Recruitment in a Monopsonistic Labour Market: Will Travel Costs be reimbursed?

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Recruitment in a monopsonistic labour market: will travel costs be reimbursed?

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Abstract
Reimbursement of commuting costs by employers has attracted little attention from economists. We develop a theoretical model of a monopsonistic employer who determines an optimal recruitment policy in a spatial labour market with search frictions and show that partial reimbursement of commuting cost will in general be an element of the recruitment policy. The empirical evidence we offer is consistent with the interpretation of reimbursement as the result of monopsonistic behaviour. The alternative explanation that stresses the role of tax incentives is unlikely to provide a full explanation of the commuting costs reimbursement.

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1 Introduction

According to many observers, the labour market is less than perfectly competitive. Arguments suggesting monopsonistic competition have been around at least since Mortensen (1970) observed that in a labour market with search, employers face an upward sloping supply curve for labour. Boal and Ransom (1997) provides a review of the literature on monopsonistic labour market models that emerged since then. Bhaskar et al. (2002) provide a more recent discussion of the relevance of this market type for labour market analysis, e.g. for the effect of minimum wages on employment. Proponents of monopsony argue that the textbook model of perfect competition is extreme in that it assumes that small wage cuts cause workers to leave instantaneously (Manning, 2006).

In this study we analyze the reimbursement of commuting costs in the context of a monopsonistic labour market. Such reimbursement may be regarded as implying unequal treatment of identical workers within the same firm. Many employers in Europe reimburse part of the home-to-work travel costs of their employees. We will document later in this paper that approximately one third of the Dutch workers receive such reimbursement, and that – for those who receive it - it amounts on average to almost 5% of total earnings, which is clearly non-negligible. Since reimbursement of commuting cost implies paying a different price to workers that are equally productive but live at different locations, it seems natural to regard it as an example of intra-firm wage discrimination. However, the phenomenon seems to have been virtually ignored in the literature on monopsonistic competition, see Rogerson et al. (2005), and as far as we are aware there exists no empirical studies of intra-firm wage discrimination based on commuting costs.¹ The only exceptions we are aware of is a standard wage bargaining model in the spirit of Pissarides (2000) allowing for commuting costs (Van Ommeren and Rietveld, 2005) and a brief discussion of a spatial labour market in Bhaskar and To (1999) and Bhaskar et al. (2002). In the latter study it is shown that inter-firm wage discrimination on the basis of location would be profitable to the firm. However, the authors do not pursue the issue of intra-firm discrimination. Furthermore, in their model, location is a metaphor for unobservable preferences for job characteristics.

¹ There is a substantial literature on the empirical relationships between wages and the length of the commute. Virtually all studies establish a positive relationship, consistent with the current study. However, these studies are not able to distinguish between the effect of intra-firm discrimination and other effects such as regional differences in supply and demand, search behaviour, see also Manning (2003).
There is no reason to regard location only as a metaphor when studying monopsonistic behaviour. In this respect, we agree with Manning (2003), who argues that the ‘thinness’ of the labour market that is required for monopsonistic behaviour is closely related to the geographical aspect of that market. In Manning’s model, firms do not discriminate between employees and therefore do not explicitly reimburse commuting costs of their employees. Nevertheless, in equilibrium, workers are partially compensated for commuting costs by higher wages as a result of the matching process on the labour market. In this paper we take a different look at the spatial aspect of the labour market and examine whether it provides a monopsonistic employer a reason to discriminate workers based on the length of the commute, and provides an explanation for reimbursement of commuting costs.

The focus on commuting has a number of theoretical and empirical advantages. An important advantage is that the commute is, in principle, not directly related to the productivity level of the worker. A second advantage is that the commute can be easily observed by employers at no cost. A third advantage is that the length of the commute may change through a residence move when a worker remains with the firm. This implies that given panel data observations, one is not only able to control for (unobserved) worker characteristics but also for job and firm characteristics when analyzing reimbursement behaviour. Total commuting costs, being the sum of monetary and time costs, can be quite substantial. For a worker with a 8 hour working day and a one-way commute of half an hour, the total commuting costs are estimated to be about 10 percent of the daily wage. About 70% of these costs are due to time costs and about 30% due to monetary costs (Small, 1992). For workers with longer commutes, the commuting cost can be substantially higher.

In the Netherlands, to which our empirical work refers, but also in some other countries, reimbursement of commuting expenses is especially earmarked by employers (for institutional

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2 Zenou (2002) argues that the commute may be related to productivity levels due to fatigue etc, implying that workers with a long commute are less productive. The main implication is that it is less attractive for an employer to offer reimbursement of commuting costs implying that our estimates (which show a positive relationship between reimbursement levels and commuting) are conservative.

3 In a recent employer survey in the UK (RCI, 2001), almost all employers were able to report the commuting time of recently recruited employees. This also suggests that it plays a role in the recruitment process.

4 Controlling for job and firm characteristics is relevant in the current paper to distinguish between explanations based on monopsonistic behaviour and favourable tax treatment of fringe benefits.

5 For low wage workers, the commuting costs can be much more important. For minimum wage workers in the U.S., the monetary costs of travel are about 6% to 9% of a full-time gross income (Bhaskar and To, 1999). For part-time workers, the costs may even be more significant (Manning, 2003).
reasons and tax purposes). This makes interpretation of the econometric analysis more straightforward, because employers and workers distinguish between payments for productive labour (the “normal wage”) and compensation for commuting expenses. The majority of the employees in the Netherlands are subject to central bargaining agreements, which usually include rules about reimbursement of commuting costs at the level of the firm or industry. So, observed reimbursement of commuting expenses is unlikely to be related to individual productivity levels.6

The focus on reimbursement of commuting costs as a way of measuring monopsonistic behaviour has one potential weakness: it may be argued that reimbursement is entirely tax-induced, because reimbursement of commuting expenses is taxed at lower marginal tax rates than wages.7 Tax facilities may explain the presence of reimbursement practices on a competitive labour market when reimbursement of commuting expenses is entirely offset by lower (gross) wages, so the total compensation paid by the employer is identical for workers with the same productivity. We will present the results of a panel data analysis, which indicates that the tax-induced explanation is unlikely to hold.8

Before turning to these issues, we provide in section 2 a theoretical analysis that examines whether it may be profitable for an employer to offer reimbursement to workers with a long commute, even though their productivity does not depend on the commuting distance. We demonstrate that, under general assumptions, employers are inclined to partially compensate the commuting costs of their workers, because this reduces the employer's recruitment costs (since vacancies are filled more quickly). Note that we abstract from issues that are important for inter-firm wage discrimination, such as on the notion that firm's cost per worker depends on the size of the firm or the number of recruits per time unit (Manning, 2006; Oi, 1962).

In section 3 we consider the role of taxes and the institutional setting of the Netherlands. Moreover, we analyze the consequences of introducing taxes into the model of section 2. In

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6 In a recent Dutch employer survey (MDPITT, 2005), about 50% of the employers state that they always reimburse some of the commuting expenses, whereas 15% to 35% never reimburses commuting expenses for certain well defined groups of workers. This also indicates that the large majority of employers decide on the level of reimbursement (as a function of the commute) unconditional of the productivity level of a certain worker.

