country in the U.S (Glaeser – Maré 2001). Compared with other CEE countries, the average wage difference between Budapest and rural areas is not outstanding. For Poland Cieślik and Rokicki (2013) recently found that average gross monthly wages in the Mazovian voivodship (the region including Warsaw) are 43% higher than outside of it. According to the results of Sýkora (2007), the wage difference between Prague and the national average in the Czech Republic exceeded 40% in 2001, which means that the gap between the capital city and rural areas are supposedly much higher.

The second specification in column 2 only contains individual characteristics like gender, education, occupation, experience and its square, time dummies and a constant term. These controls have the expected sign and significance. Females and manual workers earn lower wages, while workers with more education earn higher wages. Experience has an increasing and concave effect on average monthly wages. These patterns persist in the subsequent models, as well. The inclusion of the supply side variables has an enormous effect on our parameters of interest. Wage differences between rural and smaller urban areas virtually disappear, and the wage premium of Budapest drops to its half. The introduction of firm-level variables in column 3 continues to attenuate the wage gap between Budapest and the countryside, but it remains significant. Sectoral variables do not seem to have a large effect on the wage premium of Budapest; however, after including unemployment rate into the model, it lessens again. The last specification in column 5 reports that average monthly wages are significantly higher in Budapest even after controlling for the characteristics of both the supply and demand side of the labour market as well as unemployment. Individuals working in the urban agglomeration of Budapest earn 12% more than those working outside of it.

Table 3. Regression estimates on local productivity effects

Dependent Variable: Log of gross monthly wage	OLS estimates				
	1	2	3	4	5
Metropolitan area of Budapest	0.335***	0.160***	0.145***	0.154***	0.122***
	(0.032)	(0.017)	(0.012)	(0.010)	(0.014)
Urban agglomerations	0.057***	-0.015	-0.010	0.003	-0.009
	(0.033)	(0.032)	(0.026)	(0.026)	(0.022)
Agglomerating urban areas	0.062***	0.000	-0.011	-0.001	-0.021
	(0.020)	(0.022)	(0.011)	(0.012)	(0.013)
Urban settlement groups	0.049***	-0.008	-0.008	0.001	-0.011
	(0.026)	(0.027)	(0.019)	(0.018)	(0.018)
Individual controls		Yes	Yes	Yes	Yes
Year dummies		Yes	Yes	Yes	Yes
Firm-specific controls			Yes	Yes	Yes
Industry (NACE Rev.2 two-digit)				Yes	Yes
Unemployment rate					Yes
R2	0.063	0.375	0.519	0.550	0.550

Notes: Standard errors corrected for LAU-2 clustering are shown in parentheses. All regressions are estimated by weighted least squares using individuals' weights.
*** Significance at 1% level.

HETEROGENEOUS EFFECTS OF AGGLOMERATION

Descriptive statistics on average wages presented in Section 5 indicate that the urban –rural wage gap is wider in the case of most educated workers and managers. This might be due to the fact that returns to education, experience increase with urban size. In the section we investigate how agglomeration affects the structure of wages. In particular, we are interested in examining whether returns to education, experience vary with urban size.

The next model reported in Table 4 allows agglomeration effects to differ depending on worker education. The results are similar to those in Wheeler (2001), Rosenthal and Strange (2008a) and Baum-Snow and Pavan (2012). Those working in Budapest or its commuting area earn more regardless of the educational level of the individual. For smaller urban areas we cannot find any positive and statistically significant effects. However, negative effects can be found in the lowest categories for college-educated workers. Agglomeration effects in the metropolitan area of Budapest increase monotonically with education. For workers with less than upper secondary education the effect is 5-6%. For college-graduates the effect slightly exceeds the double of the effects for those with upper secondary education. For college-graduates the estimated effect is 24%. This result suggests that workers with more education capitalize productivity effects of agglomeration more effectively.

Table 4. Heterogeneous effects by educational groups

Urban categories	Primary	Lower secondary	Upper secondary	Tertiary
Metropolitan area of Budapest	0.059**	0.068***	0.119***	0.240***
	(0.018)	(0.014)	(0.015)	(0.023)
Urban agglomerations	-0.009	0.011	-0.013	-0.021
	(0.021)	(0.018)	(0.026)	(0.040)
Agglomerating urban areas	-0.057	0.014	-0.013	-0.073**
	(0.031)	(0.017)	(0.013)	(0.028)
Urban settlement groups	-0.018	0.015	-0.001	-0.066*
	(0.020)	(0.014)	(0.020)	(0.033)

Notes: The model contains individual, firm-level variables, industry dummies and also unemployment rate. Standard errors corrected for LAU-2 clustering are shown in parentheses. All regressions are estimated by weighted least squares using individuals' weights. The number of observations is 637406. R^2=0.554
*** Significance at 1% level. - ** Significance at 5% level; - * Significance at 10% level.

