45th CONGRESS OF THE

EUROPEAN REGIONAL SCIENCE ASSOCIATION

Amsterdam, 23-27 August 2005

IDENTIFICATION OF 'WASTEFUL COMMUTING' USING SEARCH THEORY

Jos Van Ommeren

Free University
Free University, Amsterdam, the Netherlands, jommeren@feweb.vu.nl

Willemijn Van Der Straaten

Free University
Free University, Amsterdam, the Netherlands, wstraaten@feweb.vu.nl

Abstract

In this paper, we employ search theory as a micro-economic foundation for the wasteful commuting hypothesis. In the empirical analysis, the extent of the 'wasteful commuting' is identified by comparing the commute of employees and self-employed individuals who do not work from home. It is argued that the commute of the self-employed is the result of a search process for vacant workplaces, whereas employees search for vacant jobs. Because the arrival rate of workplaces exceeds the arrival rate of jobs, the self-employed have a shorter commute. We reject alternative hypotheses why the self-employed have a shorter commute. We find that 38 % of the commuting time may be considered 'wasteful'.

KEYWORDS: commuting, search, mobility, self-employed
JEL classification: R20, R64, J64;

We would like to thank Marcel Hoogzaad and Jolanda van Velsen for valuable assistance.

1. INTRODUCTION

The 'wasteful commuting' literature tests the assumption that workers optimally choose their residence or workplace location so that the costs related to commuting are minimised. Given the existence of a simplified static world with perfect labour or housing market markets, such an assumption would be plausible. In an economy with imperfections, however, this will not be the case (Weinberg et al., 1981; Zax, 1991; Holzer, 1994). In the wasteful commuting literature, market imperfections are defined as the presence of job and residential moving costs and lack of perfect information about job opportunities and vacant residences. Moving costs are relevant because they prevent employees to move job or workplace to reduce the commute, because the discounted moving costs exceed the benefit of a reduced commute. Imperfect information implies that employed and unemployed workers decide to accept jobs and residences, which do not minimise the commuting costs, because they do not have full information about all jobs and residences and have to search for vacant jobs and residences.

The theoretical literature suggests that the length of the commute is increased by market imperfections. For example, Crane (1996) shows that uncertainty concerning job locations combined with positive residential moving costs increases the ratio of actual-to-minimum commuting in urban areas.

Although the wasteful commuting literature started as a test of the monocentric urban model (Hamilton, 1982, 1989; White, 1988), it is nowadays used to test the minimising commuting costs assumption.[1] The 'wasteful commuting' hypothesis Cropper and Gordon (1991), Small and Song (1992) and Kim (1995) provide evidence that more commuting occurs than the minimum amount required for workers to commute. The best evidence suggests that the ratio of actual-to-minimum commuting is around two (Kim, 1995; Manning, 2003; Rodriguez, 2004). It is useful to distinguish between tests based on micro and aggregate data. Tests based on aggregate data are contaminated, because they presume that all workers are homogeneous. Micro data have the advantage that the homogeneity assumption is less problematic. For example, Rodriguez (2004) focuses on a micro sample of bank tellers who work at different locations of the *same* firm. He repeats that the excess commute is about 50% for employment in the same firm.[2]

[1] Hamilton (1982) argued that 10 times more commuting actually occurs in metropolitan areas than is predicted by urban economic models.
[2] Note that bank tellers may reduce their commute by finding employment at other banks, so 50 percent is an underestimate.

This paper starts from the basis that the lack of information about job opportunities implies that individuals who search for a job are confronted with a spatial distribution of acceptable job opportunities. We provide then a micro-economic foundation for the 'wasteful commuting' hypothesis. The aim of this paper is to estimate the extent of 'wasteful commuting' employing micro-economic data about the length of the commute.

The outline of the paper is as follows. In Section 2, we introduce a basic search model. In Section 3 we will estimate the model and in Section 4 we conclude.

2. The basic labour market model

2.1 Employees

A key assumption in the 'wasteful commuting' literature is that matches in the labour market and housing market are not unique. In other words, employees can be replaced by other employees who are equally productive and receive the same wage. We follow this literature by assuming that all jobs are identical and pay the same wage *w* but differ *only* with respect to the distance to the residence location, and therefore with respect to the commuting costs. The commuting costs are proportional to the commuting distance *t* and can be written as ηt (see also Manning, 2003).