7 In the empirical analysis, we focus on the Netherlands. We will explain later on in more detail, but in essence the lower tax rate only applies when the reimbursement exceeds a certain minimum and is less than a certain maximum. In the USA, reimbursement up to $105 per month for public transport and $205 per month for parking does not attract personal income tax. Furthermore, there are special tax rules related to company cars, including the value of the fuel provided to employees (IRS, 2005). In the UK, reimbursement for parking is not taxed. The use of the company car, including free fuel, is also taxed at lower rates than income.

8 Our analysis is consistent with results by Morrison et al. (2006) who demonstrate that inter-firm wage differences may arise when employers are concerned about turnover costs.
section 4 we investigate empirically reimbursement of commuting costs testing for monopsonistic behaviour. Section 5 concludes.

2 Theoretical analysis: optimal recruitment strategy in a spatial labour market with search

2.1 The wage posting model
Consider a firm that is small in comparison to the relevant spatial labour market and therefore takes labour market conditions as given (e.g. Seater, 1979). Assume the firm has a vacancy. As long as the vacancy is not filled, the firm has a cost rate \( k (k>0) \). It's vacancies are offered to job seekers at an intensity \( \mu \) that is beyond its control. The firm will be allowed to make the offered wage a function of the commuting distance of the job seeker. We will not impose any particular (for instance, linear) reimbursement schedule, but allow for complete generality in this respect. The wage offered to a job seeker at distance \( x \) is denoted as \( w_x \). When the job seeker accepts the wage, he will incur commuting costs. The commuting costs are assumed to be proportional to the distance between the firm and the job seeker’s residential location, denoted as \( x \). To emphasize that the utility depends on \( x \), we rewrite the utility as \( v_x = w_x - tx \), where \( t \) denotes transportation cost per unit of distance. Hence, the utility \( v_x \) refers here to the wage \( w \) paid by the firm minus the commuting cost (see Manning, 2003). The employer has the possibility to determine the size of his own recruitment area. The recruitment area is a set of commuting distances, which is denoted as \( A \).

We assume that the reservation utility of job seekers is a random draw from a distribution known to the employers. The distribution of the reservation utility of job seekers is given by a function \( H_x(v_x) \) that depends on the distance \( x \) between these workers and the firm. The corresponding probability density is denoted as \( h_x \). To avoid discontinuities that are unlikely to occur in reality, we assume that the distribution functions for all distances belong to the same parametric family. We denote the vector of parameters of this family as \( \gamma \) and assume that is it a continuous function of the commuting distance \( x \). We may therefore write \( H_x(v) = H(\gamma(x),v_x) \).

The distribution function \( H_x \) could, for instance, be lognormal and its two parameters may depend on the commuting distance. We assume that the distribution \( H_x \) is log-concave in its second argument, so the second partial derivative of \( H_x \) with respect to \( v \) is negative. Log-concavity is a weaker assumption than concavity. It is not restrictive, as many popular distributions possess this
property, for instance the uniform, the (truncated) normal, the lognormal and the gamma
distributions (see e.g. Bagnoli and Bergstrom, 2005). Further, the support of $H_x$ has a lower
bound $b_x$, so no worker living at a particular commuting distance $x$ will accept a job if the offered
net wage is less than $b_x$. The lower bound is ‘sharp’ in the sense that $H_x > 0$ if $v_x > b_x$.

We allow the quit rate $\lambda$ to be dependent on the commuting distance $x$ of the worker and
on the net wage paid to him. A worker will quit the job if an offer for a better job arrives. Since
the probability that this happens may depend on his location, this introduces a direct relationship
between the quit rate and the commuting distance. This probability will also depend on the
worker’s utility and this motivates the introduction of the utility as a second argument in the quit
rate, which we will write as $\lambda_x(v) = \lambda(x, v)$. We assume that the quit rate is decreasing in the
utility and that it is log-convex in the second argument. Log-convexity is a stronger assumption
than convexity and we will discuss the possibility to relax this assumption later on.

We will take into account that the value of the filled position may depend on the
commuting distance of the worker. It is therefore necessary to be explicit about the distribution of
the job seekers over space. The density of job seekers at distance $x$ from the firm is denoted as
$f(x)$.

The probability $\theta$ that a job seeker will accept the job offer is equal to:

$$\theta = \int_{x \in A} f(x) H_x(v_x) \, dx.$$  \hspace{1cm} (1)

When the vacancy is filled, it adds $r-w$ to the profits of the firm, where $r$ denotes the contribution
of this position to the firm’s total value-added, and $w$ the wage. Filled positions become vacant
again at a (given) rate $\lambda$. Denoting the value of a vacancy as $V_0$ and that of a filled position as $V_1$,
we write the Bellman equations associated with this process as:

$$\rho V_0 = -k + \mu \int_{x \in A} f(x) H_x(v_x) [V_{1x} - V_0] \, dx.$$  \hspace{1cm} (2)

The value of a filled position, $V_{1x}$, is defined by the following Bellman equation:

$$\rho V_{1x} = r - w_x + \lambda_x(v_x) [V_0 - V_{1x}].$$  \hspace{1cm} (3)

Interpretation of the above equations is straightforward. The first states that the discounted
present value of a vacant job is equal to the sum of the recruitment cost $k$ and the expected
additional value of filling the vacancy. The second equation states that the discounted present
value of a filled position is equal to the difference of the profit rate \( r-w_x \) and the expected loss of the position becoming vacant. The employer chooses his optimal recruitment strategy by determining the optimal recruitment area and wage offers, so as to maximise the value of \( V_0 \). It is shown in Appendix A1 that this leads to the following equation for the optimal wages:

\[
 w_x = r - \rho V_0 - \frac{1}{\frac{\partial \ln H_x(v_x)}{\partial w_x} - \frac{\partial \ln(\rho + \lambda_x(v_x))}{\partial w_x}}.
\] (4)

Further, the optimal recruitment area \( A \) is the set of commuting distances for which a wage satisfying (4) can be set (see Appendix A2).

2.2 A spatially homogeneous labour supply

In order to consider the relationship between the optimal wage and the commuting distance, we will consider the case of spatially homogeneous labour supply, that is, a market where both the distribution of the reservation utility \( H_x \) and the quit rate \( \lambda_x \) do not depend on the commuting distance \( x \), so \( H = H(\gamma, v) \) and \( \lambda = \lambda(v) \).

It is shown in Appendix A3 that given spatially homogeneous labour supply, the overall effect of distance \( x \) on the wage \( w_x \) is:

\[
 \frac{dw_x}{dx} = \left( \frac{M}{N^2 + M} \right) t,
\] (5)

where:

\[
 M = -\frac{\partial^2 \ln H}{\partial w_x^2} + \frac{\partial^2 \ln(\rho + \lambda)}{\partial w_x^2},
\] (6)

\[
 N = \frac{\partial \ln H}{\partial w_x} - \frac{\partial \ln(\rho + \lambda)}{\partial w_x}.
\] (7)

Under the log-concavity and log-convexity assumptions that have been made, \( M \) is positive. Hence, the ratio on the right-hand side of (5) is positive and at most equal to 1. The implication is that the wages \( w_x \) will be set in such a way that commuting cost is partially reimbursed.\(^{10}\)

---

9 Note that we are interested in the overall, and not the partial, effect of \( x \) on the wage, because we estimate the overall effect of \( x \) later on.

