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Workers' marginal costs of commuting

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ABSTRACT

This paper applies a dynamic search model to estimate workers' marginal costs of commuting, including monetary and time costs. Using data on workers' job search activity as well as moving behaviour, for the Netherlands, we provide evidence that, on average, workers' marginal costs of one hour of commuting are about 17 euro.

1. Introduction

In the current paper, we aim to estimate workers' marginal costs of commuting. These costs include mainly travel *time costs* and *monetary costs*, but they may also include other costs that affect the utility of travel (e.g., stress, risk of accidents). Commuting costs play an important role in hundreds of studies that contribute to urban economics theory (e.g., Wheaton, 1974; Fujita, 1989). In the Alonso–Muth–Mills monocentric model, commuting costs not only determine urban spatial structure—by influencing the size of the city—they also determine whether a city is monocentric at all (Ogawa and Fujita, 1980; Fujita and Ogawa, 1982), and generally they will determine land, and therefore house, prices, as well.[1] However, it turns out that we know surprisingly little about the size of these commuting costs.

A large number of transport economics studies focus on the *time component* of commuting costs (e.g., Small et al., 2005). Estimates of the time component of commuting costs vary by a large margin, but studies tend to find that the value of travel time is 20 to 100% of the hourly (gross) wage (Small, 1992). De Borger and Fosgerau (2008) find strong reference-point effects in stated preference data and suggest a way to correct for this effect. Revealed preference studies tend to find substantially higher values than stated preference studies.[2] Although the time component is an important part of the commuting costs, the other components are not negligible, and may therefore not be ignored (Cogan, 1981). For commuters, the monetary costs are thought to be about 30 to 40% of the time costs (e.g., Fujita, 1989; Small, 1992). Furthermore, workers may vary the speed of their commute through their choice of travel mode, so the share of the time costs as part of the total commuting costs is endogenously determined. As a consequence, information on the costs of the time component is not necessarily informative about the total commuting costs.

For all travel modes except car use, the marginal *monetary* costs are easy to determine. For non-motorized transport (bicycling, walking), the marginal monetary costs are (close to) zero; for

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[1] Commuting costs are also relevant to other economics fields, such as labour economics, because these costs affect the cost of being employed, and therefore workers' labour supply (e.g., Wales, 1978; Cogan, 1981; Parry and Bento, 2001), as well as workers' reservation and realised wages (e.g., Van den Berg, 1992; Van den Berg and Gorter, 1997; Manning, 2003a, 2003b).

[2] The majority of (transport economics) studies that assess the costs associated with travel time are based on *actual* commuters' mode and route choices (Miller, 1989; Small, 1992; Hensher, 1997; and Small et al., 2005). There are likely, however, some serious problems with these studies, with regard to correlation between travel time and cost, and the difficulty of measuring the travel time and cost associated with different travel alternatives. A related technique avoids these problems by exploiting subjective response data on choices among hypothetical trip or mode alternatives that differ in time and cost components (see Hensher, 1997; Verhoef et al., 1997; Calfee and Winston, 1998; Fosgerau, 2005). With such data, the problems of revealed preference data are eliminated by design. However, this advantage is gained at the cost of introducing a range of biases related to the hypothetical nature of data (McFadden, 1999).

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public transport (train, bus, metro), the marginal monetary costs can be derived from the price paid for the ticket. For car users, however, who are the majority of commuters, the marginal monetary costs associated with commuting are not so straightforward to determine. These costs of car use comprise not only the variable costs of car use (fuel, depreciation of the car due to its use), but also costs that are related to the ownership of the car (interest, insurance, etc.). The latter cost component is frequently treated as *fixed,* and it is therefore assumed not to affect workers' marginal costs of travel. This may be argued to be a relevant assumption in the United States, where car availability is high and almost all workers commute by car. Outside the United States, the proportion of workers who commute by car is much smaller. For example in the Netherlands, approximately 50% of workers commute by car. Car ownership decisions will frequently depend on the length of the commuting distance, which constitutes about one third of a car's mileage (De Jong, 1990). Consequently, even though treating car ownership costs as fixed may make sense with respect to some travel decisions, these costs are clearly not fixed with respect to commuting.[3]

Workers' marginal commuting costs can be derived in various ways. One method, familiar to labour economists, is to use the trade off between wages and the length of the commute, using hedonic wage models, as developed by Rosen (1986), see for example Zax (1991). But such a method has a number of disadvantages, as it relies on the (implicit) assumption that workers have full information about availability of jobs and do not have to search for jobs (Hwang et al., 1992; Hwang et al., 1998; Gronberg and Reed, 1994). A number of studies have shown that estimates of valuation of job attributes, such as commuting time, are likely seriously downward-biased if hedonic wage models are used (Gronberg and Reed, 1994; Van Ommeren et al., 2000; Villanueva, 2007). An alternative method is to rely on the trade off between house prices and commuting (which implicitly also relies on Rosen, 1986). For certain relatively simple spatial structures of cities with well-defined workplace centres, such as Hong Kong, this method seems promising (see Tse and Chan, 2003, and Yiu and Tam, 2007). For complex urban structures, such as in the Netherlands, application of this method seems difficult.