Each worker is either unemployed (state 0) or employed as an employee (state 1). At random time intervals, an unemployed receives job offers randomly from each point in space at a rate λ_0. Employees do not receive job offers.[3] The commuting distance implied by a job offer is assumed to be a realisation of a random draw from a continuous differentiable cumulative employment density function $F(t)$, where $F(t)$ is the proportion of vacancies (employment offers) at a commuting distance no greater than *t*. The unemployed accept or reject job offers as soon as they arrive. Given this set up, the unemployed accept jobs with a certain range, defined by the maximum acceptable commuting distance T (see, similarly, Van den Berg and Gorter, 1997). We assume that workers do not move residence.

We assume that employees are dismissed and thus become unemployed at rate δ. Any unemployed worker receives utility flow *b* per instant (*b* can be interpreted as an unemployment benefit). All individuals discount future income at rate *r*. Given the above assumptions, the expected discounted lifetime income when an individual is unemployed, V_0, can be expressed as the solution to the following Bellman equation:

[3] Extensions of our model, which include on-the-job search render qualitatively similar results.

$$rV_0 = b + \lambda_0 [\int \max\{V_0, V_1(x)\} dF(x) - V_0]. \qquad (1)$$

In words, lifetime income is equal to the flow of income while unemployed (the benefit) plus the expected gain in income attributable to finding acceptable jobs, where acceptance only occurs if the value of employment $V_1(t)$, exceeds that of continued search V_0. Similarly, the expected lifetime income of an employee who travels commuting distance *t* solves:

$$rV_1(t) = w - \eta t + \delta [V_0 - V_1(t)]. \qquad (2)$$

$V_1(t)$ is decreasing in *t*, whereas V_0 is independent of it, which implies that there exists a maximum acceptable commuting distance T, such that: $V_1(t) < V_0$ as $t > T$ and $V_1(t) > V_0$ as $t < T$.

Derivation of T is straightforward, since T is defined by $V_1(T) = V_0$. Equation (1) can be written as:

$$rV_0 = b + \lambda_0 \int_0^T [V_1(x) - V_0] dF(x), \qquad (3)$$

and, therefore equations (2) and (3) imply, using integration by parts, that:

$$T = \frac{w - b}{\eta} - \frac{\lambda_0}{r + \delta} \int_0^T F(x) dx. \qquad (4)$$

It can be easily seen that if λ_0 becomes larger, then the maximum commuting distance is reduced, so the unemployed worker becomes more choosy and more job offers are rejected. In the extreme case that λ_0 approaches infinity, T approaches zero. In the current model, the employee's commuting distance *t* is positive (and less than T) due to search frictions because the arrival rate of jobs λ_0 is finite. In equation (4), F(*t*) is proportional to λ_0. Hence, an arrival rate that is high or high employment density has the same implication for T. We will focus now on λ_0, keeping F(t) constant.[4]

[4] Note that according to the model when the commuting costs are only determined by time costs which is proportional to y, and speed is constant, then T does *not* depend on y. This explains why the expected commuting time does *not* strongly depend on income, but mainly on educational level which determines λ_0.

Let us presume now the absence of search frictions, so λ_0 is infinite. So, the employee will choose the *optimal* commuting distance. In the current model, the optimally chosen commuting distance is the minimum distance, which is equal to zero. This can be easily seen, because V_1 is decreasing in *t* and F is differentiable everywhere. Hence, a positive commuting distance *t* can be interpreted as 'wasteful commuting'.

We will calculate now the average extent of the wasteful commute. Given homogeneity, the expected commute is equal to the average commute. According to (4), the *observed commuting* distribution G(t) is equal to $F(t)/F(T) = F(t|t \leq T)$ for $t \leq$ T. The observed commuting distribution function is equal to the *conditional employment* distribution function, the condition being that the unemployed only accept offers within a certain range defined by T. The expected commute defined as $E(t|t < T)$. It follows under quite general assumptions that $\partial E(t|t < T)/\partial \lambda_0 < 0$, because T depends negatively on λ_0 and $E(t|t < T) = \int_0^T [1 - F(t|t \leq T)]dt$. In case that $F(t) = \alpha t^2$, so firms are distributed homogenously over two-dimensional space, then $T = w - b - \lambda_0 \alpha T^2 / 2(p + \delta)$, so T decreases in λ_0.

Now let us presume that the nearest job opportunity is at distance τ. So, $F(t) = H(t - \tau)$ for $t \geq \tau$ and $F(t) = 0$ for $t < \tau$, where H is differentiable. In this case, $t - \tau$ is wasteful commuting, and τ is the optimally-chosen minimum commuting distance. For example, in case that for $t \geq \tau$ space is homogeneous and two-dimensional then $H(t) = \alpha t^2$. This implies that $E(t|t < T) = \tau + \frac{2}{3}(T - \tau)$, and $\frac{2}{3}(T - \tau)$ is the average size of the wasteful commuting.