10 This conclusion depends crucially on the condition that \( M \) is positive. It should be noted that it can be fulfilled even when the quit rate, \( \lambda \), is not log-convex. This assumption can therefore be relaxed to the requirement that the log-concavity of \( H_x \) is sufficient to compensate for a possible lack of log-convexity of \( \lambda \).
This result is consistent with the study by Van Ommeren and Rietveld (2005), where a proportion of the commuting costs is reimbursed given Nash wage bargaining. To be precise, in that paper $1 - \beta$ of the commuting costs are reimbursed, where $\beta$ is the worker's bargaining power. In Van Ommeren and Rietveld (2005) firms have full information about the outside options of job seekers. We do not make such an assumption.

A simple illustration of the above result is obtained when the quit rate is independent of utility and a homogeneous distribution of reservation utility is assumed:

\[ H(v) = a(v - b), \]  
\[ \text{defined for } b \leq v \leq b + 1/a. \]  
Substitution of (8) into (4), and noting that $v = w_x - tx$, it follows that:

\[ w_x = \frac{1}{2}(r - \rho V_0 + b + tx), \]  
which shows that the wage is equal to a constant $(r - \rho V_0 + b)/2$ plus $tx/2$, implying that half of the commuting costs will be reimbursed. In this simple model, the marginal reimbursement is constant and does not depend on any exogenous variable (e.g. the quit rate $\lambda$ or recruitment cost $k$). Generally speaking however, marginal reimbursement depends on the distribution of the reservation utility and the sensitivity of the quit rate to increases in the wage.

2.3 Will commuting costs always be reimbursed?

The result of the previous subsection shows that a profit maximizing monopsonist will partially reimburse the commuting cost of his workers if the labour market is homogeneous. The empirical information, to be discussed in section 4, suggests that approximately one third of the Dutch workers receive such a reimbursement. What are the reasons why the rest does not receive it?

One possibility, which is consistent with the empirical evidence provided later on, is that the commute must exceed a threshold value before a worker can claim compensation for his commuting cost. The reason for this threshold may be found in administrative costs associated with reimbursement. Since many workers live close to their work, a substantial fraction of workers is unable to claim reimbursement. The data show that more than 60% of those with a commute of at least 30 minutes one-way receive some compensation for the associated cost of commuting.
The model of the previous section suggests another possibility for explaining the absence of reimbursement: labour supply may not be spatially homogeneous (see Appendix A3 for details). For example, if the reservation utility of workers who live further away from firms is, on average, lower than the reservation utility of those living nearby, there is less need to pay a reimbursement. There are situations in which this is probable. For instance, house prices or rents are often higher in residential locations with a good accessibility to jobs. This implies that the housing market provides a (partial) compensation for workers living at less attractive locations and therefore having to accept lower wages.\(^{11}\) This also suggests that reimbursement of commuting costs is industry dependent due to the difference in locations of these industries relative to residential areas.

Another possibility is that workers with longer commutes are less productive. Workers with long commutes may arrive late more often than others, may want to depart early and may be less concentrated during the working day. This possibility has been suggested in a slightly different context by Zenou (2002). This effect can be incorporated into the model by rewriting the value added, \(r\), as a function of the commuting distance, \(x\). Equation (5) then becomes:

\[
\frac{dw}{dx} = \frac{\partial r}{\partial x} + \frac{M}{N^2 + M^2}  
\]

If \(\frac{\partial r}{\partial x}\) is negative, then the tendency to reimburse commuting costs is reduced.\(^{12}\)

Finally, there is also the possibility that on some segments of the labour market employers do not have substantial monopsony power, implying that wage discrimination based on residential location is unfeasible.

### 3 Taxes and the reimbursement of commuting cost

In the present section we consider the effect of tax facilities on reimbursement of commuting expenses. The discussion focuses on the Netherlands, to which our empirical work refers. We start with a general discussion of the incentives provided by the tax facilities. We then discuss their implications in the context of a competitive market. Finally, we consider the consequences of introducing taxes into the model of monopsonistic behaviour of the previous section.

\(^{11}\) The standard monocentric model assumes a competitive labour market. In equilibrium the rent gradient provides full compensation for commuting costs. Empirical evidence confirms the existence of a house price gradient, which is far from steep enough to provide full compensation for commuting to the CBD (see, e.g., Söderberg and Janssen).

\(^{12}\) Hence, if one ignores in the empirical application that workers with longer commutes are less productive, then one underestimates the reimbursement of commuting costs due to monopsonistic competition.
3.1 Tax facilities for the reimbursement of commuting costs

In the Netherlands, as in many other countries, there are tax facilities for commuting costs.\textsuperscript{13} The presence of tax facilities provides an incentive to use reimbursement even in the absence of monopsony power. To see how plausible this behaviour is, we consider the institutional setting in some detail.

It is useful to distinguish between net wage, gross wage and labour cost.\textsuperscript{14} The gap between labour cost and net wage is considerable in the Netherlands and this makes it attractive to provide fringe benefits and reimbursements that are exempt from income taxation and social insurance premiums instead of wages. In principle both parties can gain from such a substitution (see Appendix A4).\textsuperscript{15} However, there are some institutional arrangements that make this less attractive than it appears to be at first sight.

The income tax in the Netherlands is based on the principle that costs that have to be made by the employee in order to realize earnings (e.g. clothing) are deductible from taxable income. The cost of travelling from home to work is considered to be such a cost and any employee with a commute of at least 10 km is allowed to deduct a prescribed amount of money, to be denoted as $A$, from taxable income, independent of whether the employer pays any compensation to the employee.\textsuperscript{16}

The difference between the deductible amount and the reimbursement received from the employer can be subtracted from taxable income. When the reimbursement does not exceed the deductible amount, then there are no income tax gains. Hence, there is a gain for the employer, but not for the employee. When the reimbursement received by the worker exceeds the deductible amount, the excess reimbursement has no effect on the employee’s taxable income as long as it does not exceed a critical value, to be denoted as $B$. Payments in excess of this critical value are

\textsuperscript{13} One advantageous aspect of this situation for the purpose of the present paper is that, for this reason, reimbursement of commuting cost is specified separately from other earnings components.

\textsuperscript{14} The net wage is equal to the gross wage minus income tax and worker's social insurance premiums. The labour cost is equal to the gross wage plus the taxes and social insurance premiums the employer has to pay.

\textsuperscript{15} It can be shown that the marginal reimbursement $dw/dx$ (viz the additional reimbursement for an additional commuting kilometre) is reduced to the gap between labour costs and (after tax) wage (see Appendix A4).

