Moving House

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What is this paper about?

- Sales volume in the housing market is an important statistics
  - At the origin of most housing-market transaction is the decision of a homeowner to put a house up for sale
  - volume of salses is determined by how quickly come on to the market and how quickly they come off
- Present evidence showing the importance of moving decisions in understanding changes in housing market activity (sales volume)
- Build a tractable model to analyse moving house
  - A theory of investment in 'match quality'
  - Aggregate moving rate depends on macroeconomic and policy variables such as interest rate and taxes
- Apply to the boom in housing-market activity 1995-2004 (U.S. data).
  - The model accounts for half of the rise in sales and listings volume through predicting a rise in moving rate consistent with the data.

Endogenous moving

- Individual match quality subject to idiosyncratic shocks. The decision to move hinges on comparing an owner's current match quality to an endogenous threshold
  - Aggregate moving rate varies if moving threshold (or distribution of match quality) change
  - The model generates an endogenous distribution of match quality across existing homeowners.

- Two important implications relative to exogenous moving model:
  - Aggregate moving rate is equal to an exogenous arrival rate of idiosyncratic shocks in previous models. Here, changes in market conditions can affect the moving rate even if that arrival rate remains the same
  - Those who move are not a random sample of homeowners — they come from bottom of match quality distribution, which gives rise to a cleansing effect, leading to overshooting of housing-market variables

Existing literature

- Search-and-matching models of the housing market:
  - Growing literature, but almost all focus on the buying and selling process and take moving as exogenous:
  - Wheaton (1990); Albrecht, Anderson, Smith & Vroman (2007); Anenberg & Bayer (2013); Moen, Nenov & Sniekers (2014); Caplin & Leahy (2011); Coles & Smith (1998); Diaz & Jerez (2013); Head, Lloyd-Ellis & Sun (2014); Krainer (2001); Ngai & Tenreyro (2014); Novy-Marx (2009); Piazzesi & Schneider (2009)
  - Hedlund (2013) and Guren (2014) model endogenous moving, but focuses on price fluctuations and foreclosure
- Endogenous separations in labour-search models: Mortensen & Pissarides (1994).
  - In MP, the stochastic process is 'memory-less'. Here match quality is persistent, aggregate moving rate depends also on transaction threshold (and moving threshold), moving decision is like an investment decision influenced by a predetermined stock of existing match quality.

The importance of the moving rate

The importance of moving rate – basic idea

- A stock-flow accounting identity:

$$\dot{u}_t = n_t(1 - u_t) - s_t u_t$$

  - Convergence to the steady state occus at rate $s + n$. Houses sell quick (a few months), convergencce to steady state is fast. (90% convergence in one year)

- Steady state state sales volume:

$$S_t^* = \frac{s_t n_t}{s_t + n_t}$$

- The total derivative of sales volume S^* is:

$$= \frac{s}{s+n}\frac{dn}{n} + \frac{n}{s+n}\frac{ds}{s}$$

- The average time taken to sell a house is a few months whlie the average time spent in a house is a decade, suggesting s/n is around 30.

Data

- U.S. monthly data (1989–2013), National Association of Realtors:
  - Monthly sales (S_t) of existing single-family homes during month t
  - Inventories (I_{t+1}) of existing single-family at end of month t (beginning of month $t+1$)
- Derive a series for new listings (N_t) of houses for sale from stock-flow accounting identity:

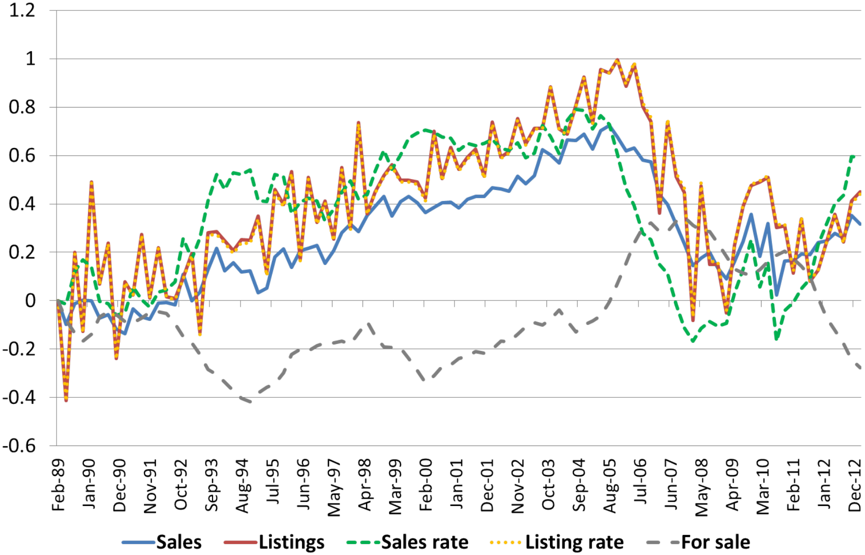
$$N_t = I_{t+1} - I_t + S_t$$

- If sales and listings are uniform within months, houses for sale (U_t) during month t are:

$$U_t = I_t + \frac{N_t}{2} - \frac{S_t}{2} = \frac{I_t + I_{t+1}}{2}$$

- Sales rate (s_t) is $s_t = S_t/U_t$, and given estimate of housing stock K_t, listing rate (n_t) is $n_t = N_t/(K_t - U_t)$
- Convert data to quarterly series and remove seasonality

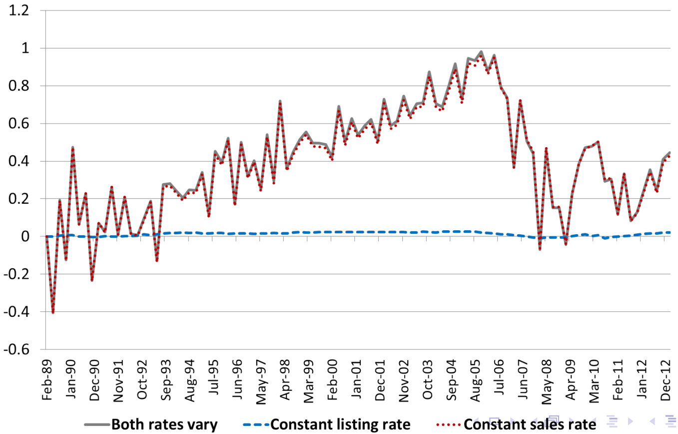
Time series (log difference)



The importance of the moving rate – data

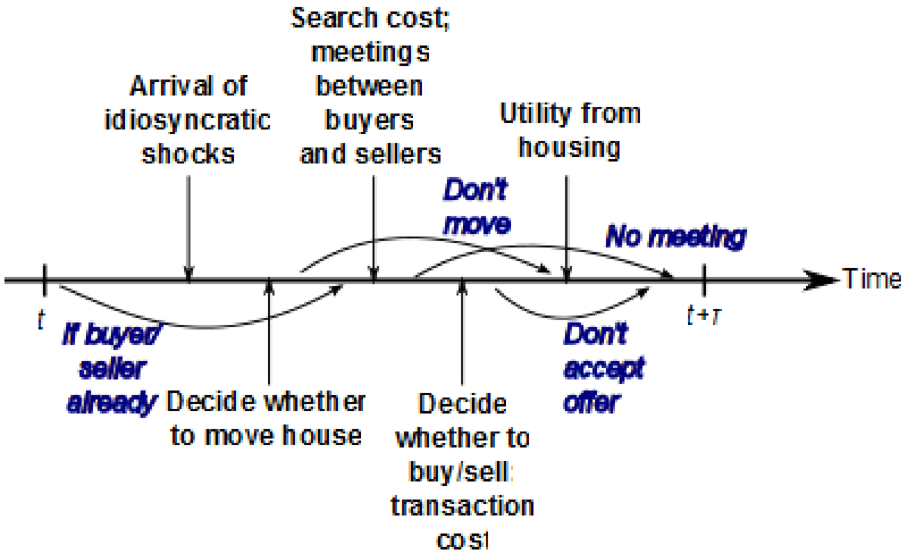
- Correlation between S_t^* and S_t is 0.88
- Compare the relative importance of changes in s_t and n_t:

$$S_t^* = \frac{s_t n_t}{s_t + n_t} \quad , \quad S_{s,t}^* = \frac{s_t \bar{n}}{s_t + \bar{n}} \quad , \quad S_{n,t}^* = \frac{\bar{s} n_t}{\bar{s} + n_t}$$