Let us extend the above model by allowing for on-the-job mobility. Jobs arrive with arrival rate λ_1. It can then be shown that

$$G(t) = 1 - \frac{1 - F(t)/F(T)}{1 + \lambda_1 F(t)/\delta}.$$

Note that when $\lambda_1 = 0$, we obtain $G(t) = F(t) / F(T)$ as derived above. Now suppose that λ_1 approaches infinity (keeping λ_0 constant). It can be easily seen that $G(t) = 1$ for all $t \geq 0$, hence $E(t|t \leq T) = 0$.

2.2 The self-employed

In the previous section, we have focused on employees. We will focus now on the self-employed. One main distinction between the employees and self-employed is that a large proportion of the self-employed work from home. It seems reasonable to assume that the decision to work from home is determined by the suitability of the residence (restrictions due to type of work, the presence of subordinates) and the costs of renting (buying) a workplace. It seems less likely that working from home is the outcome of an unsuccessful search process for suitable workplaces, where workplaces are not suitable because the commuting length to the workplace is considered to be too long. Hence, we analyse the search process of a self-employed without a workplace who is looking for a suitable workplace location for her company. So, we can use the same search model (equations (1) to (4)) as used for the unemployed.

Another distinction between employees and self-employed is that the arrival rate of suitable workplaces is *much* higher than that of suitable jobs. The main reason is that the job searcher looks for a job which matches her skills. The density of workplaces is much higher than the density of jobs that match her skills. For example the spatial density of suitable workplaces may easily be thousand times larger than those of jobs for any occupation which require a standard office. Other reasons are that the job searcher has to be accepted for the job offer by the employer and that office vacancy rates tend to exceed job vacancy rates. Hence, from a job perspective, the workplace arrival rate is close to infinite, so the excess commute due to search frictions, and therefore the size of the wasteful commuting, should largely disappear.

We will test this hypothesis in the next paragraph.

3. Descriptive data

In this paper, we use the Dutch labour force surveys (1998). In the survey, one can distinguish between employees and the self-employed. It also allows us to distinguish between those who work from home. In total, we analyse 44,260 observations of workers of which 11% is self-employed. In Table 1, we give the basic descriptives of the main variables of interest (descriptives of other explanatory variables can be found in Appendix 1).

As can be seen from Table 1, the self-employed are much more likely to work from home than the employees (47,3 % versus 0,8 %), and their average commuting time is much smaller (22,45 minutes versus 14,38 minutes). Further, they have a shorter commuting distance, are more likely to use the car and work on average more hours a week.

Multivariate analysis

In the current analysis, we employ the Dutch labour force. We have selected observations who have a non-zero commuting time. We exclude the self-employed who work at the firm of their partner of parents. We are interested in the effect of being self-employed on the logarithm of commuting time and we use OLS. We include a large number of explanatory variables including size of the firm, regions, educational level, gender, occupation, industry, age dummies, presence of children, number of hours worked, and presence of spouse. The empirical results can be found in the first column of Table 2. It appears that, on average, the commuting time of the self-employed is considerable less than those of the employees. This result is in line with our theoretical model. It predicts that the self-employed have shorter commuting times, because the arrival rate of workplaces is much larger than those of jobs, so the extent of the wasteful commute is close to zero. Based on the results of column 1, about 38 % of the commuting time is due to job search imperfections, and therefore 'wasteful'. From the first column we can also see that being male and being high educated has a positive effect on the commuting time. Working in a firm with less than ten or hundred workers reduces the commuting time compared with firms with more than hundred workers.

One objective to our interpretation is that we do not control sufficiently for education level, occupation and industry. Therefore, we estimate models which controls for these variables more in detail and include 74 occupations instead of 8. We also include the cross product of different levels of education and self-employed. As reference we take the employees. The results can be found in the second column. Having a basic education reduces the commuting of a self-employed with 47% compared to the commuting time of employees. Being higher educated reduces this differences, but still the self-employed with a university degree commute 24% less than the employees.

A second objective is that many employees are in sectors in which the self-employed are not present, in particular the public sector, utilities etc. Although we control for these sectors, it may be the case that due to interactions with other variables our estimates are biased. We therefore select only occupations in which at least 1% of the workers is self-employed. This reduces the number of observations to 28,202. The results can be found in the third column.

A fourth objective to our interpretation is that we use commuting *time* instead of *distance*. One may argue that workers search over space in terms of distance and then choose the optimal commuting speed endogenously. Van Ommeren and Dargay (2004) show however that the chosen commuting speed for the self-employed is only slightly higher (and statistically insignificant). We estimate the effect on commuting *distance,* taking into account that distance is reported in classes. The results are given in the last column.

