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Commuting Time, Wages and Reimbursement of Travel Costs. Evidence from Hungary[1]

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ABSTRACT: The paper explores the hypothesis that high costs of commuting are responsible for the persistent unemployment of Hungarian villages. An attempt is made to estimate the compensating wage differential associated with commuting time using individual-level data, taken from a survey conducted among workers who have left the unemployment register and got a job in March 2001. The empirical analyses are motivated by a simple wage posting model, which predicts a positive effect of commuting time on wages and explicit reimbursement of travel expenses, which is conditional on the unemployment rate at place of work. We find that the unemployment rate in settlements where jobs are located lowers the positive effect of commuting time on wages, but it increases the probability of receiving some reimbursement of travel expenses, conditional on high unemployment at place of work. The findings suggest that wages paid by employers located in high unemployment areas do not compensate for costly commuting. Our study therefore supports the hypothesis that persistent unemployment is maintained by high costs of commuting, relative to wage advantages.

Keywords: Commuting, Spatial Mismatch Hypothesis, Compensating Wages

1 Introduction

One of the unique features of the Hungarian labor market is the persistence of regional differences in economic prosperity and unemployment. Unemployment rates are substantially higher in the villages situated in the North-Eastern and the Southern part of Hungary, and the rate of unemployment has been persistently high since the early 1990s. Similar to the logic of the well-known spatial mismatch hypothesis, which claims that the suburbanization of job opportunities accounts for the high unemployment rate among black inner-city residents (Kain 1992; Ihlanfeldt–Sjoquist 1998), it was proposed that the high costs of daily commuting to urban labor markets accounts for the high unemployment rates in villages

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(Köllő 1997, 2006; Kertesi 2000). Using a transportation database with settlements as units of observation, Köllő (1997, 2006) showed that in the absence of public transportation linkages, commuting with cars would use up a substantial part of the expected wages. Public transportation links are especially underdeveloped in regions where villages with high unemployment rates are typically situated. He also estimated lower-bounds of travel expenses. Kertesi (2000) relied on these estimates when analyzing the 1996 micro-census of the Hungarian Statistical Office and found that the probability of commuting decreased with commuting costs.

In this paper, we make an attempt to estimate the compensating wage differential (Leigh 1986; Zax 1991) associated with costly commuting using individual-level data. The positive correlation between wages and commuting time is often explained with the help of search theory: prospective commuters are more critical towards low wage jobs, because the reservation wage is expected to increase in commuting distance or commuting time (Rouwendal 1999; Manning 2003b). However, standard urban economic theory offers another explanation in terms of residential choices. There is a trade-off between costs of commuting and costs of housing, and high-wage employees might prefer residential locations which are far away from their job (Dargay–van Ommeren 2008), while low-income employees are forced to live close to their jobs. The relationship between commuting time and wages arises as a by-product of choosing the best residential location. The Hungarian labor market provides a unique opportunity to assess the explanatory power of the former approach. Labor mobility in Hungary is substantially constrained by the small housing rental market; the vast majority, more than 90 percent of houses are owner-occupied. Besides, housing transactions involve substantial transaction costs and a bad decision may put more than the annual income at risk (Hegedűs 1994). Moving is more characteristic for high-income families, which is evidenced in the suburbanization process especially around the capital city Budapest but also around other larger towns. (Budapest lost about 15 percent of its inhabitants during the 1990s). Given the difficulties associated with changing residence, we expect that people who wish to improve their labor market situation will choose commuting, especially those who are unemployed or often face the risk of unemployment, and mostly think of commuting as the means of improving their economic condition.

The paper is organized as follows. Section 2 presents a simple model of wage determination, which allows one to study the relationship between commuting distance and wages. The key hypothesis derived from the model is that the positive effect of commuting time on wages is conditional on unemployment rate at place of work. More specifically, the higher the unemployment rate, the larger are the returns to commuting. The remainder of the paper is devoted to empirical analyses. Section 3 describes the data and variables used in the subsequent sections. Section 4 begins with the examination of the relationship between commuting time, wages and reimbursement. Then we provide estimates for the returns to commuting time in terms of both wages and the probability of receiving reimbursement of travel expenses. Section 5 concludes.

2 Theoretical background

2.1 The wage posting model

In recent years, research into the relationship between commuting and labor market outcomes has been increasingly influenced by modern theories of monopsonistic labor markets (Manning 2003a, 2003b; Rouwendal–van Ommeren 2007). This line of literature argues that commuting costs are an important source of monopsony power. Theories of monopsonistic behavior rely on wage posting models, which elaborate the simple idea that even high wages may maximize profit, provided high wages guarantee a steady flow of applicants and reduce the probability of job separations. Wage posting models assume that wages are posted by employers before workers and jobs meet and that the respective rates at which worker-job matches are formed and terminated are related to wages.

Our study of the relationship between commuting time and wages will be motivated by a simple wage posting model. The wage setting problem is formally described and analyzed in the Appendix. Here we restrict ourselves to an informal presentation.

In essence, the maximization problem consists of maximizing the expected profit associated with holding a vacancy. If vacancies were always filled, the profit would be maximized by paying the lowest possible wage, since profit in this case is the difference between the productivity of the worker and the wage. However, vacancies are not filled with probability one because workers are to some extent selective. Obviously, low wages are rejected if unemployed workers can find better jobs. Therefore, employers take into account the probability with which job seekers accept a wage offer. We refer to this probability as acceptance probability throughout this paper.

Since the acceptance probability reflects the desirability of the job offer, it is assumed to depend on the wage offer, the reservation income and the unemployment rate. First, the better the job offer, the higher is the acceptance probability. Second, independent of the wage offer, the acceptance probability is an increasing function of unemployment rate. That is, unemployed people are more likely to accept a job if unemployment is serious; and they become more selective as unemployment decreases. Even the minimum wage is acceptable, provided that the unemployment rate is sufficiently high. Finally, the acceptance probability depends on the reservation income: job seekers reject all wage offers which are below the income they can earn while being unemployed.

