Transport infrastructure and quality of life index

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February 14, 2019

1 Research question

Cities are a main determinant of the higher productivity but they also evoke congestion and pollution phenomena. Households therefore face trade-off between, on one hand productivity and consumption advantages (high-paying jobs and high quality local urban amenities), and on the other hand higher costs of leaving and dis-amenities (high housing costs, congestions and pollution), when they decide where to live. Transportation infrastructure facilitates interaction within cities. It relieves pressure on urban land by enabling workers to live at some distance from their jobs at reasonable commutes. Transport infrastructure thus affect the attractiveness of urban areas.

We construct a transport adjusted Quality of Life Index (QLI) for the 98 urban areas - municipalities - covering Denmark. Using this index we investigate the importance of adjusting for the inter area commute patterns in terms of the quality of life of a typical household. We also investigate the relationship between transport infrastructure investments and the QLI.

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2 Methodology

We follow Albouy and Lue [2015] and extend the Rosen [1979] model by including commuting cost. Households are assumed to be homogeneous, perfectly mobile and fully informed about the municipality characteristics. They consume housing y at municipality specific price p_j, a traded good x with the price normalized to one, as well as leasure time l and commuting time f. Each municipality grants access to the amenities z aggregated into a single index $Q = Q(z)$. The preferences of households are represented by the quasi-concave utility function $U(x, y, l, f, Q)$ that is increasing in x, y, l, Q and decreasing in f.

Households choose a municipality of residence j and a municipality where they work k. They also choose consumption levels of x, y and how many hours to work h. The resulting household budget constraint is

$$x + p_j y \leq w_k h - \tau(w_k h) - c f_{jk}, \tag{1}$$

where $\tau(w_k h)$ is tax of wage income and cf_{jk} are the monetary cost of commuting. In spatial equilibrium the expenditure function gives rise to the equation

$$\begin{aligned} E(p_j, w_k, f_{jk}, Q_j, u) := \min\{x + p_j y - w_k h + \tau(w_k h) + c f_{jk} \\ : l + f_{jk} + h \leq 1, U(x, y, l, f, Q) \geq u\} = 0, \end{aligned} \tag{2}$$

where u is the equilibrium level of utility. Implicit differentiation with respect to j gives the following two equations

$$\frac{\partial E}{\partial p_j} dp_j + \frac{\partial E}{\partial f_{jk}} df_j + \frac{\partial E}{\partial Q_j} dQ_j = 0 \tag{3}$$

$$\frac{\partial E}{\partial w_j} dw_j + \frac{\partial E}{\partial f_{jk}} df_k = 0. \tag{4}$$

Applying the envelope theorem and combining the equations (3) and (4) gives the equation that relates the marginal willingness-to-pay for local quality of life $\hat{Q}_j$ to housing prices, wages and commuting cost

$$\hat{Q}_j = s_y \hat{p}_j - (1 - \tau') s_w \hat{w}_k + \underbrace{\left[s_c + (1 - \tau') s_w \frac{\bar{f}}{\bar{h}} - \alpha \frac{\bar{f}}{\bar{m}} \right]}_{\hat{c}_{jk}} \hat{f}_{jk}, \tag{5}$$

3 Data and results

The data used in the empirical analysis are derived from annual register data from Statistics Denmark for the year 2010. We observe the full population of workers. We have information on workers residence and workplace (both at the municipal level), hourly wages, and a range of explanatory variables for each worker: educational level, age, gender, full-time versus part-time, and the sector of employment. We also observe all the realized real estate transactions for the year 2010. This data set includes transaction price and the structural attributes, such as age of building, size (sqm) and number of rooms. Finally, we also use data on travel times and mode choice from the Danish National Transportation model.