Model

Model — Timeline



Model set-up

- Unit continuum of families; unit continuum of houses, each owned by one family
- Houses either occupied (yield utility to family, only for one house) or for sale:
  - Measure of buyers $= b_t$
  - Measure of sellers ('unsatisfied owners') $= u_t$
  - Under our assumptions, $b_t = u_t$
- Three decisionmakers:
  1. Homeowners (value function $= H_t(\epsilon)$, $\epsilon =$ match quality)
  2. Buyers (value function $= B_t$)
  3. Sellers ('unsatisfied owners') (value function $= U_t$)

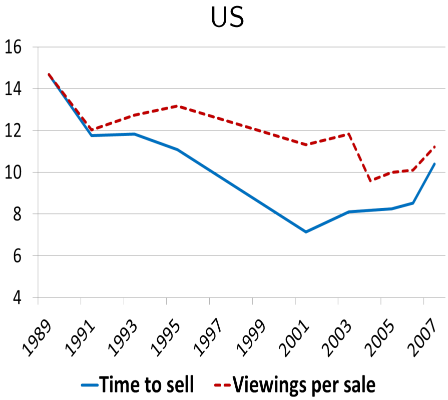
Model assumptions (I)

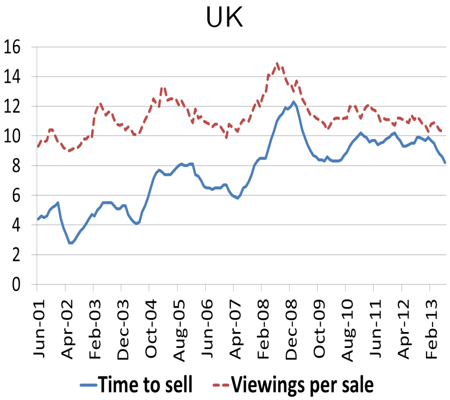
- Two types of search frictions:
  1. Difficult for buyers and sellers to meet each other:

     Total viewings occur at a continuous rate given by the constant returns to scale meeting function $\mathcal{V}(u_t, b_t)$
  2. Idiosyncratic match quality can only be revealed by a viewing:

     Match quality ϵ is drawn from a distribution with cdf $G(\epsilon)$
- Costs:
  - Transaction cost $= C$
  - (Flow) search cost $= F$
  - (Flow) maintenance cost $= M$

Importance of match quality





Model assumptions (II)

- Utility flow value from occupying house $= \epsilon\xi$
- $\xi =$ common level of housing demand
- Match quality ϵ is a persistent variable:
  - It remains constant unless an idiosyncratic shock is received
  - Shocks arrive at rate *a*
  - Following a shock, match quality is degraded to $\epsilon' = \delta\epsilon$ (with $\delta < 1$, a constant)
- Following a shock, homeowners decide whether to move (become both a buyer and seller)

Equations of model (I): Homeowners — Moving decision

- Bellman equation for homeowner:

$$rH_t(\epsilon) = \epsilon\xi - M + a\left(\max\{H_t(\delta\epsilon), W_t\} - H_t(\epsilon)\right) + \dot{H}_t(\epsilon)$$

  - Combined buyer and seller value: $W_t = B_t + U_t$
- Moving occurs if ϵ is less than a moving threshold x_t:

$$H_t(x_t) = W_t$$

- Moving decision depends not only on homeowner's existing match quality but also depends on overall housing market conditions

Equations of model (II): Homebuyers and sellers — Transaction decision

- Total surplus if a transaction occurs is:

$$\Sigma_t(\epsilon) = H_t(\epsilon) - W_t - C$$

- Transactions occur if ϵ is greater than a transaction threshold y_t:

$$\Sigma_t(y_t) = 0$$

- Bellman equation for combined buyer and seller value:

$$rW_t = -F - M + v \int_{y_t}^{\infty} \Sigma_t(\epsilon) \mathrm{d}G(\epsilon) + \dot{W}_t$$

where $v = \mathcal{V}(u_t, u_t)/u_t$ is the constant viewing rate, and new match quality follows a Pareto distribution

$$G(\epsilon) = 1 - \epsilon^{-\lambda}$$

Equations of model (III): Stocks and flows

- Accounting identity:

$$\dot{u}_t = n_t(1 - u_t) - s_t u_t$$

- Probability that viewing leads to a sale:

$$\pi_t = y_t^{-\lambda}$$

- Sales rate:

$$s_t = v\pi_t$$

- Moving rate:

$$n_t = a - \frac{a\delta^\lambda x_t^{-\lambda} v}{1 - u_t} \int_{\tau \to -\infty}^{t} e^{-a(1-\delta^\lambda)(t-\tau)} u_\tau \mathrm{d}\tau$$

