A dynamic equilibrium model of home and job location decisions

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Objectives

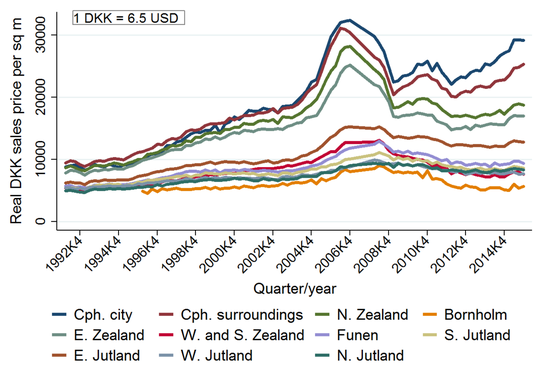
Set up a dynamic structural equilibrium model to analyze

- Trade-off between wages, commuting time, amenities and house prices in home and job location decisions.
- How these decisions, house prices and welfare are affected by changes in infrastructure between rural and urban areas.

Introduction

Worldwide, urbanization rates are increasing as jobs and people move to the bigger cities. This has caused cities to grow and thrive but on the negative side implied major societal changes such as the question of how to cope with rural regions that are declining both economically and in terms of population. In areas with high economic activity on the other hand we need to deal with the increasing number of inhabitants and job commuters that bring high congestion. These large and systematic flows of people also impact the housing market and cause large changes in house prices across regions and over time, see figure 1 for the **Danish context**. Until now, the literature on location choices has mainly used static models and focused on either the home or job location, e.g. [1]. [2] is a notable exception and dynamics are indeed crucial since the moving decision is made under uncertainty and involves substantial fixed costs. This paper aims at studying whether better infrastructure between rural and urban areas induces people to move out of the cities, takes off the pressure on the urban housing market and improves welfare. An important contribution is to endogenize house prices.

Figure 1: Real sales price of houses have diverged since start 1990s with the capital Copenhagen areas (+ Northern and Eastern Zealand) in front

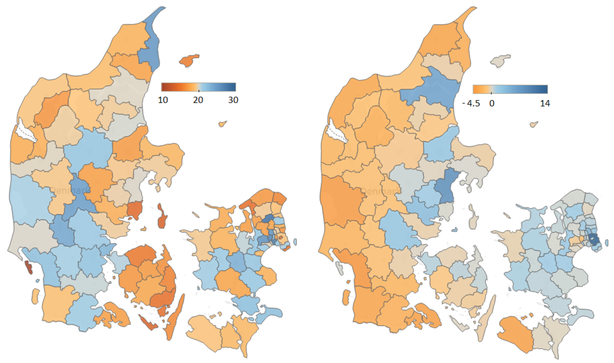


Data

The model of the paper will be estimated on *Danish administrative panel data* for 1992-2015 holding information on the entire population about home address, moving in dates, characteristics of person, spouse and kids, house characteristics, transaction price of houses, job address and characteristics. Data on travel time by car, bike and public transport between 907 zones of DK are provided along with GIS data on crime, school and air quality.

Descriptives

Figure 2: Avg. commute distance and total net migration by municipality



(a) Avg. commute 2008-2014 by work region (km) (b) Total net migration 2006-2016 ('000s)

Figure 3: Real mean wages across provinces of Denmark (1992-2011)

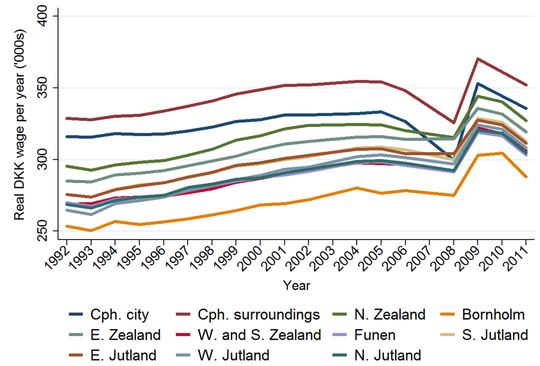


Figure 4: Distribution of job region moves at time t-1, t and t+1 when moving home region in t

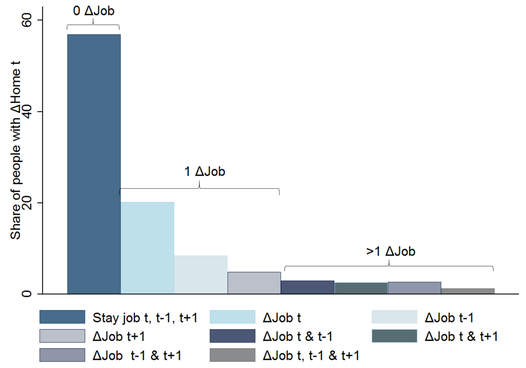


Figure 2a shows that workers commute between 10 and 30 km on average. In general, those working in big cities commute 10-20 km on average indicating that they tend to live rather close by but not necessarily in that same city. More rural Southern Jutland and on Zealand south of Copenhagen have the longer commutes, i.e. people do not generally live where the jobs are when working outside the big cities. According to *figure 2b* the big cities are also those with the highest net migration since 2006 while the southern part of Denmark and most of Jutland has had negative net migration. This is overall in line with the evolution of prices in figure 1. When moving, *figure 4* tells that 43% of home region moves at time t are associated with a job region move in $t-1, t$ or $t+1$ thus making clear that modeling these choices simultaneously is crucial. Like prices, mean wages are highest in the Copenhagen area, cf. *figure 3*, but the gap across regions has not widened as much.