Under these assumptions, the profit maximizing wage depends on the productivity of the representative worker, denoted by y, the reservation income z, and the unemployment rate. More specifically, the profit maximizing wage, w^* can be shown to be the weighted sum of productivity minus search costs $-k$ and the reservation income:

(1) $$w^* = \frac{\theta(y+k)+z}{1+\theta},$$

where θ is the ratio of the number of vacancies to the number of unemployed job searchers. (For the derivation, consult the Appendix.) Although we assume an unilateral wage posting process, the profit maximizing wage is the solution of the generalized Nash bargaining process where the worker and the employer are characterized with the respective threat points z and $-k$, and the „bargaining power" of the worker is $\frac{\theta}{1+\theta}$.

The study of the compensating wage differential paid to commuters relies on the simple assumption that the reservation income depends on commuting distance. The starting point is the assumption that workers living at distance t evaluate jobs on the basis of the difference between wage w and commuting costs (Manning 2003b). That is, $w_t=w-ct$ where c captures both the monetary cost of travel and the monetary value of time associated with travel. As shown in the Appendix, the profit maximizing wage in spatial labor markets is

(2) $$w_t^* = \frac{\theta(y+k)+(z+ct)}{1+\theta}.$$

The result is simple. In spatial labor markets, commuters behave as if their reservation income were the sum of the true reservation income and commuting costs. This implies that the profit maximizing wage offer must be higher for commuters, since the optimal wage offer is a function of the reservation income. Since our model implies that the effect of reservation income on wages is conditional on unemployment, we hypothesize that returns to commuting are larger in labor markets where unemployment is high. Employers are willing to pay higher wages to commuters because they perceive the reservation income of commuters as the sum of the true reservation income and commuting costs. This is consistent with search theoretic models claiming that the reservation wage is an increasing function of commuting distance (Rouwendal 1999).

If employers were free and able to bargain wages on an individual basis, they would pay different wages to commuters and to local residents. The wage premium, denoted by $\Delta w(t)$, is simply the difference between the optimal wage offers w_t^* and w_0^*, the later denoting the optimal wage as defined by equation (2). That is:

(3) $$\Delta w(t) = w_t^* - w_0^* = \frac{ct}{1+\theta}.$$

If employers were free to set different wages to workers with different commuting time, the theoretical compensating wage premium would be observable in wages. However, employers rarely pay different wages to workers with similar productivity but different residential location. Employers often avoid intra-firm wage discrimination because wage differences, often perceived as "unfair" by employees put team performance at risk (see, for example, Akelof –Yellen 1986). Employers therefore aim at establishing a wage structure, which is relatively independent of the personal characteristics of the employed or prospective workers. Assuming that there are no systematic differences in the productivity of workers with different commuting time, employers cannot discriminate on a spatial basis. While employers are "spatially blind" during their decisions with respect to the wage structure, they might legitimately reimburse some of the travel expenses (Rouwendal–van Ommeren 2007). Indeed, employees of various European countries, including Hungary, receive explicit reimbursement of travel expenses, the extent of which being often stipulated in collective wage agreements or in labor law. Our paper does not assume that such agreements and legal rules are binding. Instead, we argue that reimbursement equals the profit-maximizing compensating wage; that is, the theoretical compensating wage premium is paid in the form of explicit reimbursement. Similar to the argument developed in the previous paragraph, the effect of commuting distance on reimbursement must be larger in settings where unemployment is more pronounced. While employers should remain "spatially blind" during their decisions with respect to the wage structure, they can discriminate on a spatial basis and offer reimbursement to travel expenses. In short, the compensating wage premium, as defined by equation (3) is paid in the form of explicit reimbursement.

Whatever interpretation of equation (3) is adapted, the result is that returns to commuting depend on the ratio of the number of vacancies to the number of unemployed workers. Employers reimburse, either implicitly in the form of higher salaries or explicitly, the fixed fraction $\frac{1}{1+\theta}$ of commuting costs. If the number of vacancies and the number of job seekers were the same, half of the travel expenses were reimbursed.[2] Travel expenses are fully reimbursed when the labor market becomes extremely tight ($\theta \rightarrow 0$). Contrary to this, employers are not willing to reimburse travel expenses if there is substantial labor shortage ($\theta \rightarrow \infty$). The logic is as follows. Labor shortage induces firms to increase wages up to the point where wages equal productivity. The side effect of wage competition is that wages become independent of the reservation income. In the eyes of employers, commuting costs are a component of the reservation income, and not of productivity. If firms compete with offering better reimbursement schemes, it is because there is an excess supply of labor.

The negative effect of the improvement of labor market conditions on reimbursement can be illustrated by two additional results. First, the ratio of reimbursement to the wage is $\frac{ct}{\theta(y+k)+z}$. Keeping commuting time constant, the rela-

2 Rouwendal–van Ommeren (2007) arrive at the same result, albeit using a different reasoning.

tive amount of explicit reimbursement becomes smaller as the relative number of vacancies increases. Second, note that employers are not willing to reimburse the costs of too long commutes. Letting the (instantaneous) profit zero, we obtain the largest commuting time $t^{max} = \frac{y-\theta k-z}{c}$.

The largest commuting time reimbursed would be independent of tightness and wage distribution if search costs for new workers were zero. Otherwise the largest commuting time eligible for reimbursement becomes shorter as the ratio of vacancies to unemployed workers increases. Thus the improved chances of earning high wages reduce the chances of receiving reimbursement for longer commutes. The surprising implication is that employers are more willing to reimburse travel expenses if the unemployment rate is higher.

2.2 Empirical model

In this subsection, we elaborate the empirical implications of the wage posting model. To arrive at a tractable empirical model, we first rewrite Equation (2) as

(4) $$w_t = \frac{u_0}{u_0+v}[z_t + ct - y - k] + (y + k),$$

where u_0 and v denote the number of unemployed people and the number of vacancies at the place of work, respectively. Since the fraction appearing in the right-hand side increases with unemployment at a decreasing rate, we use the approximation $\frac{u_0}{u_0+v} \approx \ln u_0 - \ln v$.