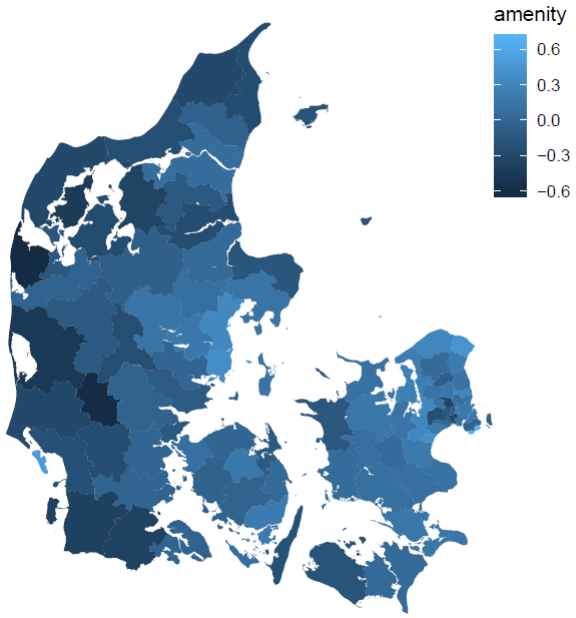
We use the available micro data to estimate housing price differentials $\hat{p}_j$ and wage differentials $\hat{w}_j$ and then combine them with data on commuting cost differentials $\hat{c}_{jk}$ from the Danish National Transportation model in order to calculate $\hat{Q}_j$. For more details see the Appendix.

4 Results

We find that wage differentials $\hat{w}_j$ are substantially higher in the Greater Copenhagen Area and other large cities in Denmark (Aarhus, Odense and Aalborg). Housing price differentials $\hat{p}_j$ are also, not surprisingly, significantly higher in the same areas. Moreover, our results show that heterogeneity is important when estimating wage differentials $\hat{w}_j$ and housing price differentials $\hat{p}_j$. For example, before correction for worker heterogeneity, the percentage wage gap between the municipality with the lowest and the municipality with the highest wages is about 50 %. This gap reduces significantly when correcting for the observed heterogeneity.

We find a strong positive correlation between $\hat{w}_j$ and $\hat{p}_j$ (correlation coefficient is 0.76). Finally, our estimation results suggest that the marginal willingness-to-pay for local quality of life $\hat{Q}_j$ is higher in cities as well, see figure (1). More interestingly, we find a negative relationship between distance to the nearest highway ramp and $\hat{Q}_j$. Our empirical results suggest that 1 % reduction in the distance to the nearest highway ramp is related to 0.2 % increase in the marginal willingness-to-pay for local quality of life $\hat{Q}_j$.

Figure 1: Marginal willingness-to-pay for local quality of life $\hat{Q}_j$



References

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5 Appendix

5.1 Empirical strategy

Specifically we estimate

$$\ln w_i = \mathbf{x}_i^\top \beta_w + \lambda_{k(i)} + \epsilon_{ij}, \tag{6}$$

with $\lambda_{k(i)}$ being a municipality fixed effect and then construct the wage differentials

$$\hat{w}_j := \sum_k \hat{\pi}_{jk} \hat{\lambda}_k, \tag{7}$$

by averaging $\hat{\lambda}_k$ according to the proportion of workers $\hat{\pi}_{jk}$ living in municipality j and working in municipality k. Then we estimate housing price differentials $\hat{p}_j = \hat{\mu}_j$ using data on real estate transactions

$$\ln p_i = \mathbf{x}_i^\top \beta + \mu_{j(i)} + \epsilon_i, \tag{8}$$

adjusting for observed characteristics $\mathbf{x}_i^\top$ of the houses. The commuting cost differentials are averaged

$$\hat{c}_j := \sum_k \hat{\pi}_{jk} \hat{c}_{jk}, \tag{9}$$

in proportion to the number of workers living in municipality j and working in municipality k. Finally the marginal willingness-to-pay for local quality of life is calculated using

$$\hat{Q}_j = s_y \hat{p}_j - (1 - \tau') s_w \hat{w}_j + \hat{c}_j. \tag{10}$$