\textsuperscript{16} The exact amount depends on some broad intervals of commutes and differentiates between public and private transport in an attempt to stimulate the former.
not accepted by the tax authorities as a compensation for commuting cost, but are considered as an addition to the wage, so that there is no tax advantage left for either employer or employee. When the reimbursement exceeds $A$, but is less than $B$, the reimbursement is not taxed, so the marginal increase in labour costs is equal to the marginal increase in reimbursement received by the worker. Otherwise, the marginal increase in labour costs exceeds the marginal increase in (after tax) reimbursement.\[17\]

On a competitive labour market, labour cost per employee is equal to the marginal product. Identical employees will therefore have the same total labour cost, independent of their commute. Given a lower tax on reimbursements, the normal (taxable) wage must be reduced when the commuting cost reimbursement will be paid.\[18\] This requires that normal wages can be set at an individual level. If this would be impossible and workers (have to) receive the same gross wage, the employer has no incentive to provide any reimbursement for commuting costs on a competitive labour market, since that would offer no savings on tax payments and increases labour costs.

For institutional reasons, it may be difficult (or even impossible) for employers to decrease normal wages and increase commuting costs reimbursements to decrease total labour costs. In the Netherlands, wages are often determined as a result of collective bargaining and reimbursement of commuting cost is then part of such agreements. Reimbursement of commuting costs is treated as an addition to a wage that is defined by the type of job, but excludes the possibility for the employer to pay lower normal wages for those with higher commuting costs reimbursement.\[19\]

\[17\] The values of $A$ and $B$ depend on the length of the commuting distance in kilometres and on the transport mode used. For example, in 1998, $A$ was maximally 170 Dutch guilders per month (this refers to car drivers with a commute of at least 20 km) and $B$ maximally 390 Dutch guilders (this refers to public transport users with a commute of at least 80 km). In most situations, the difference between $A$ and $B$ was close to 100 Dutch guilders. A priori, it is not clear whether a monopsonistic employer will reimburse more, or less, than the maximum reimbursement $B$. It is straightforward to construct examples such that it may be optimal for the monopsonistic employer to reimburse exactly the amount $B$ and pay a (taxable) wage to workers that is independent of the length of the commute.

\[18\] For a given level of labour cost, the employer has an incentive to pay an amount $B$ as a compensation for commuting cost, since this would imply the lowest possible amount of taxes and social insurance premiums to be paid. This incentive is likely weaker than it appears to be at first sight. An important reason is that the value of a worker’s pension, unemployment benefit, and disability insurance are entirely based on wages net of cost reimbursements, which makes it less attractive to accept a lower wage for reimbursement of commuting cost. Based on information from the Dutch housing market survey (2002), it appears that only a minority of workers who receive a reimbursement receive the maximum reimbursement. This result is consistent with monopsonistic behaviour.

\[19\] Since employers wish to avoid the administrative costs associated with reimbursement, there must be good reasons for introducing a reimbursement for travel costs in collective bargaining agreements. We suggest that the
These considerations suggest an empirical test of the hypothesis that reimbursement of commuting cost is entirely induced by tax facilities and not by monopsonistic behaviour. If workers are paid the same normal wage, but receive different commuting costs reimbursements, then their labour costs are different, which is incompatible with perfect competition on the labour market. In section 4 we will report the results of an empirical test based on this idea.

4 Empirical analysis: reimbursement of commuting costs in the Netherlands

4.1 Descriptives
The data we use are based on a survey that was carried out bi-annually by the OSA (Organisation for Strategic Labour Market Research). We focus on employees. The survey contains the following question:

“Over the last 12 months, did you receive a reimbursement of commuting expenses on top of your normal wage?”

In case of a positive answer, respondents were asked for the monthly net reimbursement. We focus on answers to this question, that is, on what one might call explicit reimbursement. We will therefore in the present section distinguish between reimbursement and wages. This does not imply that we exclude the possibility of reimbursement of travel cost through the normal wage. We will also consider the possibility of such implicit reimbursement (e.g. reimbursement through wages), where this is appropriate. It may be recalled that the ‘wage’ in the theoretical model of the previous section refers here to the sum of the normal wage and the explicit reimbursement.

Until section 4.4 we concentrate on 1998, the most recent year for which the data are at our disposal. From a sample with 2349 observations we exclude observations referring to combination of monopsonistic incentives on the employer’s side and equity considerations on the workers’ side induces the likelihood that commuting cost reimbursement is included in these agreements. The empirical evidence that is presented in the next section endorses this opinion.

We assume that respondents interpreted net reimbursement as referring to the amount of money paid by their employer as reimbursement of commuting expenses (i.e. to \( r_c \)). The question could in principle also be interpreted as referring to the amount of cost reimbursement that remains after its effect on the income tax has been subtracted (i.e. to \( n_{rc} \)). If respondents have chosen the other interpretation (that is, have computed the reimbursement that remains after taking into account the effect on income taxation), this affects the magnitude of estimated reimbursement, but not our conclusions.

20 In section 4.4 we extend the analysis with data from 1994 and 1996 so as to carry out a panel data analysis.
workers with a company car\textsuperscript{22} and to respondents reporting to work less than 12 or more than 60 hours per week. Further we exclude observations that are likely outliers, such as workers who receive more than 1000 Dutch guilders per month as a reimbursement for commuting expenses, who commute more than two hours (one way) and respondents who reported to receive a reimbursement whereas at the same time stated that the reimbursement equals 0. This leaves us with 2078 observations.

Table 1 Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Workers with reimbursement</th>
<th>Workers without reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>739</td>
<td>1339</td>
</tr>
<tr>
<td>Average commuting time\textsuperscript{1}</td>
<td>31.37</td>
<td>15.85</td>
</tr>
<tr>
<td>Average net monthly wage\textsuperscript{2}</td>
<td>2861.96</td>
<td>2402.23</td>
</tr>
<tr>
<td>Average monthly reimbursement \textsuperscript{2}</td>
<td>132.93</td>
<td>-</td>
</tr>
<tr>
<td>Reimbursement/monthly wage</td>
<td>0.051</td>
<td>-</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Minutes, one-way trip  
\textsuperscript{2} Dutch guilders at current (1998) prices

Table 1 shows the most relevant descriptive statistics.\textsuperscript{23} We distinguish between workers with and without reimbursement. Workers that receive a reimbursement (36\% of the sample) have an average commuting time that is twice as long and earn on average 19\% more than other workers. The average reimbursement amounts to 133 Dutch guilders in 1998 prices (approximately 60 euros) per month, approximately 5\% of the net monthly wage.

In order to interpret the numbers shown in the Table, now consider a representative full time worker who travels half an hour from home to work and vice versa five days per week. His monthly commuting time is then 20 hours, approximately 12.5\% of total monthly working hours. The reimbursement of commuting cost is therefore approximately one third of the wage rate. The average reimbursement amounts to 6.5 Dutch guilders per hour of travel time. If we interpret it as a compensation for travel time, we must conclude that it is slightly lower than the value of travel time suggested by transportation studies, which often find values of time that equal about 50\% of

\textsuperscript{22} In the large majority of cases the company car is used for commuting. However, reimbursement of commuting cost is difficult to identify in these cases as it cannot be distinguished from the compensation for travel for business purposes.
the wage rate (see, for instance, Small, 1992). However, this ignores monetary costs of travel (fuel and maintenance for car drivers, or public transport expenses) which are about one third of the total commuting costs, so reimbursement is about 50% of the workers' commuting costs. Hence, the descriptive statistics indicate that the reimbursement does, on average, not cover all commuting costs, in line with our theoretical model.