Substituting this approximation into (4), we obtain

$$w_t = [\ln u_0 - \ln v][z + ct - y - k] + y + k.$$

In our dataset, which will be described in the next section, there is no information about the number of vacancies in local labor markets and search costs. Substituting constants for unobserved variables leads to the linear model

(5) $$w_t = \beta_0 + \beta_t t + \beta_z z + \beta_u \ln u_0 + \beta_y y + \beta_{ut} t \ln u_0 + \beta_{uz} z \ln u_0 + \beta_{uy} y \ln u_0.$$

We have shown in the previous subsection that employers are not willing to compensate for long commutes that would turn the instantaneous profit to zero or even negative. In order to account for this ceiling effect, the square of commuting time can be added. The revised version of the above model is

(6) $$w_t = \beta_0 + \beta_t t + \beta_{t2} t^2 + \beta_z z + \beta_u \ln u_0 + \beta_y y + \beta_{ut} t \ln u_0 + \\ + \beta_{ut2} t^2 \ln u_0 + \beta_{uz} z \ln u_0 + \beta_{uy} y \ln u_0 \quad .$$

Interest centers on the coefficients (main effects) of commuting time and on the coefficients of the product terms. The compensating wage approach to commuting time research usually boils down to estimating regression models which involve commuting time as well as personal and eventually firm-level and regional characteristics (Leigh 1986; Zax 1991; Manning 2003b). Our empirical model differs from earlier models in two important respects. First, we also add the square of commuting time to allow for a ceiling effect, which is related to the fact that neither workers nor employers tolerate too long commuting. Second, we also include interaction terms between unemployment and human capital characteristics, meaning that an increase in unemployment should reduce the returns to productivity. If our model is correct then previous regression models are misspecified and regression estimates of the compensating wage differential are biased.[3]

Explicit reimbursement, denoted by R_t will be studied using the same logic. Using the above approximation, equation (3) becomes

$$R_t = [\ln u_0 - \ln v][z + ct].$$

Given the limitations of our data, our empirical reimbursement model is

$$(7) \qquad R_t = \beta_0 + \beta_t t + \beta_z z + \beta_u \ln u_0 + \beta_{ut} t \ln u_0 + \beta_{uz} z \ln u_0.$$

If there is a ceiling effect, the model is extended to

$$(8) \quad R_t = \beta_0 + \beta_t t + \beta_{t2} t^2 + \beta_z z + \beta_u \ln u_0 + \beta_{ut} t \ln u_0 + \beta_{ut2} t^2 \ln u_0 + \beta_{uz} z \ln u_0$$

3 Data

In April 2001, a survey was conducted among registered unemployed who were entitled to unemployment benefits (N=105,924) and eventually found a job between the 18th of March and 7th of April 2001. The primary purpose of data collection was the evaluation of the effect of the dramatic rise of the minimum wage on changes in unemployment.[4] In the above mentioned period, 9474 people got a job, out of which 8339 people completed the questionnaire (Köllő 2002). The questionnaire contains both retrospective questions about the previous job and questions about the new job. This paper will use a subset of the data, consisting of 801 observations.

Survey data are rarely free of data problems. In our dataset, two problems are of special interest. First, respondents who were reemployed by the former employee were not asked about the receipt of reimbursement. Since commuting costs cannot be assumed to remain constant, these cases must be excluded. Our sample therefore is restricted to job changers. Second, when asked about the prospective job, respondents were asked to estimate the lower and the upper bounds of the salary. Unfortunately the reported minimums and maximums differ substantially

3 The expectation that unemployment rate should have a positive regression coefficient does not contradict the fact that unemployment is negatively associated with individual wages. A small increase in log unemployment changes wages by $\beta_u + \beta_{ut1} t + \beta_{ut2} t^2 + \beta_{uz} z + \beta_{uy} y$, which can (and should) be negative.

4 In January 2001, the minimum wage rised from 25.5 to 40 thousand HUF.

in a considerable proportion of cases. We omitted respondents where the difference between the maximum and the minimum exceeds 10 thousand HUF.

Since our focus is on the effect of commuting, and migration might disturb the empirical relationship between commuting time and commuting decisions (Ihlanfeldt–Sjoquist 1998), we exclude those unemployed who changed their place of residence during their unemployment spell. Since we wish to generalize our results to the population of job seekers with low education, we omitted respondents with college or university education. The sample selected for analyses include full-time employees aged 15–74 in 2001, who travel to work and back no more than four hours. Note that the sample includes cases where none of the variables take missing values. As a result of these decisions, we are left with 783 observations for further analyses.

Our interest centers on the relationship between wages, commuting time and reimbursement. The hourly wage variable is the reported gross monthly salary and is measured in thousand HUF. Commuting time is the time spent on traveling on an average day. Reimbursement is a dummy variable indicating respondents who either received some reimbursement of travel expenses or were transported to work on the cost of the employers. Note that we do not know the exact amount of money received by the workers.

The productivity of workers is captured by gender, a dummy indicating general high-school education and experience. The latter variable measures the number of years elapsed since the first entry to the labor market, minus the years having been unemployed. The reservation income is captured by the last gross wage (measured in thousands of HUF) and the unemployment rate at the place of residence. In our paper, all unemployment figures were computed using the 2000 wave of the TSTAR database of the Hungarian Statistical Office. They actually measure the average number of registered unemployed divided by the size of the active population. The hourly wage variable is the reported gross monthly salary and is measured in thousands of HUF.

Table 1 shows the means and standard deviations of the variables used in subsequent analyses. The average wage exceeds the minimum wage by 7.5 thousand HUF among women and 12 thousand HUF among men. 44 percent of women and 52 percent of men receive some compensation for travel expenses. Average commuting time is 0.88 hours (53 minutes) among women and one hour among men, the grand mean being 56 minutes. The average commuter thus does not travel more than one hour per day.