Model

The model is a finite horizon life cycle model where individual i each period t makes choice d_{it} consisting of a home (rh) and job (rw) region from choice set D_{it} taking into account his current state x_{it}, alternative-specific taste shock ϵ^d_{it} (iid Gumbel distributed) and where he has job offers. The latter arrive at an exogenous rate and determine D_{it} as i can only choose work regions with a job offer. Job regions differ in terms of exogenous wages and commute time while home regions are differentiated by amenities and house prices P^{rh}_t that equilibrate supply and demand on the housing market. x consists of previous home and job location, number of kids, civic status, schooling, birth region, age, macro state and unobserved moving and income types.
To optimize, i recursively solves the **Bellman equation**:

$$V^D_t(x_{it},\epsilon_{it}) = \max_{\{d_{it}\}^T_t \in D_{it}} \left\{ \left[u^d_{it}(x_{it}) + \epsilon^d_{it} + \delta EV_{t+1}(x_{it}) \right] \right\}, \quad (1)$$

where EV is the expected future value function given state x, δ is the discount factor and u the **flow utility** given by

$$u^d_{it}(x_{it}) = \kappa^{mu}(inc_{it}, m_t) \cdot inc^{rw}_{it}(x_{it}) + taste^{rh}_{it}(x_{it}) - P^{rh}_t - swcost^{rh,rh_{t-1}}_{it}(x_{it}) - comcost^{rh,rw}_{it}. \quad (2)$$

κ^{mu} is the marginal utility of income function and inc^{rw} income in rw, $taste^{rh}$ describes the taste for amenities of rh, $swcost^{rh,rh_{t-1}}$ is the cost of moving from previous home rh_{t-1} to a given rh and $comcost^{rh,rw}$ the commuting costs between rh and rw.
The conditional choice probability (CCP) coming out of the model depend on $P = (P^1, P^2, ..., P^{|rh|})$ with $|rh|$ being the last home index. Let $\Pi(d|x,P)$ denote CCP of choice d and let P solve the system of $|rh|-1$ **equilibrium conditions** on the housing market:

$$\underbrace{\sum_{rh_{t-1}\neq 2} \Pi(2|x(rh_{t-1}),P)}_{\text{Expected demand for region 2}} = 1 - \underbrace{\sum_{rh_{t-1}=2} \Pi(2|x(rh_{t-1}),P)}_{\text{Expected supply of region 2}}$$

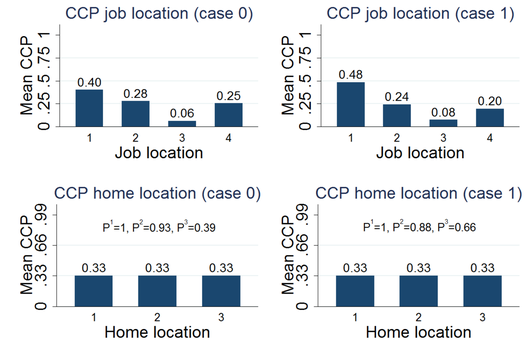
$$\vdots$$

$$\sum_{rh_{t-1}\neq \bar{rh}} \Pi(\bar{rh}|x(rh_{t-1}),P) = 1 - \sum_{rh_{t-1}=\bar{rh}} \Pi(\bar{rh}|x(rh_{t-1}),P) \quad (3)$$

Simulations

Figure 5 shows two simulations Case 0 and 1 from a model with 3 home and job regions plus unemployment ($rw = 4$). Region 1 is considered the urban center, 2 the suburb and 3 the rural area. Parameters are set such that $inc^{rw_1} > inc^{rw_2} > inc^{rw_3} > inc^{rw_4}$ and travel times in Case 0 given in footnote of the figure.

Figure 5: Simulations of base (Case 0) and effect of lowering commute time (Case 1) between rw_3 (rural) and rw_1 (urban) work regions



Note: travel time in min. (rw_1,rw_1)=(rw_1,rw_3): (1,1): 7, (1,2): 15, (1,3): 44, (2,2): 11, (2,3): 36, (3,3): 38.

In Case 0 equilibrium prices are $(P^1, P^2, P^3) = (1, 0.93, 0.39)$ which reflect the higher wages in rw_1 and the more favorable commute. In Case 1 the commute time between rw_1 and rw_3 is reduced by 60%. As the top panel shows the CCP of rw_1 increases at the expense of rw_2 or unemployment rw_4. This is because people living in rh_3 now find it worthwhile to commute to rw_1 to earn the highest wage. The equilibrium prices ensure that the CCP of either home location is unchanged (Case 0 was initialized with an equal fraction living in either rh), but now $(P^1, P^2, P^3) = (1, 0.88, 0.66)$ reflecting that rh_3 has become more attractive since it now offers the option of commuting fairly short to a good wage in rw_1. P^2 has fallen since in Case 0 some people lived here as a compromise to get the shorter commute to rw_1 but actually would prefer living in the countryside rh_3 had it not implied a poor wage or long commute.

Conclusion

I model the home and job region choice in a dynamic model that endogenizes house prices and accounts for different wages, amenities and commute times across regions. Simulations show how house prices increase in rural areas if infrastructure to the city is improved. Computational challenges incl a curse of dimensionality in the choice set and solving for equilibrium prices.

References

[1] John Kennan and James R Walker.
The effect of expected income on individual migration decisions.
Econometrica, 79(1):211–251, 2011.

[2] Moshe Buchinsky, Chemi Gotlibovski, and Osnat Lifshitz.
Residential location, work location, and labor market outcomes of immigrants in israel.
Econometrica, 82(3):995–1054, 2014.