To get some insight of how agglomeration effects prevail according to the labour market experience of workers, the full model in the last column of Table 3 is re-estimated including interaction terms between the urban dummies and experience (and its square). The results are reported in Table 5. In the case of smaller urban areas the effect of experience is not higher than in rural areas. In contrast, for those working in the metropolitan area of Budapest the return to experience is higher. Patterns of the wage-experience relationship are depicted in Figure 2. Workers in Budapest follow a much steeper career path compared to those working outside the area. According to the predictive margins, wages grow faster in Budapest until they reach their maximum at 30 years of experience. Then expected wages start to decrease sharply. This result is in concordance with the hypothesis that older workers set lower reservation wages in over-stocked urban labour markets to defend their jobs from younger competitors. Moreover, the pattern also suggests that learning in cities might contribute to faster wage growth as emphasised by Glaeser and Maré (2001).

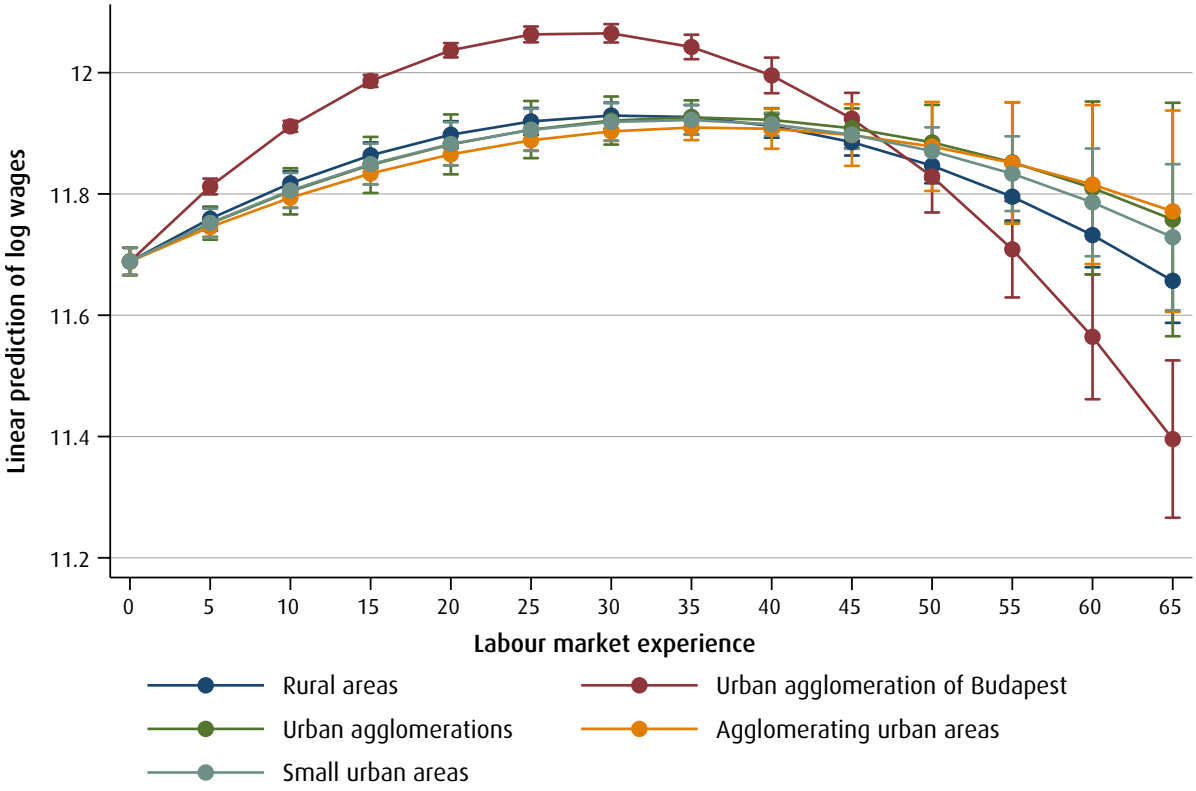
Table 5. Heterogeneous effects by experience

Urban categories	Experience		Experience sq.	
Metropolitan area of Budapest	0.012***	(0.001)	-2.4x10-4**	(3.3x10-5)
Urban agglomerations	-0.002	(0.003)	5.2x10-5	(6.4x10-5)
Agglomerating urban areas	-0.003**	(0.002)	7.5x10-5*	(4.2x10-5)
Urban settlement groups	-0.002	(0.002)	4.2x10-5	(4.6x10-5)

Notes: The model contains individual, firm-level variables, industry dummies and also unemployment rate. Standard errors corrected for LAU-2 clustering are shown in parentheses. All regressions are estimated by weighted least squares using individuals' weights. The number of observations is 637406. R2=0.551
*** Significance at 1% level. - ** Significance at 5% level; - * Significance at 10% level.