Table 1 Means and standard deviations of variables

Variable	Women (N=344)		Men (N=439)		Total (N=783)	
	mean	sd	mean	sd	mean	sd
Dependent variables						
gross monthly wage	47.536	12.333	55.764	17.658	52.149	16.064
log monthly wage	3.836	0.212	3.978	0.283	3.916	0.264
Receipt of reimbursement	0.445	0.498	0.517	0.5	0.485	0.5
Independent variables						
Commuting time	0.881	0.638	0.987	0.714	0.941	0.683
Commuting time squared	1.182	1.893	1.483	2.283	1.351	2.124
Last monthly wage	45.163	48.419	52.417	28.782	49.23	38.798
Unemployment rate at place of residence	5.488	2.77	5.979	3.512	5.764	3.215
Log unemployment rate at place of work	0.74	0.159	0.753	0.158	0.747	0.158
Interaction of log unemployment at workplace with						
Commuting time	0.631	0.447	0.722	0.516	0.682	0.489
Commuting time squared	0.82	1.264	1.06	1.58	0.955	1.453
Last monthly wage	32.595	33.343	38.674	21.476	36.003	27.478
Unemployment rate at place of residence	4.387	3.284	4.877	4.246	4.662	3.858

Our theoretical assumption is that persistent unemployment is maintained by the lack of spatial mobility. A brief comparison of our estimates to estimates presented in other studies shows that Hungarian workers do not lack spatial mobility in international comparison. Using Dutch aggregate statistics, van der Vlist (2001) reports an average commuting distance of 17.5 km among men and 11.0 km among women (the gross average being 15.3 km) for 1997. In Hungary, traveling 15 kilometers using public transportation costs about 30 minutes, so the approximately one hour commuting time seems to be consistent with the Dutch findings. Using data from another Dutch survey conducted in 1998, Rouwendal–van Ommeren (2008) report an average of one hour for workers with reimbursement and half an hour for workers without reimbursement. Since 46% of the sample received reimbursement, the sample average is about 40 minutes. Almost the same figure, about 45 minutes is reported by Manning (2003) using the British Labour Force Survey for 1993-2001 and the British Household Panel Survey for 1991–2000. To summarize, the workers we study do not travel less than workers in Britain or the Netherlands. This is striking because our sample does omit people with good education and high earnings, who tend to commute larger distances (see, for example, van der Vlist [2001]).

4 Empirical analyses

4.1 The relationship between commuting time, wages and reimbursement

Before making any attempt to explain the relationship between commuting and wages, we first examine the question whether there is any relationship to explain. *Table 2* shows the distribution of daily commuting time, as well as mean wages and the level of reimbursement of travel expenses as a function of commuting time. The distributions are presented separately for female and male workers. The vast majority of workers (80 percent of women and 74 percent of men) do not travel more than one hour, and the proportion of workers commuting more than 2 hours is very low. The distribution of commuting distances resembles the exponential distribution among women and the log-normal distribution among men. This pattern is not surprising: since the household is supposed to be run by women, they find longer commutes more costly than men. Our descriptive findings are similar to those reported in the literature on commuting[5]

Table 2 Distribution of wages and reimbursement by commuting distance

Commuting time	Women			Men		
	N	Mean wage	% receive reimbursement	N	Mean wage	% receive reimbursement
1–30 minutes	144	45.94	15.97	156	51.97	19.87
31–60 minutes	133	46.99	55.64	167	56.49	58.68
61–90 minutes	27	46.59	70.37	44	57.31	72.73
91–120 minutes	26	51.6	92.31	50	60.3	90.00
121–180 minutes	12	66.04	91.67	19	63.45	94.74
181–240 minutes	2	47.5	100.00	3	65.67	100.00

The distribution of commuting time is not surprising if we look at the relationship between wages and commuting time. While average wages are monotonically increasing with commuting time among men, an inverted U shaped pattern describes the relationship among women. Given our estimates, men and women should follow different commuting strategies in order to realize the highest marginal increase in wages. Men might find it rational to commute 31–60 minutes instead of 1–30 minutes because this change improves the wage of the average male worker by about 10 percent. However, women do not gain anything from commut-

5 For the United Kingdom, Manning (2003b) finds that about 80 percent of employees commute less than or equal to one hour; for selected cities, an average of 4.5 km is found (Frost–Linneker 1998). For the Netherlands, van Ommeren (1996) found that half of the workers commute less than 8 kilometers and only 10 percent of workers commute more than 32 kilometers. In terms of commuting time, half of the workers commute less than 20 minutes. (These estimates use the so-called Enquete Beroepsvolking, having been conducted in 1992.) For the United States, estimates are 8.7 miles (Hamilton 1982), estimates in commuting time are 22.5 minutes (White 1988). A recent overviews of empirical findings (Rodriquez 2004) suggest that average commuting time in US cities ranges between 14 and 23 minutes and average commuting distance ranges between 14 and 25 kms.

ing 31–60 minutes or even one and half hours; if they wish to improve their wages substantially, they should commute 2-3 hours.

The proportion of people receiving any reimbursement is an increasing function of commuting time among both sexes. Especially commuters traveling more than one and half hours receive some reimbursement with a probability equal or larger than 90 percent. However, short travels, not exceeding the half an hour value, are not likely to be covered by employers. Unlike wages, the relationship between reimbursement and commuting time does not differ substantially between men and women.