4. Conclusion

The assumption that labour markets are perfect has been frequently criticised (e.g. Anas, 1982; Hamilton, 1982, 1989). In particular, it has been argued that imperfect information about job opportunities are ignored. An essential characteristic of the labour market is therefore that individuals have to search for jobs. A large number of micro-economic studies is concerned with the empirical analysis of commuting distance or time (e.g. White, 1986; Rouwendal and Rietveld, 1994; Benito and Oswald, 1999; Van Ommeren et al., 1999). A notable result of these studies is that the reported R^2 is typically very low, which suggests that commuting is mainly an outcome of a stochastic process in which the lack of information plays an important role.

In this paper we have analysed the extent of 'wasteful commuting' by comparing the commute of employees and self-employed individuals. Our main conclusion is 38% of the commute is due to job search imperfections, and therefore 'wasteful'.

Reference

Anas, A. (1982), *Residential location markets and urban transportation: economic theory, econometrics and policy analysis with discrete choice models*, Academic Press, New York.

Benito, A. and A.J. Oswald (1999), Commuting in Great Britain in the 1990's. University of Warnick.

Buliung, R. and P.S. Kanaroglou (2002), Commute minimization in the Greater Toronto Area: applying a modified excess commute, *Journal of Transport Geography*, 10, 177-186.

Crane, R. (1996), The influence of uncertain job location on urban form and the journey to work, *Journal of Urban Economics*, 37, 342-56.

Cropper, M. & Gordon, P. (1991), Wasteful commuting: a re-examination, *Journal of Urban Economics*, 29, 2-13.

Hamilton, B.W. (1982), Wasteful commuting, *Journal of Political Economy*, 90, 1035-1053.

Hamilton, B.W. (1989), Wasteful commuting again, *Journal of Political Economy*, 97, 1497-1504.

Holzer, H. J. (1994), Work, search and travel among white and black youth, *Journal of Urban Economics*, 35, 320-345.

Kim, S. (1995), Excess commuting for two-worker households in the Los Angeles metropolitan area, *Journal of Urban Economics*, 38(2), 166-182.

Manning, A. (2003), The real thin theory: monopsony in modern labour markets, *Labour Economics*, 10, 105-131.

Rodriguez, D. (2004), Spatial choices and excess commuting: a case study of bank tellers in Bogota, Colombia, *Journal of Transport Geography*, 12, 49-61.

Rouwendal, J. and P. Rietveld (1994), Changes in commuting distances of Dutch households, *Urban Studies*, 31, 09, 1545-1557.

Small, K. & S. Song (1992), Wasteful commuting: a resolution. *Journal of Political Economy*, *100*, 888-898.

Van den Berg, G.J. and C. Gorter (1997), Job search and commuting time, *Journal of Business and Economic Statistics*, 15, 2, 269-281.

Van Ommeren, J.H., P. Rietveld and P. Nijkamp (1999), Job moving, residential moving and commuting: a search perspective, *Journal of Urban Economics*, 46, 230-253.

Van Ommeren J.H. and J. Dargay (2004), The optimal choice of commuting speed: Consequences for commuting time, distance and costs, *Tinbergen Institute Discussion Papers*, 04-092/3.

Weinberg, D.H., J. Friedman, and S.K. Mayo (1981), Intraurban residential mobility: the role of transaction costs, market imperfections and household disequilibrium, *Journal of Urban Economics*, 9, 332-348.

White, M. J. (1986), Sex differences in urban commuting patterns, *American Economic Review*, 76, 368-372.

White, M.J. (1988), Urban commuting journeys are not "wasteful", *Journal of Political Economy*, 96, 1097-1110.

Zax, J.S. (1991), Compensation for commutes in labor and housing markets, *Journal of Urban Economics*, 30, 192-207.

Table 1: Descriptives

	Employee	Self-employed
Work from home	0,8 %	47,3 %
Commuting time *	22,45 min.	14,38 min.
Commuting distance **	1,97	1,58
Commute by car *	57,8 %	70,8 %
Working hours	34,19	51,82

* Note: only for those who work outside the home

** Note: only for those who work outside the home. In the Dutch labour force survey distance is reported in four categories; 0 - 7 km, 8 - 17 km, 18- 32 km and > 32 km.