Table 2 Commuting reimbursement and commuting time

<table>
<thead>
<tr>
<th>Commuting time(^1)</th>
<th>% receiving reimbursement</th>
<th>Average amount of reimbursement(^2)</th>
<th>Reimbursement/ Net monthly wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1-5</td>
<td>8</td>
<td>70.36</td>
<td>0.025</td>
</tr>
<tr>
<td>6-10</td>
<td>13</td>
<td>79.87</td>
<td>0.033</td>
</tr>
<tr>
<td>11-15</td>
<td>27</td>
<td>83.64</td>
<td>0.037</td>
</tr>
<tr>
<td>16-20</td>
<td>49</td>
<td>109.22</td>
<td>0.048</td>
</tr>
<tr>
<td>21-25</td>
<td>54</td>
<td>157.57</td>
<td>0.064</td>
</tr>
<tr>
<td>26-30</td>
<td>53</td>
<td>121.35</td>
<td>0.047</td>
</tr>
<tr>
<td>31-45</td>
<td>73</td>
<td>159.04</td>
<td>0.054</td>
</tr>
<tr>
<td>46-60</td>
<td>74</td>
<td>190.56</td>
<td>0.068</td>
</tr>
<tr>
<td>&gt;60</td>
<td>65</td>
<td>275.59</td>
<td>0.095</td>
</tr>
</tbody>
</table>

\(^1\) Minutes, one way trip
\(^2\) The average refers only to workers who receive compensation for commuting cost, expressed in Dutch guilders at current prices

Table 2 shows the relationship between commuting time and the explicit reimbursement for commuting costs. The share of workers receiving commuting reimbursement increases from less than 10% for those with a commute of at most five minutes, to more than 60% for those that travel at least 30 minutes from home to work.\(^{24}\) This is the pattern one expects to observe if compensation for commuting costs is used as an instrument of a firm’s recruitment strategy. The amount of compensation received increases with commuting time, but it does not appear to be proportional to commuting time.\(^{25}\) The table also shows that the compensation for commuting

\(^{23}\) We use information about commuting time. We lack information about commuting distances. Both measures have their advantages in the current context.

\(^{24}\) None of the 27 workers who report a zero commute receive compensation.

\(^{25}\) The amount of compensation received per minute of commuting time is highest for those with short commutes and decreases with the length of the commute. This makes sense when compensation for commuting expenses is
cost is a substantial share of net monthly wage for longer commutes and comes close to 10% for those who travel more than one hour from home to work.\textsuperscript{26}

### 4.2 The probability that reimbursement will be received

In order to get more insight into the determinants of receiving a compensation for commuting cost, we estimate a standard probit model.\textsuperscript{27} To allow for nonlinear effects of commuting time, we also included its square and cube. Further we interacted commuting time with permanent position.\textsuperscript{28} Table 3 reports the results for only a limited number of explanatory variables included in the model. There appears a significant effect of commuting time on the reimbursement probability. For commutes between 30 and 90 minutes, the probability of receiving reimbursement is an increasing convex function of commuting time. This pattern is consistent with the use of a threshold value for reimbursement claims and with the information of Tables 1 and 2.

A permanent position greatly increases the probability that compensation will be received, but it does not influence the effect of the commute on this probability. Note that the theoretical model presented above refers to jobs that are permanent. For temporary jobs, vacancy costs may be lower and considerations with respect to the effect of a reimbursement on the quit rate are probably absent, suggesting less compensation. Employment in the public sector implies a significantly lower probability of receiving compensation for commuting cost\textsuperscript{29}, employment at a proportional to the length of the commute in kilometres, with a threshold value below which no compensation can be claimed. Such a reimbursement scheme implies that commuters who use a fast mode (car) will receive more compensation per minute of commuting time than those who use a slow mode (bike or public transport).

\textsuperscript{26} There are substantial differences between the shares of the workers receiving compensation for commuting cost in various industries. Almost 50% of those employed in the financial sector receive such compensation, but only 28% of the workers in the trade and retail industry; 33% of the civil servants receive a reimbursement of their commuting cost. The differences between industries cannot be explained by tax incentives, since these are equal for all industries. Other explanations, for instance related to the geographical location of firms in the various industries have to be invoked. It may, for instance, be noted that companies in the trade and retail industry are more likely to be located close to residential areas, whereas companies in the financial sector and manufacturing are usually located in business districts. Approximately a quarter of the workers employed by a firm with less than 20 employees receive reimbursement for commuting cost, but more than 45% of those employed in a firm with more than 100 employees. Since large firms are more likely to have a monopsonistic position on local labour markets, this pattern is consistent with an explanation of reimbursement of commuting costs on the basis of monopsonistic behaviour.

\textsuperscript{27} The dependent variable equals 1 if the worker receives reimbursement of commuting cost and 0 otherwise.

\textsuperscript{28} We have included the monthly wage as a control variable in alternative specifications. If reimbursement behaviour is (partly) driven by tax incentives, this variable will be endogenous. However, the coefficient for the wage was small and statistically insignificant. Results for the model excluding the wage are almost identical to those reported here.

\textsuperscript{29} This result is consistent with the idea that public organisations internalize the external effects of commuting (e.g. congestion) and offer less reimbursement than private employers.
large firm implies a significantly larger probability.\textsuperscript{30} The latter result suggests that larger firms have more monopsonistic power, but other explanations cannot be ruled out (see Burdett and Mortensen, 1998).

Table 3 Probit estimates for receipt of reimbursement for commuting costs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient (st. err.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuting time</td>
<td>0.124 (0.011)</td>
</tr>
<tr>
<td>(Commuting time)$^2/10^2$</td>
<td>-0.182 (0.028)</td>
</tr>
<tr>
<td>(Commuting time)$^3/10^4$</td>
<td>0.0804 (0.019)</td>
</tr>
<tr>
<td>Permanent position</td>
<td>0.578 (0.14)</td>
</tr>
<tr>
<td>Hours worked per week</td>
<td>-0.002 (0.004)</td>
</tr>
<tr>
<td>Metal manufacturing</td>
<td>0.211 (0.16)</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>0.104 (0.16)</td>
</tr>
<tr>
<td>Trade and retail</td>
<td>-0.240 (0.13)</td>
</tr>
<tr>
<td>Transport</td>
<td>-0.0740 (0.16)</td>
</tr>
<tr>
<td>Financial sector</td>
<td>0.160 (0.14)</td>
</tr>
<tr>
<td>Public sector</td>
<td>-0.383 (0.11)</td>
</tr>
<tr>
<td>20-100 employees</td>
<td>0.113 (0.09)</td>
</tr>
<tr>
<td>More than 100 employees</td>
<td>0.350 (0.09)</td>
</tr>
<tr>
<td>Control variables</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Number of observations 1987
Log likelihood -974.24

Apart from the variables reported in the table a constant and controls for gender, age, wage, education, type of work (dangerous, dirty, et cetera), job level dummies, working on Saturday or Sunday, flexible working hours, partner were included in the estimation. The reference for industry is a rest category containing agriculture, mining, construction and public utilities; the reference for firm size are firms with less than 20 employees, and a small number of observation for which firm size was not reported. When only a constant is estimated the likelihood is –1352.49. The pseudo-$R^2$ equals .25. Standard errors are reported in parentheses.