Table 2 also shows that reimbursement and wages are positively correlated among men. Keeping daily commuting time constant, the higher the wages, the higher the probability of receiving some reimbursement. This finding might seem to contradict our theoretical model assuming the absence of intra-firm wage discrimination. If workers oppose intra-firm wage discrimination, employers are forced to pay the compensating wage premium in the form of explicit reimbursement, being independent of actual wages. The assumption of wage bargaining, which allows for intra-firm discrimination, seems to be more capable of explaining the positive correlation. Employers ready to pay high wages can pay a relatively small proportion of wages in the form of explicit reimbursement. The underlying incentive is tax-evasion: explicit reimbursement in Hungary is not taxed, therefore both employers and workers are interested in receiving a part of the wage in the form of reimbursement (see for example, Rouwendal–van Ommeren 2008). Since firms paying (and workers receiving) high wages gain more from tax evasion, the correlation between wages and reimbursement must be positive. However, the conclusion that a positive association between wages and reimbursement is at odds with the assumption of no intra-firm wage discrimination is premature. First, the positive correlation between wages and reimbursement might be due to the presence of a common cause. For instance, larger firms pay higher wages, and these are large firms as well who are more likely to comply with the legal rules prescribing the reimbursement of travel expenses. It is also possible that respondents who received some reimbursement misinterpreted the survey question concerning the wage and reported a higher figure.[6]

4.2 The effect of commuting time on wages

We proceed with the regression analysis of the relationship between wages and commuting time in order to estimate the net effect of commuting time. We will estimate the models as specified in Equations (5) and (6), being labeled the linear and curvilinear specifications, respectively. The models are estimated using ordinary least squares. In the literature, returns to commuting time are often

6 Unfortunately, the survey question did not make it clear to the respondents that they should not think of reimbursement when they estimate or tell their wages.

estimated using household or individual level fixed effects regressions. The aim of this modeling strategy is to minimize the bias arising from endogenous residential choices and to remove spurious correlations arising from the effect of unobserved characteristics on both wages and commuting time. Endogenous moving are not a concern here because our sample does not include people who have changed place of residence. We believe that the last wage, which is intended to capture the reservation income, also reflects unobserved personality traits. The assumption here is that employers can observe the personality traits that were hidden at the beginning of the match and update their beliefs about workers' productive abilities. The last wage variable refers to the end of a worker-job match, thus it can be expected to incorporate the employers' assessment of productive abilities. We therefore use simple ordinary least squares instead of using fixed-effects regressions.

Estimation results are presented in *Table 3*. While the coefficient of commuting time lacks statistical significance in the linear specification (Model 1), it is significant in the curvilinear specification (Model 2). The same applies to the interaction between commuting time and log unemployment at place of work. The significance level of other variables is not affected by the choice of specification. The interpretation of the results therefore is based on the estimates of the curvilinear specification (Model 2). As we well see, the results from Model 2 also explain why we failed to find a significant effect of commuting time in Model 1.

Table 3 OLS estimates of log monthly wages

Variable	All		Women		Men	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Main effects						
Commuting time	0.0428	0.4536*	–0.0031	0.5083*	0.0391	0.4695*
	(0.262)	(0.003)	(0.486)	(0.032)	(0.348)	(0.02)
Commuting time squared		–0.1572*		–0.2141*		–0.1502*
		(0.006)		(0.037)		(0.018)
Last monthly wage	0.0003	0.0003	0.0042	0.0045	0.003	0.003
	(0.457)	(0.447)	(0.171)	(0.161)	(0.125)	(0.123)
Unemployment rate at place of residence	–0.0288*	–0.0313*	–0.0027	0.0007	–0.0272*	–0.0311*
	(0.003)	(0.001)	(0.425)	(0.48)	(0.017)	(0.01)
Experience	0.0022	0.0022	–0.0111	–0.0082	0.001	–0.0011
	(0.428)	(0.425)	(0.272)	(0.331)	(0.478)	(0.476)
Experience squared	0.0000	0.0000	0.0004	0.0003	0.0001	0.0001
	(0.45)	(0.479)	(0.26)	(0.323)	(0.436)	(0.405)
High-school education	0.201*	0.2135*	0.0441	0.0775	0.3332*	0.329*
	(0.022)	(0.016)	(0.374)	(0.288)	(0.024)	(0.025)
Male	0.3898*	0.3796*				
	(0.000)	(0.000)				
Log unemployment rate at place of work	–0.1649	0.0543	–0.1217	0.2629	–0.3134	–0.1047
	(0.183)	(0.394)	(0.358)	(0.241)	(0.103)	(0.344)
Interaction of log unemployment at workplace with						
Commuting time	0.033	–0.5137*	0.0855	–0.7053*	0.0369	–0.4746
	(0.354)	(0.01)	(0.229)	(0.041)	(0.39)	(0.055)
Commuting time squared		0.2154*		0.3357*		0.1842*
		(0.011)		(0.037)		(0.036)
Last monthly wage	0.0014	0.0013	–0.0054	–0.0059	0.0003	0.0003
	(0.325)	(0.335)	(0.192)	(0.181)	(0.464)	(0.464)
Unemployment rate at place of residence	0.0217*	0.024*	–0.0053	–0.0098	0.0202*	0.024*
	(0.012)	(0.007)	(0.364)	(0.262)	(0.042)	(0.026)
Experience	–0.0004	–0.0006	0.0284	0.0236	–0.0034	–0.0008
	(0.49)	(0.484)	(0.111)	(0.16)	(0.437)	(0.486)
Experience squared	–0.0001	–0.0001	–0.0009	–0.0007	–0.0001	–0.0001
	(0.381)	(0.412)	(0.115)	(0.171)	(0.464)	(0.43)
High-school education	–0.1038	–0.1225	0.1344	0.0865	–0.3394	–0.3369
	(0.201)	(0.161)	(0.221)	(0.313)	(0.055)	(0.055)
Male	–0.3189*	–0.3069*				
	(0.001)	(0.002)				
Constant	3.8573	3.691	3.8007	3.5484	4.046	3.8663
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	783	783	344	344	439	439

Notes: Numbers in parentheses are p-values. Coefficients significant at the 5 percent level are marked by asterisk.