Equilibrium

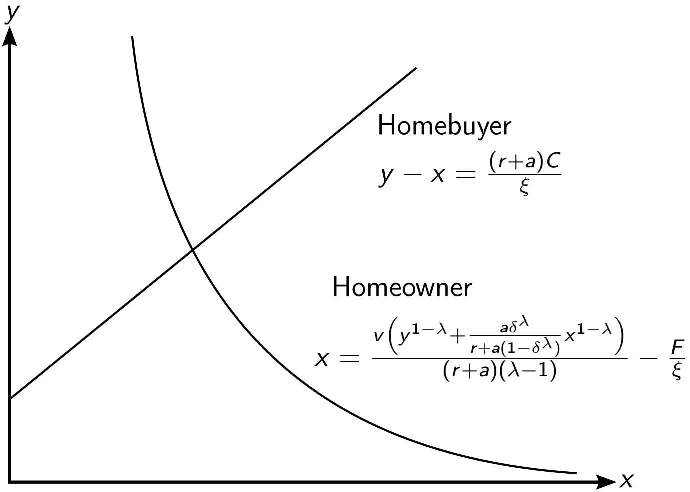
Steady-state equilibrium

The steady-state is found using the following steps:

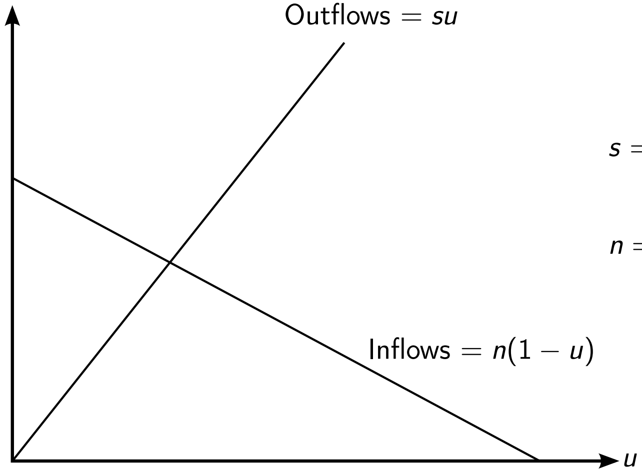
- There are two equations for the moving threshold x and the transactions threshold y
- These determine the sales rate s and the moving rate n
- These rates pin down the fraction u of homes for sale

- The steady-state equilibrium can be summarized in two figures.

Determination of moving and transactions thresholds



Determination of houses for sale



$$s = vy^{-\lambda}$$

$$n = \frac{a}{1+\frac{\delta\lambda}{1-\delta\lambda}\left(\frac{y}{x}\right)^{\lambda}}$$

Special case of exogenous moving

- The model embeds an exogenous moving model as a special case when $\delta = 0$
- Match quality goes to zero after an exogenous shock, so moving is automatic

The importance of transactions costs

- If transactions costs were zero ($C = 0$) then the transaction and moving thresholds would be the same ($y = x$)
- Since the moving rate is a function of the ratio y/x, the steady state of the model would be isomorphic to an exogenous-moving model

Dynamics

Dynamics

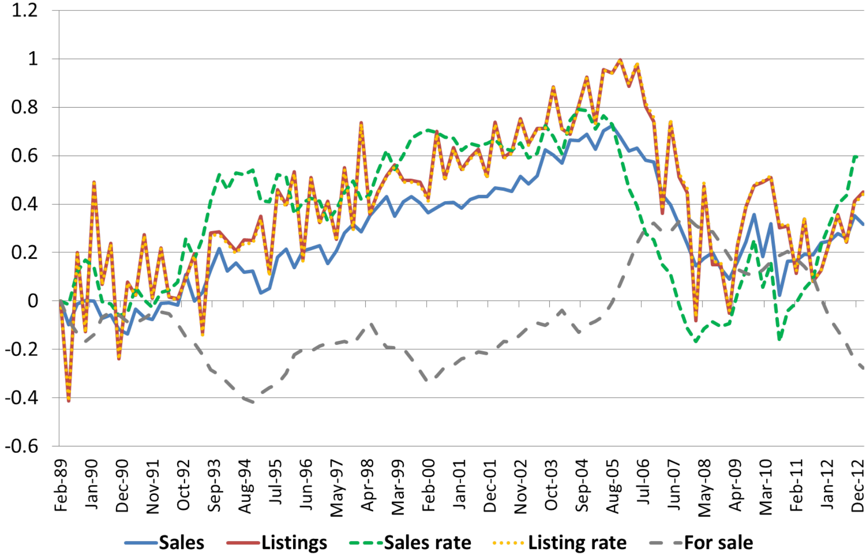
The model also has interesting dynamic implications:

- First, there are the usual transitional dynamics to the steady-state stock of houses for sale, but not so interesting quantitatively because convergence is very fast (half-life 4 months)
- But endogenous moving adds a new aspect to the transitional dynamics:
  - Those who move are not a random sample of homeowners (movers have low match quality)
  - ‘Cleansing effect’ on endogenous match quality distribution
  - This implies that listings will overshoot: more moving now makes moving in the future less likely because average match quality is higher
  - Quantitatively interesting: convergence to steady-state match quality distribution takes much longer (half-life is around 6 years)

Application:

The boom in housing-market activity 1995–2004

Time series (log difference)



The boom in housing-market activity 1995–2004

Stylized facts (1995–2004, U.S.):

1. There is a large increase in sales volume of 51% and sales rate increases by 22%
2. Houses for sale increases by 29%, in spite of the rise in the sales rate
3. Similar to sales, there is a large increase in new listings of 54% (listing rate rises by 55%)

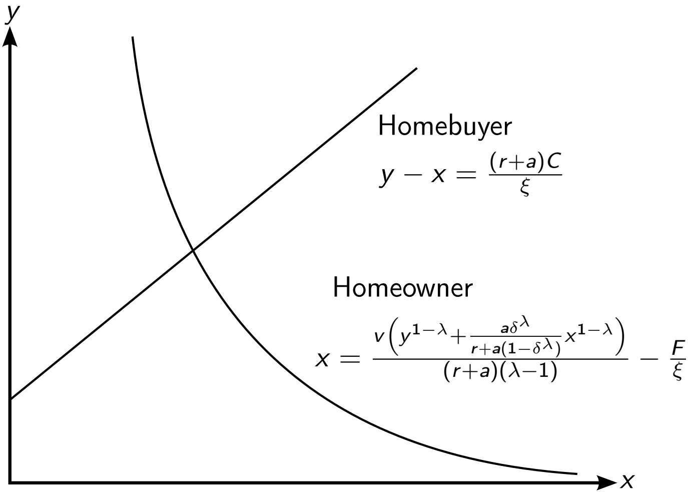
- There is a construction boom during this period where the stock of single-family home has increased by 20%.
- Removing the effects of this, we are left with:
  - Sales volume increases by 31% (listings volume increases by 34%)
  - listings rate increase by 35% (Sales rate increases by 22%)
  - Houses for sale increase by 9%

The boom in housing-market activity 1995–2004

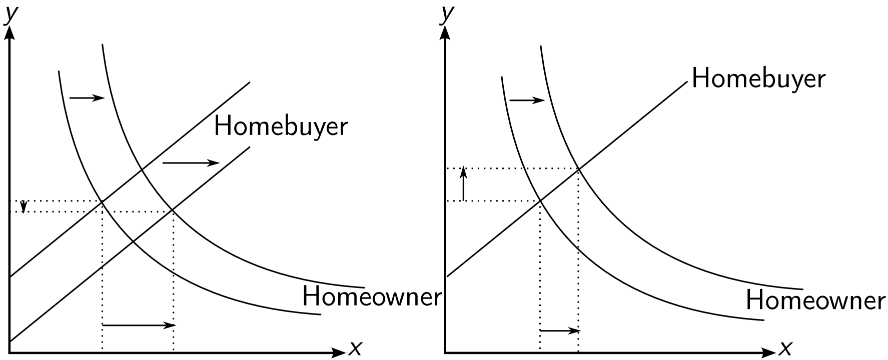
Relevant developments in the U.S. economy (1995–2004):

1. The decline in mortgage rates (interpret as fall in r)
2. The productivity boom (interpret as rise in ξ)
3. The rise of internet-based property search (interpret as rise in v)

Determination of moving and transactions thresholds



Analysis



- Left panel, the effects of a fall in r or a rise in ξ
- Right panel, the effects of a rise in v