Overall, OLS estimates indicates substantial wage premium for those working in Budapest, but not for those having a job in smaller urban areas. After controlling for the composition of the labour markets, the data show that the effect of working in Budapest has positive significant effects on wages, and the premium increases with education and experience.

Figure 2. The relationship between experience and expected wages in urban areas.



Notes: Calculations are based on the model reported in Table 5.

ENDOGENEITY ISSUES

So far, we assumed that spatial sorting does not confound the estimates due to the relatively low geographical mobility of Hungarian workers. Note, however, that there might be unobservable factors correlated to urbanisation and wages even in the absence of labour mobility. As Rosenthal and Strange (2008b) argues, individuals in large urban areas are subject to a more intense rivalry which urges them to work longer hours to signal their productivity and diligence. Such rivalrous behaviour is more likely to be typical among young workers (Akerlof 1976). Although average gross monthly wage used as the dependent variable contains overtime pay, dues and bonuses, the relationship between agglomeration and hours worked might still be an issue if average wages do not reflect the real amount of hours worked.

Another factor that might also confound OLS estimates can be linked to social and institutional differences between urban and rural areas. The transition from a central plan regime to a market economy is a complicated process requiring economic, institutional as well as social transformations. However, urban and rural areas differ drastically in terms of the nature of such transformations. Large cities were more successful in adapting to the new economic conditions during the transition process, while the role of power, personnel acquaintances, network connections and authoritarian practices inherited from the socialist regime are still discoverable in small rural communities. This is problematic if these social and institutional differences affect the mode of wage determination, and have systematic effect on wages. If these practices in rural areas implicate lower average wages, OLS estimates are inconsistent and upward biased.

In order to investigate whether these factors indeed make any difference in the estimates, we undertake some robustness checks on the previous results. An arguably useful way of dealing with endogeneity is to instrument the agglomeration variables or perform fixed effects estimation on a panel of individuals. In the latter case agglomeration effects are identified by workers changing their residence over time (movers) and those staying at their original location (stayers). Unfortunately, HWS is not capable of constructing such a panel in the absence of individual identifiers. However, as it is mentioned in Section 5, using the prime number of firms, and some time-invariant characteristics of the workers, a quasi-panel of stayers can be built. However, when the panel includes only stayers, dummies on different types of urban areas cannot be identified using fixed effects models, because they only use information on the within variance of the covariates and ignore between variance (Wooldridge 2002). Hence, an alternative strategy should be used. An estimator that allows for gauging the impact of time-invariant variables in a panel setting is the one suggested by Mundlak (1978) and Krishnakumar (2006). The estimation procedure involves two steps. Firstly, *within* regression on equation (5) is performed, then the *within* residual means are regressed on the time-invariant variables and the time averages of all time-varying variables (Krishnakumar 2006).[9]

Table 6. Panel estimates

	Pooled OLS		Mundlak-Krishnakumar	
Metropolitan area of Budapest	0.125***	(0.020)	0.127***	(0.020)
Urban agglomerations	0.003	(0.020)	0.006	(0.020)
Agglomerating urban areas	-0.041***	(0.015)	-0.042***	(0.015)
Small urban areas	-0.003	(0.022)	-0.002	(0.022)

Notes: The model contains individual, firm-level variables, industry dummies and also unemployment rate. Standard errors corrected for LAU-2 clustering are shown in parentheses. All regressions are estimated by weighted least squares using individuals' weights. The number of observations is 637406. R2=0.551
*** Significance at 1% level.

[9] Another advantage of this estimator is that it can also be used as a pre-test estimator to decide which time-varying variables are endogenous and which are not. This information can be useful for the Hausman-Taylor procedure (Chatelain and Ralf 2010).

Results are reported in Table 6. The first model re-estimates the full model from Table 3 on the sample of stayers. It confirms the existence of a substantial wage premium in Budapest; however, it also shows that wages are 4% lower in agglomerating urban areas than in the rural hinterland. In the two remaining urban categories we cannot find any significant results. The second column shows the results of the Mundlak-Krishnakumar estimator. According to the results, agglomeration wage premium in Budapest is unchangeably 13%. The quantitatively similar results could mean two things. It might indicate that the urban dummies are indeed exogenous, or that the Mundlak-Krishnakumar estimator is analogous to the pooled OLS. Further research is required to decide which explanation is valid. However, the remarkable constancy of results across the two samples and methods is indeed highly indicative.