Since our regression models include interaction terms, the positive main effect of commuting time together with the negative main effect of its square does not imply that there is an inverted U shaped relationship between commuting time and wages. The main effects of commuting time variables are meaningful in an economy where unemployment rate at place of work is 1 percent.[7] If this were the case, there is indeed an inverted U shaped relationship; the wage-maximizing commuting time is about 71 minutes among women and 94 minutes among men. Note, however, that the interaction between log unemployment and commuting time is positive and the the interaction between log unemployment and commuting time is negative. This means that as unemployment at place of work increases, the relationship between commuting time and wages first becomes more and more flat then U shaped. Another implication is that the wage-maximizing commuting time decreases as the unemployment at place of work increases. Among women, the predicted optimal commuting time is zero (or lower than zero) if unemployment at place of work is 5 percent or higher. Among men, the predicted optimal commuting time reduces to zero if unemployment at place of work is about 10 percent or higher. In our sample, the average of unemployment at place of work is about 5 percent, which explains why the commuting time variable lacked statistical significance in the linear specification (Model 1).

Our wage posting framework implies that unemployment at place of work modifies the returns to human capital and the reservation income. More specifically, if unemployment in the center of local labor markets increase, returns to human capital should decrease but returns to the reservation income should increase. Our results do not support this prediction unambiguously. The main problem is with commuting time. Unemployment does affect returns to commuting time, but the direction of the effect is negative instead of being positive. Commuting time is a component of the reservation income in the model, therefore the returns to commuting time should increase with unemployment at place of work. The evidence presented here clearly contradicts this expectation. Within our theoretical model, the unexpected negative interaction effect can be explained in three different ways. First, one might assume that commuting increases productivity: since unemployment lowers the returns to productivity, the negative interaction effect between commuting time and productivity obtains. The assumption of a positive relationship between commuting distance and productivity were realistic in a sample of qualified white-collar workers who moved to suburbs and commute to well paid jobs, or in a sample of urban residents who work in rural areas. Since our sample includes people with low educational levels, and mainly rural residents who work in urban areas, this explanation can be rejected. Second, one might argue

7 The unemployment at the place of work variable (u) was logarithmized using the transformation $\log_{10}(u+1)$. The wage maximizing commuting time is defined by $\frac{1}{2}\frac{b_1+c_1\log_{10}(u+1)}{b_2+c_2\log_{10}(u+1)}$, where b_1 is the main effect of commuting time, b_2 is the main effect of the square of commuting time, c_1 is the interaction between log unemployment and commuting time, and c_2 is the interaction between log unemployment and the square of commuting time.

that searching for employees who live in spatially remote areas is more costly than to search for local workers. This assumption is standard in the literature on spatial mismatch (see Gobilon–Selod–Zenou 2007). The positive association between commuting distance and search costs is also consistent with the hypothesis that employers prefer informal employee referrals as the means of filling vacancies. If personal contacts are more likely to emerge with commuting distance, employers who wish to hire spatially remote workers cannot rely on referrals and must incur some recruitment costs. The final logical possibility is that one assumes that the reservation income decreases with commuting time. This assumption is realistic if the representative commuter is engaged in informal economic activities as well, so that she establishes a lower reservation level towards market income.

Another puzzling finding is the positive interaction effect between log unemployment at workplace and unemployment at residence among men. Our model implies that unemployment at place of work should decrease the (negative) effect of unemployment at place of residence on wages since the latter is negatively associated with the reservation income. The finding can be explained with the assumption that unemployment at place of residence also expresses a low level of productivity (Gobillon–Selod–Zenou 2007). One reason is that longer trips make workers tired, and commuters are more likely to be late, especially if public transport is bad. Another reason is territorial discrimination, emerging from the spatial segregation of ethnic minorities. In Hungary, a substantial proportion of the discriminated Roma minority lives in small villages far from urban areas, thus pessimistic expectations concerning the productivity of Roma should overlap with pessimistic expectations about the productivity of commuters. The spatial location of the worker thus signals not only a low reservation income but also a low level of productivity.

One should also note that unemployment at place of work does not seem to modify the returns to human capital, with the exception of gender in the full sample. A straightforward explanation of the lack of empirical support concerns the characteristic of our sample. First, the sample includes people who were successful in escaping unemployment. Since productive abilities deteriorate during unemployment, it might be the case that employers think of past unemployment of individuals as a dominant signal of productive abilities, which suppress other available information, like education and experience. Besides, the discovery of interaction effects is usually difficult in samples which are larger than our sample.

4.3 The effect of commuting time on reimbursement

Finally, we examine the effect of commuting time on reimbursement. Again, we estimate both a linear and a curvilinear specification, as described in Equations (7) and (8). The estimation method is logistic regression. We omit human capital variables since they do not appear at the right-hand sides of the equations. But we do include monthly wages in order to check whether reimbursement is independent of the wage. Under the assumption of no intra-firm discrimination, the probability of receiving some reimbursement must be independent of wages. If, however, reimbursement is a form of tax evasion, we should observe a positive relationship between reimbursement and wages, since the gains from tax evasion increase with wages.

Table 4 Logistic regression estimates of receipt of reimbursement

Variable	**All**		**Women**		**Men**	
	Model 1	**Model 2**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Main effects						
Commuting time	0.2567	0.7274	1.6692	4.7338	–0.6737	–0.1338
	(0.758)	(0.734)	(0.193)	(0.228)	(0.569)	(0.962)
Commuting time squared		0.0921		–1.1379		0.1064
		(0.901)		(0.449)		(0.909)
Last monthly wage	–0.0056	–0.0043	0.0345	0.039	0.0012	0.0011
	(0.777)	(0.83)	(0.423)	(0.37)	(0.963)	(0.965)
Unemployment rate at place of residence	0.6376*	0.6118*	1.0679*	1.0099*	0.5116*	0.5015*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.005)
Log unemployment rate at place of work	–4.172*	–4.419	0.2036	1.4248	–4.130	–4.3302
	(0.041)	(0.074)	(0.958)	(0.767)	(0.122)	(0.174)
Gross monthly wage	0.009	0.0097	0.0472*	0.0500*	–0.0059	–0.0059
	(0.144)	(0.125)	(0.003)	(0.003)	(0.427)	(0.436)
Male	–0.831	-0.853				
	(0.374)	(0.364)				
Interaction of log unemployment at workplace with						
Commuting time	2.7352*	4.1228	1.0587	–0.8962	3.9504*	5.0329
	(0.015)	(0.171)	(0.51)	(0.874)	(0.018)	(0.199)
Commuting time squared		–1.0486		0.5465		–0.9616
		(0.345)		(0.813)		(0.497)
Last monthly wage	0.0091	0.0074	–0.0553	–0.0612	0.0095	0.0095
	(0.749)	(0.799)	(0.377)	(0.333)	(0.778)	(0.778)
Unemployment rate at place of residence	–0.4532*	–0.4241*	–0.8071*	–0.7468*	–0.3655*	–0.3488*
	(0.000)	(0.001)	(0.002)	(0.003)	(0.028)	(0.025)
Male	1.2174	1.2361				
	(0.336)	(0.33)				
Constant	–0.9986	–1.4744	–6.6813	–8.373	–0.1575	–0.6072
	(0.486)	(0.398)	(0.015)	(0.015)	(0.936)	(0.794)
N	783	783	344	344	439	439
Log-likelihood	–397.624	–392.626	–162.534	–160.141	–225.606	–223.159
χ^2	121.568	178.736	64.322	88.852	67.162	93.937