4.3 Determinants of reimbursement level

To get further insight into the effect of commuting time and other determinants on the reimbursement level, we estimated a linear equation, using a standard Heckman (1979) two-step

\textsuperscript{30} None of the other control variables included in the probit model has a significant coefficient. For instance, working on Saturday or Sunday does not appear to have a relationship with reimbursement of commuting cost, and also those with flexible working hours do not have a significantly smaller probability of receiving a reimbursement. Introduction of the hourly wage rate as a dependent variable does not result in a significant coefficient.
procedure to account for possible selection effects. The column denoted as ‘Model I’ gives the results of a model with travel time as the only explanatory variable. It appears that workers receive a compensation of approximately 2.5 Dutch guilders per minute of commuting time.

Table 4 Determinants of reimbursement of commuting costs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model I</th>
<th>Model II</th>
<th>Model III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>55.44 (16.69)</td>
<td>-18.20 (15.34)</td>
<td>-57.80 (60.1)</td>
</tr>
<tr>
<td>Commuting time</td>
<td>2.55 (0.26)</td>
<td>2.68 (0.28)</td>
<td>4.52 (1.19)</td>
</tr>
<tr>
<td>Hours worked per week</td>
<td>2.62 (0.51)</td>
<td>3.42 (0.81)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Working hours</td>
<td></td>
<td>-0.034 (0.025)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Metal</td>
<td></td>
<td>-0.78 (0.87)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Other Man.</td>
<td></td>
<td>-0.71 (1.06)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Trade and retail</td>
<td></td>
<td>-0.68 (0.74)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Transport</td>
<td></td>
<td>-0.42 (0.88)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Financial sect.</td>
<td></td>
<td>-0.28 (0.66)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*Public sector</td>
<td></td>
<td>-1.16 (0.60)</td>
<td></td>
</tr>
<tr>
<td>20-100 empl.</td>
<td>-25.23 (10.14)</td>
<td>3.60 (19.1)</td>
<td></td>
</tr>
<tr>
<td>&gt;100 empl.</td>
<td>-14.66 (10.06)</td>
<td>-27.7 (18.5)</td>
<td></td>
</tr>
<tr>
<td>Comm. time*20-100 empl.</td>
<td>-0.97 (0.52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comm. time* More than 100 empl.</td>
<td>0.33 (0.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control variables</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\( \lambda \) (inverse Mill’s ratio) | -4.36 (12.5)  | -10.04 (15.07)| 12.71 (15.28) |

Number of observations 710

Heckman’s two step procedure has been applied in order to correct for possible selectivity effects. The probit model of the previous subsection has been used as the selection equation. In models II and III all the variables used in this probit model except the squared and cubed commutes have been added as control variables. Linear regression without this correction gives almost identical results for each of the three models. Standard errors are reported in parentheses.

Model II is a more elaborate version that also contains control variables. The marginal effect of commuting time on reimbursement is now about the same. In line with the theoretical model, these results imply that reimbursement is partial. The implied reimbursement for a one

---

31 The squared and cubed commutes have been used in the first step but not in the second step. This can be justified as these are less likely to have an effect given a positive reimbursement. We have also estimated tobit models. However, earlier in this section we observed that some employers probably use a (strictly positive) threshold value for the compensation of commuting costs, which makes the tobit specification less attractive, as it is probably misspecified.
hour commute is about one fourth of the wage rate. The workers' costs of a one hour commute are estimated to be considerably higher. Reimbursement is about one third of the workers' commuting costs, and is therefore partial. Working hours appear to have a large effect on the size of the total reimbursement capturing the number of days travelled per month.

In ‘Model III’ we add interactions between commuting time and a number of control variables: hours worked, industry and firm size. Interaction effects turn out to be less relevant. The coefficient for the interaction between working hours and commuting time is insignificant, indicating – maybe surprisingly - that the marginal reimbursement of commuting time for full-time workers does not differ from that of part-time workers. Interactions of commuting time and industry dummies are also insignificant, except maybe for the public sector, where about one guilder less per minute of commuting time is reimbursed.

4.4 A panel data analysis
In this subsection we report the results of an empirical investigation of the validity of the hypothesis that travel cost reimbursements are entirely tax-induced. If reimbursement of commuting cost is totally tax-induced, changes in the commute of employees who changed residence but did not change their employer would result in a shift of the composition of total payment: a larger commuting time would imply a higher compensation for commuting cost, but a lower normal wage. In a cross-section, differences in the composition of total payments could be the result of heterogeneity among employer and employees. Panel data allow us to control for such differences.

The data for 1998 that have been used in the previous subsection are a single wave from a larger panel data set and they therefore allow us to carry out this test. Every two years a new wave is added to the OSA panel. We have combined the data from 1994 and 1996 with those of 1998. These data allow us to measure the effect of a change in the commute, while keeping the characteristics of the worker and his employer constant. In order to keep employer characteristics constant, we select workers that were observed at least twice and did not change employer. Moreover, we selected observations in which the employee received a positive amount of

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32 The total number of observations in these three waves is 7,372.
reimbursement. The remaining observations refer to 488 individuals observed at least twice, and 136 of them observed three times.

Table 5 Fixed effects results for 3 income components

<table>
<thead>
<tr>
<th>Variable</th>
<th>Reimbursement</th>
<th>Wage</th>
<th>Reimbursement + wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuting time</td>
<td>2.13 (0.27)</td>
<td>0.925 (1.2)</td>
<td>2.79 (1.2)</td>
</tr>
<tr>
<td>Hours worked</td>
<td>1.33 (0.87)</td>
<td>45.07 (4.0)</td>
<td>47.34 (4.2)</td>
</tr>
<tr>
<td>Dummy for 1996</td>
<td>8.33 (4.3)</td>
<td>224.81 (19.8)</td>
<td>232.42 (20.5)</td>
</tr>
<tr>
<td>Dummy for 1998</td>
<td>10.23 (5.5)</td>
<td>280.98 (25.2)</td>
<td>293.41 (26.1)</td>
</tr>
<tr>
<td>R² between</td>
<td>0.20</td>
<td>0.32</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Standard errors are reported in parentheses.

In Table 5, we report the effect of time-varying explanatory variables on 3 income components. The second column of Table 5 shows a marginal effect of the commute of 2.13 Dutch guilders per minute of commuting time on the level of reimbursement. This effect is close to but somewhat smaller than the earlier – cross-section - estimate. It is still highly statistically significant. Changes in hours worked have no significant effect on the compensation for commuting costs.