CONCLUSION

This paper has analysed agglomeration wage premium in different urban size categories. According to our results wages are 12% higher in the urban agglomeration of Budapest than outside of it even after controlling for local labour market characteristics. Such wage premium cannot be observed in smaller urban areas, which indicates that the impact of urban size on wages is non-linear.

Working in cities hides substantially different gains for different types of workers. We find that in Budapest the monetary return to education is higher and the wage gains are the highest for college-educated workers. For them, the impact of working in the capital city is 22%, while in the case of those with only primary education the effect is 5%. Moreover, wages grow faster in Budapest than in other parts of the country. This pattern of results is in concordance with previous findings for the U.S., Italy and Germany; however, the magnitudes are remarkably high. In their update survey on the empirical literature, Halfdanarson et al (2010) conclude that depending on urban definitions and methods agglomeration wage premium is typically lower than 10%. The only study which reports similar results is the one of Yankow (2006), who found that urban wage premium is 10-11% after controlling for unobserved abilities using fixed effects. However, his estimates for college-educated workers are not as high as ours.

One explanation for the remarkably high effects on skilled workers is that in Hungary a substantial part of commuters is highly educated (Kiss – Szalkai 2014), which suggests that compensation for travelling is higher in their case. This hypothesis does not contradict the existence of agglomeration wage premium, in fact, it confirms it. Firms are willing to pay higher wages and finance the travelling of their workers because these workers are more productive. Another conventional explanation is that more skilled workers benefit more from knowledge spillovers in large urban areas. In this respect, working in Budapest and individual education can be considered as complements (Glaeser – Resseger 2010). Finally, each educational group

might be affected differently by endogeneity problems. Since more educated workers are prone to be more mobile, spatial sorting might be apparent in their group, which reduces the reliability of their group specific estimates.

As a first attempt this paper provides promising and valuable results; however, the investigation should be continued on both theoretical and methodological grounds. To distinguish between the sources of urban wage premium, deeper analysis is required including corrections for urban-rural price differences, capital price levels and adequate controlling for unobserved abilities.

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APPENDIX

Table A1. Classification of occupations

Urban areas	Urban type	Population in 2011	Number of settlements
Budapest	Metropolitan area of Budapest	2558672	81
Győr	Urban agglomerations	230339	68
Miskolc		261320	36
Pécs		193313	41
Balaton	Agglomerating urban areas	147928	52
Eger		79245	17
Szombathely		120526	52
Zalaegerszeg		90687	51
Békéscsaba	Urban settlement groups	139407	9
Debrecen		271243	13
Dunaújváros		60710	5
Kaposvár		86778	23
Kecskemét		135353	8
Nagykanizsa		62884	24
Nyíregyháza		148195	10
Salgótarján		50489	10
Sopron		75646	12
Szeged		213534	15
Szekszárd		48260	10
Székesfehérvár		171555	35
Szolnok		103389	12
Tatabánya		89302	11
Veszprém		87057	18
Rural areas		4545899	–

Source: HCSO Census 2011.

Table A2. Classification of occupations

Occupational classification system of the Order no. 6/1992 of the Minister of Labour		Own classification
General managers	Non-manual workers	Managerial workers
Managers		
Acting managers		
Production managers		Non-manual workers
Chief associates		
Associates		
Business apprentices		
Apprentices		
Business associates		
Craftsmen	Manual workers	Manual workers
Skilled manual workers		
Semi-skilled manual workers		
Unskilled manual workers		

ABSZTRAKT

A tanulmány célja az agglomerációs elÐnyök hazai munkavállalók bérére gyakorolt hatásának elemzése. Az NMH Bértarifa-felvételeinek 2008-2012 közti adatait felhasználva vizsgáljuk, hogy a bérszínvonal milyen mértékben változik a városok méretek függvényében. Eredményeink szerint a munkaerÐ-kínálat jellemzÐinek, illetve a munkaerÐ-kereslet eltéréseinek kiszÐrése után Budapesten és vonzáskörzetében a bérek átlagosan 12 százalékkal magasabbak, mint az ország többi részében. Hasonló bérprémium ugyanakkor a vidéki városokban és vonzáskörzeteikben nem figyelhetÐ meg, mely azt sugallja, hogy a bérekben megnyilvánuló agglomerációs hatások nem-lineárisak a méret városfüggvényében. A fÐvárosban történÐ munkavállalás emellett növeli az iskolázottság és a munkatapasztalat hozamát. A felsÐfokú végzettséggel rendelkezÐ munkavállalók esetében az agglomerációs hatás 22%, míg a nyolc osztály végzettek esetében ugyanezen hatás csupán 5%.

Kulcsszavak: bérek, agglomerációs gazdaság, termelékenység, térbeli szelekció

JEL kódok: R23, J24, J31