In this paper, we estimate commuting costs based on *actual on-the-job search,* as well as *job moving, behaviour*. Workers' marginal commuting costs will be derived from data on job search and job moving behaviour, employing a *dynamic* job search approach.[4] Our paper relates to a number of studies that have estimated the implied value of job attributes using data on job moving behaviour (Herzog and Schlottmann, 1990; Gronberg and Reed, 1994; Manning, 2003b; Dale-Olsen, 2006) and job search behaviour (Van Ommeren and Hazans, 2008).[5] It is also loosely related to the approach introduced by Bartik et al. (1992) who estimated the value of residential characteristics based on residential moving behaviour.

The dynamic job search approach assumes that workers are not in their preferred (welfare-maximising) job due to imperfect information about other jobs, but workers are able to improve their welfare over time by *searching* for other jobs, and by *moving to other jobs* if a job is found that increases welfare. This approach uses the implicit trade off between commuting time and wage, which affects both on-the-job-search and job moving behaviour, to determine workers' marginal costs of travel.[6]

Our study is related to studies that focus on the compensation workers receive, in the labour market, for commuting (e.g., Zax, 1991; Van Ommeren et al., 2000; Manning, 2003a; Van Ommeren and Hazans, 2008). Typically, these studies use either commuting *time* or *distance* as an approximation for commuting costs. This is not justified, but is seen as a restriction of the available data set. Intuitively, if commuting costs mainly consist of time costs, then the use of commuting time is preferred. On the other hand, if there exist large (unobserved) differences in speed, for example due to congestion, then commuting distance may be the preferred measure. The two measures are equivalent only if the commuting speed is fixed and constant across the population. In the current paper, we apply a dynamic search model approach, and measure commuting costs based on commuting time. The use of commuting time, when commuting distance is not observed, will be justified theoretically by allowing for endogenously chosen speed. Hence, we will measure the costs of commuting in terms of time.[7]

Although the dynamic search model approach has a number of fundamental advantages, it has also a number of disadvantages (Gronberg and Reed, 1994; Manning, 2003b). One of the main drawbacks of the dynamic search model approach is that one must assume identical utility functions across workers, and the literature remains suspicious as to what extent this assumption biases the results (e.g., see the seminal paper by Gronberg and Reed, 1994). This criticism can be (partially) addressed by means of panel data techniques; these techniques have not been applied previously in this context. In the current paper, we will show that the results remain robust, using panel data techniques.

Note that although we are aware of various studies that use either the *job mobility* or the *job search* approach to estimate the value of job attributes, this is the first study that applies both approaches to the same data set. Both approaches rely on the same underlying dynamic search model, so they should (if applied correctly) generate the same estimate of the value of job attributes. Another potential advantage is to estimate joint models of job search and mobility. In our application, though, it turns out that joint models of job search and mobility generate identical results to separate models of job search and mobility, without any gain in the efficiency of the estimates. Throughout the paper, we will provide the results for the separate models, and, discuss soon the

[3] In addition to monetary and time commuting cost, there are other cost components. For example, given the presence of a car in the household, the use of the car for commuting imposes *opportunity* costs on other members within the same household who do not have simultaneous access to the use of the car. There is also a large literature in psychology that suggests that the psychological costs of travel are substantial (for a review, see Koslowsky et al., 1995). For example, long commutes increase blood pressure, physical disorders and anxiety. Further, long commutes are thought to have adverse effects on a worker's mood, as well as on cognitive performance. The economic literature on the psychological costs of commuting indicates that these costs are relevant (Kahneman et al., 2004; Stutzer and Frey, 2004). As most of the psychological costs of travel increase with travel *time*, it is not necessary to deal with these costs separately.

[4] This approach avoids some strong assumptions underlying discrete choice-based estimates based on actual route or mode choices, including the assumption that the choice set of the worker is accurately observed, and that the characteristics of the travel alternatives not chosen by the commuter are accurately observed. It also avoids the fundamental assumption, common in transport studies, that a change in mode affects only the costs and times associated with these modes. Such an assumption may be very restrictive, as it ignores, for example, changes in convenience (see, e.g., Calfee and Winston, 1998).

[5] Isacsson and Swärdh (2007) estimate the value of commuting time based on the duration of employment, using strong assumptions regarding the choice of transport mode and the related costs.

[6] The reader may wonder whether a method that relies on the trade off between wages and commuting time, and therefore measures the long-run marginal costs of commuting, generates results that are comparable to methods, common in transport economics, that measure the short-run marginal costs of the time component. At least theoretically, the answer is yes. One of the standard micro-economics results is that long-run and short-run marginal costs are equal (because the long-run and short-run average curves are tangent, see Varian, 1992). Our dynamic search model has the same property.

[7] We believe that such a measure is generally more useful than a measure in terms of distance, for international comparisons. One notable characteristic of commuting time (and not of distance) is that the nationwide average commuting time is hardly time-varying (see Van Ommeren and Rietveld, 2005).