Notes: Numbers in parentheses are p-values. Coefficients significant at the 5 percent level are marked by asterisk.

The estimated coefficient are shown in *Table 4*. Contrary to the previous wage equations, the linear specification seems to perform better than the curvilinear one. Although the main effect of commuting time lacks statistical significance, its interaction with unemployment at place of work is positive and significant in the sample of men. This means that longer commutes imply a higher probability of receiving reimbursement only if the unemployment rate is sufficiently high at the place of work. Our estimates suggest that sufficiently high means an unemployment rate of about ten percent or higher. This pattern clearly supports the theoretical prediction that unemployment should increase the returns to commuting in terms of reimbursement. Unfortunately, the interaction effect is not significant among women.

The interaction between the two unemployment variables is also significant. The negative sign is consistent with the assumption that the unemployment rate at place of work is a negative indicator of reservation income, but contradicts the assumption that it is a negative indicator of productivity. In the previous analysis, we interpreted the unexpected positive interaction of the unemployment variables using the assumption that unemployment at place of residence expresses a low level of productivity. The change in the interpretation seems to be a contradiction. However, one should keep in mind that the decision on reimbursement differs from wage setting in an important respect: employers do consider productivity when deciding on wages, but they do not consider productivity when making decisions on reimbursement. If workers oppose intra-firm wage discrimination and employers establish a wage structure, the decision to reimburse travel expenses is made independently of productivity. Therefore, the finding of a negative interaction between the unemployment variables in the reimbursement regression does not contradict the positive interaction between the same variables in the wage regression, since only the latter is affected by the fact that employers think of unemployment at place of work as a negative signal of productivity.

5 Conclusions

Observers of the persistent regional differences in unemployment argued that high costs of commuting prevent residents of high unemployment areas from finding employment in other areas. This paper examines the relationship between commuting distance, on the one hand, and wages and the receipt of explicit reimbursement, on the other. We develop a simple wage posting model, which implies not only a positive effect of commuting time on wages and reimbursement, but also that returns to commuting must be larger if the unemployment rate where jobs are situated is large as well. We test our predictions using data on low educated workers who were registered unemployed and got a job in march 2001.

We find some evidence that returns to commuting is indeed conditional on unemployment rate. First, we find a positive effect of commuting time on wages, which, however, decreases with unemployment at place of work. This conditional effect contradicts our expectation of a positive impact of unemployment on returns to commuting time. However, the found pattern can be explained with the assumption that commuting time is also a signal of low productivity: if this is the case, the observation is consistent with the wage posting model, which hypothesizes a negative effect of unemployment on returns to productivity. We also find evidence among male workers that commuting time increases the probability of receiving some reimbursement of travel expenses, conditional on high unemployment at place of work. This finding is consistent with our theoretical framework.

The research outlined in this article is an attempt to contribute to the explanation of persistent regional inequalities in Hungary. In regions where unemployment is high, the unemployment rate in the large towns, which can be considered as centers of local labor markets, have an unemployment rate of approximately 10 percent. The findings suggest that in such a labor market commuting time is not associated with a compensating wage premium, but it is associated with a higher probability of receiving reimbursement. Although we did not observe the actual value of reimbursement, it is safe to assume that all commuting costs are never reimbursed. First, labor law prescribes that employers must reimburse a percentage of the monetary costs of travel, which is lower than 100 percent. Second, employers probably do not wish to reimburse the monetary value of time spent on traveling. These facts together imply that employers do not compensate for costly commuting. The present study therefore supports the conclusion of previous studies: commuting is too costly to induce people living in high unemployment regions to find a work in urban areas (Köllő 1997, 2006; Kertesi 2000).

The findings might suggest that reimbursement of expenses on the part of employers is a necessary condition for the reduction of persistent regional inequalities. This conclusion, however, neglects the possibility that employers will reduce labor demand as a reaction to increases in labor costs. If employers cut labor demand, it is difficult to predict the net effect of reimbursement of expenses on regional differences in unemployment rates. Without knowing the precise effect of reimbursement of travel expenses on labor demand, it is impossible to formulate firm policy recommendations.

A fundamental limitation of our study is absence of information on the level of reimbursement. Our theoretical model predicts a trade-off between wages and reimbursement. An exact test of the model predictions requires data about the amount of reimbursement received. Unfortunately, we do not have such data at our disposal. Therefore, our interpretation of the evidence is not the final word on the subject.

Our study has limitations because of the sample and the estimation method we used. A substantial limitation of our study is that our sample is probably not free of sample selection problems (Cooke–Ross 1999). Our sample was taken from a survey of unemployed, and unsuccessful job searchers are not included in the sample. This might lead to the problem of self-selection if unobserved factors determining the success of job search (getting a job) are correlated with unobserved determinants of wages or commuting decisions.

Appendix. The wage posting model

In the labor market, employers face the problem of setting a profit maximizing wage. Output is the sum of individual outputs, thus profit maximization boils down to maximizing the expected discounted lifetime value of a job. In other words, we proceed as if firms were sums of one-job firms (Pissarides 2000).