Table 2: Regression on commuting time and distance

	(1) ln (time)	(2) ln (time)	(3) ln (time)	(4) distance
Self-employed	**-0.382**			
Male	**0.067**	**0.064**	**0.079**	**0.078**
Child0	-0.020	-0.036	-0.012	**0.173**
Child1	-0.006	-0.022	0.005	**0.165**
Child2	-0.002	-0.016	0.000	**0.173**
Child3	-0.002	-0.004	0.024	**0.169**
Lower secondary educ	-0.001			
Higher secondary educ	**0.086**			
Higher vocational educ	**0.197**			
University	**0.310**			
Basis educ * self-empl.		**-0.471**	**-0.365**	-0.211
Lower secondary educ * self-empl.		**-0.400**	**-0.360**	-0.191
Higher secondary educ * self-empl.		**-0.428**	**-0.437**	-0.195
Higher vocational educ *self-empl.		**-0.263**	**-0.226**	-0.147
University * self-empl.		**-0.236**	**-0.223**	-0.174
Size firm < 9	**-0.262**	**-0.272**	**-0.277**	**-0.172**
Size firm 10-99	**-0.168**	**-0.173**	**-0.167**	**-0.120**
Single	**-0.098**	**-0.081**	**-0.080**	-0.005
Couple no children	-0.006	0.004	-0.007	**0.071**
Couple with children	-0.022	-0.022	-0.024	**0.057**
Workhours/10	**0.234**	**0.215**	**0.236**	**0.227**
$Workhours^2/1000$	**-0.275**	**-0.250**	**-0.281**	**-0.245**
Age < 25	0.024	0.025	0.017	**0.091**
Age 25- 34	**0.054**	**0.060**	**0.070**	**0.159**
Age 35 - 44	0.033	0.035	0.030	**0.124**
Age 45 - 54	0.026	0.023	0.025	**0.066**
Address density ≥ 2500 per km^2	**0.094**	**0.103**	**0.102**	**-0.182**
Address density 1500 2500 per km^2	0.002	0.003	0.008	**-0.162**
Address density 1000-1500 per km^2	-0.005	-0.009	-0.001	**-0.117**
Address density 500-1000 per km^2	**-0.025**	**-0.027**	-0.016	**-0.052**
17 sectors of industry	Included	Included	Included	Included
Occupations	8 occupations included	74 occupations included	25 occupations included	74 occupations included
R^2	0.108	0.113	0.110	
Sum of squares of residuals	17958	17854	14477	
N	34770	34770	28202	34049

Bold figures indicate coefficients that are significant at p = 0.05
Taken as reference are: employees, female, child4, size firm > 99, single parent, age > 54, address density < 500 per km^2 (non-urban).

Appendix 1

Variable definitions

Self-employed	Equals one if the respondent is self-employed
Male	Equals one if the respondent is male
Child0	Equals one if the respondent does not have a child
Child1	Equals one if the respondent has one child
Child2	Equals one if the respondent has two children
Child3	Equals one if the respondent has three children
Child4	Equals one if the respondent has four or more children
Basic educ.	Equals one if the respondent has a basic-education
Lower sec. educ	Equals one if the respondent has lower secondary education
Higher sec. educ	Equals one if the respondent has higher secondary education
Higher voc. educ	Equals one if the respondent has higher vocational education
University	Equals one if the respondent has a University degree
Size firm < 10	Equals one if the number of workers in the firm is less than 9
Size firm 10 -99	Equals one if the number of workers in the firm is 10 - 99
Size firm > 99	Equals one if the number of workers in the firm is more than 99
Single	Equals one if the respondent is single
Single parent	Equals one if the respondent is single parent
Couple no children	Equals one if the respondent belongs to a couple without children
Couple with children	Equals one if the respondent belongs to a couple with children
Workhours/10	Average number of working hours a week divided by 10
$\text{Workhours}^2/1000$	Square of the average number of working hours divided by 1000
Age < 25	Equals one if the respondent's age is less than 25 years old
Age 25- 34	Equals one if the respondent's age is between the age of 25 -34
Age 35 - 44	Equals one if the respondent's age is between the age of 35 - 44
Age 45 - 54	Equals one if the respondent's age is between the age of 45 - 54
Age >54	Equals one if the respondent's age is 55 years or older
Address density ≥ 2500 per km^2	Equals one if the number of addresses per km^2 is equal to 2500 or more
Address density 1500 - 2500 per km^2	Equals one if the number of addresses per km^2 lies between 1500 and 2500
Address density 1000 - 1500 per km^2	Equals one if the number of addresses per km^2 lies between 1000 and 15000
Address density 500 - 1000 per km^2	Equals one if the number of addresses per km^2 lies between 500 and 1000
Address density ≤ 500 per km^2	Equals one if the number of addresses per km^2 is less than 500