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The spatial decay in commuting probabilities: Employment potential vs. commuting gravity[☆]

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HIGHLIGHTS

- We compare an employment potential capitalisation model to a commuting gravity model.
- Using data from the same region we find statistically indistinguishable spatial decays.
- Our results hold for different functional forms of the spatial decay.

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ABSTRACT

We show that an employment potential capitalisation model produces estimates of the spatial decay in employment impact on land prices that are very close to the decay observed in commuting data.

1. Introduction

The standard urban economics framework predicts that *ceteris paribus* the price of land will mirror the cost of commuting. In classic stylised models, the price of land must decline as a compensation for the increase in commuting costs to the central business district (CBD), the destination of all commuting trips, in order to maintain a spatial equilibrium with no relocation incentives (Alonso, 1964; Mills, 1967; Muth, 1969). In reality, employment is dispersed and there is a remarkable degree of cross-commuting within most metropolitan areas. Recent models that rationalise these empirical observations feature agglomeration economies and idiosyncratic worker preferences for location (Ahlfeldt et al., 2015) or probabilistic household and firm location choice (Wrede, 2015). A central theoretical implication of such models is that the price of residential land at a given location depends on the proximity to employment at all locations in a labour market area, not just proximity to the CBD.

Recent empirical literature uses employment potentials to capture the labour market accessibility effects on the price of real estate in cities with a polycentric or dispersed employment distribution (Ahlfeldt, 2011, 2013; McArthur et al., 2012; Osland and Thorsen, 2008). Borrowing from Harris' (1954) market potential concept, an employment potential capitalisation model establishes a spatial relationship between the price of land at a given location and employment at all locations in the city. Briefly summarised, the employment potential at a given location is the sum of employment across all potential commuting destinations, weighted by the bilateral transport costs. Crucially, employment

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at closer locations receives a higher weight in the employment potential, with the exact rate of spatial decay being subject to estimation. Although the evidence base is fairly limited, it is notable that the existing studies tend to find a similar spatial decay (Ahlfeldt, 2013).

Employment potentials tend to be successful in empirically establishing a relationship between land prices and the spatial distribution of employment (Ahlfeldt, 2011). It is less clear, however, to which extent the estimated spatial decays in employment potential capitalisation models reflect the declining commuting probability between two locations as travel costs increase. Theoretically, an employment potential may also capture the benefits from access to the amenities that often correlate with the distribution of employment in space, such as retail services or gastronomic establishments. Locational fundamentals – such as access to parks or water spaces – that simultaneously determine the distribution of population at residence and employment at workplace could also affect the estimated spatial decay in an employment potential capitalisation model. This raises the question of how to interpret the capitalisation effect captured by an employment potential.[1]

In this short paper we seek to shed light on this question by comparing estimates of the decay parameter in an employment capitalisation model to the actual decay in bilateral commuting probabilities observed in commuting data. To benchmark the estimates from the employment potential capitalisation model we draw on a separate literature that has estimated the decay in the commuting probability between two localities as a function of effective distance (e.g. travel time) using commuting gravity equations (e.g. Ahlfeldt et al., 2015, McArthur et al., 2011).[2] This approach provides credible estimates of the rate at which the bilateral commuting probability declines in travel cost as it is directly estimated from commuting data. Commuting gravity models share many similarities with gravity models of trade (e.g. Camarero et al., 2014) or immigration (e.g. Lewer and Van den Berg, 2008), but micro-geography data on commuting flows is usually more difficult to find. If the employment potential captures the cost of commuting in a polycentric environment, the estimated decay parameters in the employment potential capitalisation model and the commuting gravity model will be of similar magnitude.