The third column shows that there is no discernible negative effect of commuting time on the normal wage. The coefficient is small and highly insignificant. If there is any effect, it is more likely to be positive. This implies that there is no support for the view that a part of regular earnings will be switched to a compensation for commuting cost in order to realize a tax benefit for employer or worker when the commute increases. These results suggest that if a reduced tax

---

33 Hence, we avoid any bias in the coefficient for commuting time that results from threshold effects in the reimbursement schedules.
34 In the analysis, we control for worker-specific fixed effects, hence we also control for worker-specific selection effects.
35 The data do not allow us to identify the workers who moved residence directly, but changes in commuting time are registered and this is the variable that is relevant for our purpose. It is plausible, however, that some workers report changes in commuting time that are caused by changes in infrastructure or congestion. In such cases we expect the compensation for commuting cost (which is maybe more related to commuting distance than to commuting time) to remain constant in most cases. It is probable that this introduces a bias towards zero in the estimated marginal effect of commuting time on the compensation. So, our results are conservative.
36 As noted above, the size of the effect implies that reimbursement is partial, in line with the theoretical model.
37 Note that the normal (after-tax) wage may change if the worker moves residence as income tax in the Netherlands depends on the tenure of the residence and the size of mortgage (interest payment are deductible). Apparently, this effect is not systematically related to the length of the commute.
on reimbursement has any effect on the level of reimbursement, then the implicit subsidies accrue to workers and not to firms in line with monopsony (see Zax, 1988).

The fourth column shows that the sum of normal wage and reimbursement increases when a worker’s commuting time goes up. The coefficient for travel time is larger than that estimated for the reimbursement equation (second column). Its standard error is of similar size to that estimated for the travel time coefficient in the normal wage equation (third column), reflecting the larger noise component in this variable. This result illustrates the relevance to distinguish reimbursement of commuting costs from other income components.\(^{38}\)

Summarizing, the results presented in Table 5 confirm our hypothesis that employees receive partial compensation from their employers when they have a large commute. Since the reimbursement of commuting costs increases and the normal wage does not decrease, this implies that labour cost increases in the commute. As argued above, this is consistent with monopsonistic behaviour, but not with a competitive labour market.

\section*{5 Conclusion}

This paper documents the widespread presence of reimbursement of commuting cost for workers in the Netherlands. Approximately one third of the workers in the Netherlands receive a compensation for commuting costs. Since compensation for commuting costs implies that identical workers (for the firm) are paid differently, such compensation will not occur on a labour market with perfect competition. Compensation for commuting cost may be interpreted as an instrument of a monopsonistic employer's recruitment policy and is an example of intra-firm wage differences for equally productive workers. There exists a large literature on wage dispersion and productivity, which essentially argues that greater intra-firm wage disparity may reduce team performance as wage disparity is not seen as fair (e.g. Akerlof and Yellen, 1988; Depken, 2000). In this literature, individual wage differences are based on individual differences in productivity. In contrast, we focus on wage differences of workers that are equally productive, \footnote{The results are consistent with the panel data study by Manning (2003) for the UK that also shows a positive relationship between wages and commuting. In this study however, it is not possible to distinguish between ‘normal wages’ and explicit reimbursement and does not control for workplace (by selecting workers who do not change employer). Manning (2003) convincingly points out that the positive relationship between wages and the commute cannot be explained by the presence of wage differences within or between urban areas, viz. the presence of a wage gradient. The latter interpretation has been common in the urban economics literature, but is entirely based on cross-section studies. In the current panel data analysis, we control for workplace location (by selecting workers that do not change workplace), hence our result may also not be interpreted as the result of a wage gradient.}

but (only) differ in their commuting costs. Note that reimbursement of commuting expenses is in line with (economic) notions of fairness (e.g. Feldman and Kirman, 1974), as those who are worse off receive a higher level of reimbursement.

The empirical analysis of the current paper is consistent with the notion of intra-firm discrimination based on worker's commute. A panel data analysis demonstrated a positive effect of commuting time on reimbursement, but showed no evidence of a offsetting reduction in the ‘normal’ wage one would expect on a perfectly competitive labour market with tax-induced reimbursement of commuting costs.\(^{39}\)

In the Dutch labour market, the average reimbursement for commuting is about 5% of net monthly income, whereas one out of three workers receives this reimbursement. Hence, up to 1.7% of average employer payments to workers may be explained by intrafirm wage variation due to spatial monopsonistic behaviour of employers.\(^{40}\) The level of reimbursement depends on the length of the commute. For workers with a minimal commute (e.g. less than 10 minutes one-way; about 30% of the workforce), average reimbursement is 0.3% of net income, and therefore almost negligible. For workers with a one-way commute that exceeds one hour (about 7% of the workforce), reimbursement is approximately 6.9% of net income, and therefore clearly substantial. Such an estimate of monopsonistic effects is not unreasonable in the light of previous studies which show that gross wages are about 20% less than marginal productivity levels (e.g. Card and Krueger, 1995). Our results suggest therefore that workers with a long commute are able to reduce the gap between wages and productivity levels up to one quarter. In the light of our monopsonistic model, applicants with a long commute are able to substantially reduce the monopsonistic power of the employer, because for these applicants employment at this firm is less valuable.

\(^{39}\) Our study has not only consequences for labour economists interested in the competitiveness of the labour market, but it also has implications in other fields. For example, a large number of studies have shown that the external costs of commuting are substantial due to congestion and negative environmental impacts. Economists' natural response to external costs is the introduction of a Pigouvian road tax. Evaluation the general welfare effects of such a tax is usually applied within a competitive labour market framework (see e.g. Parry and Bento, 2000). Our study points out that it is not implausible that an increase in the price of commuting due to a tax is partially reimbursed by employers, an element which is missing in these models. Our study suggests that up to a third of the worker's expenses on a road tax is reimbursed. As far as we know the effect of road pricing schemes on compensation by employers has received little explicit attention.

\(^{40}\) The descriptive data and the panel data analyses indicate about the same order of magnitude of the reimbursement effects, so we may interpret the above mentioned 5% as a causal effect.
References


Appendix A1 Derivation of the optimal wage for a given recruitment area

We will first consider the optimal determination of the wages while taking the set of acceptable locations of workers as given. The set of acceptable locations or recruitment area is denoted as $A$. In Appendix A2 we will discuss the optimal determination of $A$. To find the optimal wage at an arbitrary location $x \in A$ we rewrite (2) as:

$$\rho V_0 = -k + \mu \int_A f(x) H_x(w_x - tx) [V_{1x} - V_0] dx. \quad (A1)$$

Rearranging terms, this becomes:

$$V_0 = \frac{-k + \mu \int_A f(x) H_x(w_x - tx) V_{1x} dx}{\rho + \mu \theta}. \quad (A2)$$

The employer maximizes $V_0$ by choosing the offered wage as a function of $x$. The first-order implies then that for every $x$:

$$\frac{\partial V_0}{\partial w_x} = 0. \quad (A3)$$

Elaboration of this condition using the envelope theorem gives:

$$(\rho + \mu \theta) f(x) \left[ V_{1x} H_x(w_x - tx) + V_{1x} H_x(w_x - tx) \frac{\partial V_{1x}}{\partial w_x} \right] - \int_0^\infty f(z) H_z(w_z - tz) V_{1z} dz \frac{\partial \theta}{\partial w_x} = 0. \quad (A4)$$

In order to simplify this expression we rewrite (3) as:

$$V_{1x} = \frac{r - w_x}{\rho + \lambda(x, w_x)} + \frac{\lambda(x, w_x)}{\rho + \lambda(x, w_x)} V_0. \quad (A5)$$

and conclude:

$$\frac{\partial V_{1x}}{\partial w_x} = -\frac{1 + (\partial \lambda/\partial w_x)[V_{1x} - V_0]}{\rho + \lambda}, \quad (A6)$$

where the arguments of $\lambda$ have been suppressed in order to simplify notation. Moreover, it follows from (1) that:
\[
\frac{\partial \theta}{\partial w_x} = f(x) h_x (w_x - tx),
\]

because \( f(y) h_x (w_x - ty) \) does not depend on \( w_x \) for \( w_x \neq w_y \). Substitution of these results into (A3) and then using (A2) gives:

\[
V_{lx} = V_0 + \frac{H_x}{(\rho + \lambda) h_x - (\partial \lambda / \partial w_x) H_x}.
\]

where we have simplified the notation further by suppressing the arguments of \( H_x \) and \( h_x \).