Jobs are either vacant (state 0) or filled (state 1). If a job is vacant, employers search for workers and incur fixed cost k. Vacant jobs are contacted by unemployed workers at the exogenous arrival rate $\lambda(\theta)$, where θ denotes the ratio of the number of vacancies to the number of unemployed workers. If vacancies and unemployed meet each other randomly, $\lambda(\theta) = 1 - \exp(-\frac{1}{\theta})$.

Unemployed workers accept the wage offer w with acceptance probability $\alpha(w)$. The choice of the functional form is motivated by the assumption that the acceptance probability must reflect the utility of the representative worker. This is achieved by normalizing the value of job offers to the unit interval. Let z be the income received while unemployed. It is reasonable to assume that wages have an upper bound $\bar{w}$ which is the revenue of the most productive firm within the industry under study. In a vivid labor market, wages must fall into the $[z,\bar{w}]$ interval. The acceptance probability is defined as

(A1) $$\alpha(w) = \frac{w-z^{\sigma\theta}}{\bar{w}-z}$$

where σ captures the shape of the wage distribution. For analytical simplicity, we assumed that the relative frequency is weakly decreasing in wages, so that $0 < \sigma \leq 1$.

Our specification of the acceptance probability reflects not only the fact that better offers are more likely to be accepted but also the fact that a particular job offer becomes more attractive as the labor market becomes less tight or the wage distribution becomes more dispersed. Equation (A1) implies that the maximum wage offer $\bar{w}$ is always accepted. Another implication is that unemployed workers will accept job offers equaling the reservation income, provided that there is no wage dispersion ($\sigma = 0$), or there are no alternative offers so that the ratio of vacancies to the number of unemployed is (close to) zero.[8]

The acceptance probability plays a similar role to that of reservation wage in standard search models. Standard search theory argues that the reservation wage

8 The acceptance probability might also reflect preferences towards risk if $\sigma\theta$ is multiplied by a parameter ρ so that $\rho < 1$ indicates risk aversion and $\rho = 1$ indicates risk neutrality

equals the reservation income z plus the product of the arrival rate $\lambda(\theta)$ and the expected value of the (truncated) wage distribution above the reservation wage. The expected value of the truncated wage distribution is an increasing function of the dispersion of wages, since workers can expect a higher return to job search if wages are more dispersed. Thus, reservation wage is proportional to the product of the arrival rate and wage dispersion, and effect which is captured by the shape parameter $\sigma\theta$ in Equation (A1).

To compare the acceptance probability with the traditional reservation wage, it is useful to examine the effect of labor market tightness on both the reservation wage and the acceptance probability. First consider the case when there are no vacancies, implying that $\theta = 0$. In this case, the reservation wage equals the reservation income z, implying that if a vacancy were created, it would be taken by the worker, regardless of the wage. Our acceptance probability implies the same since $\alpha(w|\theta = 0) = 1$ for all w. As the number of vacancies increase, the arrival rate of job offers to workers increases as well, which implies an increase in the reservation wage. The increase in the relative number of vacancies changes the shape of the acceptance probability so that bad offers are accepted by a nonzero probability. If the number of vacancies equal or exceed the number of job searchers, the probability of accepting bad offers approaches zero. Note that the reservation wage can be related to the acceptance probability by assuming that wage offers equal to the reservation wage are accepted by probability ½..

When a match is formed, the worker produces y units sold at unit price. Matches break up at the endogenous rate $\lambda(\theta)[1 - \alpha(w)]$.[9] That is, keeping the arrival rate constant, job separations are more likely in jobs that pay low wages.

Employers aim to establish a wage which maximizes the net present value of holding a vacancy for an infinitely long period of time. The respective Bellman equations describing the net present value of vacant and filled jobs are

(A2) $$rV_0(w) = -k + \lambda(\theta)\alpha(w)[V_1(w) - V_0(w)]$$

(A3) $$rV_1(w) = (y - w) + \lambda(\theta)[1 - \alpha(w)][V_0(w) - V_1(w)]$$

Substitution of (A3) into (A2) and the assumption that $r^2=0$ yields the following expression for the value of vacant jobs:

(A4) $$rV_0(w) = -r\lambda(\theta)^{-1}k + [\alpha(w)(y + k - w) - k].$$

Interpretation of Equation (A4) is straightforward. Assuming zero search costs, the the net present value of a job, independently of being vacant or filled,

9 Usually, search models assume an exogenous separation rate or a combination of exogenous and endogenous components (for example, Manning 2003a). The implications of the model presented here are not affected by neglecting the exogenous part of job separation rate.

equals the expected instantaneous profit. Since the probability of filling the vacancy increases in the wage, which, in turn, decreases the instantaneous profit, there is an inverted U shaped relationship between wages and the value of the job.

Assuming that the discount parameter is close to zero, differentiating (A4) with respect to w leads to the first order condition

$y + k - w^* = \frac{\alpha(w^*)}{\alpha'(w^*)} = \frac{w^* - z}{\sigma\theta}$, which immediately yields the solution

$$w^* = \frac{\sigma\theta(y+k)+z}{1+\sigma\theta}. \tag{A5}$$

Equation (1) in the main text obtains after constraining the shape parameter to one. This constrain is imposed only for analytical simplicity.

In spatial labor markets, the net wage is the gross wage minus the costs of commuting. The acceptance probability for wage offers at distance t can be defined as

$$\alpha(w) = \frac{w - ct - z}{\bar{w} - z}^{\sigma\theta}, \tag{A6}$$

where c is the cost associated with traveling one hour. After inserting (A6) into equations (A2) and (A3), we proceed as before. We again substitute equation (A2) into (A3) and then differentiate a modified version of equation (A4) with respect to w. The solution for the profit maximizing wage is:

$$w^* = \frac{\sigma\theta(y+k)+(z+ct)}{1+\sigma\theta}. \tag{A7}$$

Equation (2) in the main text obtains after constraining the shape parameter to one.

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