Our contribution to the literatures is twofold. First, we estimate an employment potential capitalisation model using a large polycentric metropolitan region, which has never been analysed using these methods before. Thus, we add to the growing, but still small evidence base in this literature. Second, we compare the estimated spatial decay from the employment potential capitalisation model to the spatial decay in commuting probabilities estimated from a commuting gravity model using actual commuting data from the same region. Our results substantiate the claim in the literature that the estimated spatial decay in employment potential capitalisation models is reflective of the cost of commuting in polycentric regions. As collateral we find that commuting decays can be inferred from the spatial distribution of land prices and employment where suitable data for the estimation of a commuting gravity model are not available.

2. Data

Our core study area is the planning region South-Hesse (Planungsregion Südhessen), which roughly corresponds to the wider Frankfurt (Main) metropolitan area. comprises of 185 municipalities (Gemeinden) within the hatched area in Fig. 1. With a 2009 population of slightly less than 3.8 m and a 2009 GDP of slightly more than €150bn this region belongs to the economically more prosperous regions in Germany. From the Federal Employment Agency we obtained bilateral commuting data for all combinations of municipalities within this region with at least 10 commuters on the reporting day (30/6/2011).

For the same set of municipalities we collected standard land values (Bodenrichtwerte) of residential land from the respective local Committees of Valuation Experts (Gutachterausschüsse). Land values assessed by such committees, which exist throughout Germany, capture the fair market value of a square metre of land if it was undeveloped. The assessment by these committees is based on recent market transactions and is generally considered reliable (Weiss, 2004). Ahlfeldt et al. (2015), who use similar data, show that the standard land values tend to closely follow market prices. We further use data on the resident population 2009 and employment at workplace form the German Federal Statistical Office (Statistisches Bundesamt, 2015). To avoid border effects in the employment potential we collect employment at workplace for a much larger region, namely 2872 administrative units in Hesse and Rhineland Palatinate (both at municipality level), Baden-Württemberg and Bavaria (both at county level) illustrated in the small map in the upper-right corner of Fig. 1. Shares of the 2009 population with completed A-levels, apprenticeship, polytechnic degree, and university degree were also available from the Federal Statistical Office at the county level (Kreise und kreisfreie Städte).

3. Empirical strategy

The empirical specifications we use are reduced-form versions of equilibrium conditions of the Ahlfeldt et al. (2015) model.[3] Our employment potential capitalisation model takes the following form:

$$\ln(P_i) = \alpha + \beta \ln\left(\sum_j E_j e^{\tau^P t_{ij}}\right) + X_i b + \varepsilon_i, \tag{1}$$

where P_i is the residential land price at location i, E_j is employment at workplace j, X_i is a vector of locational control variables, and t_{ij} is the travel time in minutes between the geographic centroids of i and j.[4] The vector of corresponding implicit hedonic prices (Rosen, 1974) b, α, and τ^P are the parameters to be estimated and ε_i is a random error term. The capitalisation effect of the employment potential is jointly determined by β, the elasticity of land price with respect to employment potential, and τ^P, the spatial decay parameter, the latter being the parameter of primary interest in this research. Economically sensible combinations of parameter values satisfy $\beta > 0$ and $\tau^P < 0$. Following the standard in the literature we estimate this non-linear model using a non-linear least squares estimator.

1 One approach to dealing with this endogeneity problem would be to use an instrumental variable strategy. We refrain from such a strategy due to space constraints and because every instrumental variable model produces a local estimate while we are interested in a general comparison across the whole range of the distribution of travel times.

2 For a recent review on the reduced form literature on commuting gravity estimates see McDonald and McMillen (2010).

3 Actually, the model predicts that residential land prices are a function of the wage potential rather than the employment potential. However, the model also predicts that productivity and wages increase in local employment due to spillovers.

4 Travel times are computed using MS MapPoint 2010. We approximate the internal travel time (minutes) for $i = j$ using the following formula: $t_{ii} = 2/3\sqrt{A\pi}/30 \times 60$, where A is the geographic area of a spatial unit in km, 30 (km/h) is the assumed average speed within $i = j$, and the multiplication by 60 converts hours to minutes.