Combining (A4) and (A7), we derive the following expression for \( w_x \):

\[
w_x = r - \rho V_0 - \frac{1}{H_x} \left( \frac{\partial \lambda}{\partial w_x} \right),
\]

\[
= r - \rho V_0 - \frac{1}{\partial w_x} \left( \frac{\partial \ln H_x}{\partial w_x} - \frac{\partial \ln (\rho + \lambda)}{\partial w_x} \right).
\]

This is equation (4) in the main text.

We should note that this derivation assumes that \( H_x \) is positive. This requires that the wage is at least equal to \( b_x \), the lower bound of the support of \( H_x \):

\[
w_x \geq b_x + tx
\]

The third term on the right-hand-side of (A8) is only defined for wages that satisfy condition (A9). The assumptions made about the distribution of the reservation utility and the quit rate imply that this third term, and therefore the whole right-hand-side of (A8), is decreasing in \( w_x \). The left-hand-side is, of course increasing with slope equal to 1. We can therefore conclude that there will be a value of \( w_x \) that satisfies (A8) if and only if the left-hand-side of (A8) is smaller than the right-hand-side for \( w_x = b_x + tx \), that is if and only if:

\[
r - \rho V_0 - \frac{1}{\partial w_x} \left( \frac{\partial \ln H_x}{\partial w_x} - \frac{\partial \ln (\rho + \lambda)}{\partial w_x} \right) \geq w_x \text{ if } w_x = b_x + tx
\]

If this condition is satisfied, the wage will be set according to (A8). If the condition is not satisfied, no wage can be set.
A2 Derivation of an optimal recruitment area

We note, first of all, that it makes no sense to include commuting distances in the recruitment area for which no optimal wage can be set. Let $D(V_0)$ be the set of commuting distances for which (A10) is satisfied for a given value of $V_0$. If a commuting distance $x$ belongs to $D(V_0)$, $V_{1x} \geq V_0$ (see A7). Now observe that $A$ can, without loss of generality be considered as the union of a set of disjoint intervals of commuting distances (the reason is that isolated points will not contribute to the value of $V_0$). Let $\beta'$ be a boundary of one of its intervals and consider the change in $V_0$ that occurs as a consequence of a shift in $\beta$. Using (A1), we write this change as:

$$
\rho dV_0 = \mu \int_{x \in A} f(x) \left( h(x) \left( dw_x \right) [V_{1x} - V_0] + H_x d[V_{1x} - V_0] \right) dx + f(\beta) H_{\beta'} (w_\beta - \tau \beta) \left[ V_{1\beta} - V_0 \right].
$$

(A11)

Elaboration of $dw_x$, using (A8), and $dV_{1x}$, using (A7), leads to an equation of the form:

$$
X \ dV_0 = f(\beta) H_{\beta'} (w_\beta - \tau \beta) \left[ V_{1\beta} - V_0 \right],
$$

(A12)

where $X$ is a complicated expression that is positive under the assumptions that have been made with respect to the distribution of reservation utility and the quit rate. We can therefore conclude that extending the recruitment area through an increase in $\beta$ will increase the value of $V_0$ whenever $V_{1\beta} - V_0 > 0$ and will not decrease it when $V_{1\beta} = V_0$. Similar reasoning applies to decreasing the recruitment area through a change in $\beta$. The optimal recruitment area will therefore be equal to $D(V_0)$: the employer will accept workers from all commuting distances for which an optimal wage can be set.

A3 The relationship between the optimal wage and the commuting distance

To determine the sign of $dw_x / dx$, we rewrite (A8) as:

$$
w_x = r - \rho V_0 - \frac{1}{N},
$$

(A13)

where

$$
N = \frac{\partial \ln H_x}{\partial w_x} - \frac{\partial \ln (\rho + \lambda)}{\partial w_x}.
$$

(A14)

From (A10) we derive:
\[ dw_x = \frac{1}{N^2} dN. \]  

(A15)

Further,
\[
dN = \frac{\partial^2 \ln H_x}{\partial w_x^2} (dw_x - tdx) + \frac{\partial^2 \ln H_x}{\partial w_x \partial \gamma} \frac{\partial \gamma}{\partial x} dx 
- \frac{\partial^2 \ln (\rho + \lambda)}{\partial w_x^2} (dw_x - tdx) - \frac{\partial^2 \ln (\rho + \lambda)}{\partial w_x \partial x} dx.
\]

(A16)

If we substitute this result into (A12) and rearrange terms, we obtain:
\[
\frac{dw}{dx} = \frac{tM + M^*}{N^2 + M}
\]

(A17)

with:
\[
M = -\frac{\partial^2 \ln H_x}{\partial w_x^2} + \frac{\partial^2 \ln (\rho + \lambda)}{\partial w_x^2}
\]

(A18)
\[
M^* = \frac{\partial^2 \ln H_x}{\partial w_x \partial \sigma} \frac{\partial \sigma}{\partial x} dx - \frac{\partial^2 \ln (\rho + \lambda)}{\partial w_x \partial x} dx.
\]

(A19)

On a spatially homogeneous labour market, \(M^* = 0\). Hence, the term \(M^*\) reflects spatial changes in the distribution of the reservation utility.

A4 Taxes and monopsonistic behaviour

We now consider the effects of introducing taxes in the model. For simplicity, we presume that the labour market is spatially homogeneous and labour cost is a piecewise linear function of the wage \(w_x\). We presume now that tax facilities affect the relationship between after tax wages \(w_x\) and labour costs \(y\), such that \(\partial y/\partial w_x \geq 1\). It can be shown (proof can be received upon request) that in this case we have:
\[
\frac{dw_x}{dx} = \frac{M}{N^2 + \frac{\partial y}{\partial w_x} M} t.
\]

(A20)

If the reimbursement is not taxed, then \(\partial y/\partial w_x = 1\), otherwise, \(\partial y/\partial w_x > 1\). In the latter case, \(dw/dx\) is reduced due to the taxes. Note that the marginal labour costs \(dy/dx = (\partial y/\partial w_x)(dw_x/dx)\) are increased due to the taxes. For example, given a homogeneous distribution function \(H(v)\), it can be shown that the marginal effect of the commuting costs on the
labour costs exceeds 0.5, whereas the marginal effect on the (after-tax) wage is less than 0.5 (see (22)).