Intuition

Intuition for interest rate effect:

- Shifts of homeowner curve:
  - Lower r increases present discounted value of utility flows from high match quality
  - Become less tolerant of low quality existing house (higher x): move more
  - Also more fussy when searching (higher y)
- Shifts of homebuyer curve:
  - Reduce flow value of one-off transaction cost: narrows the gap between an acceptable new house and an acceptable existing house, hence less fussy when searching (lower y)
  - Also more intolerant of low existing match quality (higher x)

Results

- There is an unambiguous rise in x and x/y, and hence the moving rate n
- Consistent with independent emprical finding of Bachmann and Cooper (2014) of a rise in the own-to-own moving rate using household-level data from the PSID.
  - In case 1 and 2, the effect on y is ambiguous, hence the effect on the sales rate s is unclear
  - In case 3, y is certain to rise, which partially offsets the direct effect of v on the sales rate s
- The rise in moving rate implies an increase in sales (and listings) volume and rise in the stock of house for sale.

Calibration

Calibration

- The model contains 11 parameters $\{a, \delta, \lambda, v, C, F, M, r, \omega, \kappa, \xi\}$
  - Normalize steady-state $\xi = 1$
  - Directly set $\{r, \omega\}$: discount rate $r = 0.07$, seller bargaining power $\omega = 0.5$
  - The cost parameters $\{C, F, M, \kappa\}$: match data on transaction costs, search costs, and maintenance costs
  - The remaining parameters $\{a, \delta, v, \lambda\}$: match the expected duration of a new match, the average time home-owners have owned their homes, the number of viewings per sale, and the average time-to-sell

Calibration targets

Target description	Notation	Value
Time to sell (time to buy)	T_{s}	6.5/12
Viewings per sale (viewings per purchase)	V_{s}	10
Expected duration of ownership of a house	T_{d}	12.2
Average years since home-owners moved in	T_{a}	11
Ratio of transaction cost to average price	c	0.10
Ratio of flow search costs to average price	f	0.025
Ratio of flow maintenance costs to average price	m	0.045

- T_a and T_d are informative about the arrival rate a and the size δ of idiosyncratic shocks, and their difference reveals information about the slope of the hazard function for moving house
- V_s reveals information about the meeting probability v between buyers and sellers
- T_s is informative about the distribution parameter λ for match quality

Calibrated parameters

Parameter description	Notation	Value
Parameters matching calibration targets		
Arrival rate of shocks	a	0.131
Size of shocks	δ	0.862
Steady-state distribution of match quality	λ	13.0
Arrival rate of viewings	v	22.8
Total transaction cost	C	0.565
Flow search costs	F	0.141
Flow maintenance costs	M	0.254
Directly chosen parameters		
Share of total transaction cost directly borne by seller	κ	1/3
Bargaining power of seller	ω	1/2
Discount rate	r	0.07

A simple quantitative exercise

Estimates of the size of the three shocks in the 1995-2004 period:

1. Decline in mortgage rates:
   - 30-year mortgage rate (nominal) declines from 9.2% to 5.8%, inflation (PCE) goes from 2.3% to 2.8%: real rate r declines from 6.9% to 3% (57% decrease)
2. Productivity boom:
   - Real GDP per person rises by 25%, estimates of income elasticity of demand for housing $\approx$ 0.7–1.0 (Harmon, 1988, J.U.E.)
   - Upper bound: ξ rises by 25%
3. Rise of internet-based property search:
   - In the context of the model, the efficiency of search is measured by the viewing rate v, which is equal to $v = V_s/T_s$
   - Some limited data available on T_s and V_s (Genesove and Han, 2012, J.U.E.)
   - Maximum rise of V_s/T_s during the period is 33% (take as upper bound)

Quantitative Effects in the long run and short run

Shock	Sales rate	Moving rate	Sales volume	Listing volume	Houses for sale
Mortgage rates ($r \downarrow 57\%$)	-18% [-18%]	10% [23%]	9% [-18%]	9% [23%]	33% [0%]
Productivity boom ($\xi \uparrow 25\%$)	5% [5%]	10% [12%]	9% [5%]	9% [12%]	4% [0%]
Internet search ($v \uparrow 33\%$)	1% [1%]	1% [16%]	1% [1%]	1% [16%]	0% [0%]
Combined	-15% [-15%]	18% [37%]	16% [-15%]	16% [37%]	36% [0%]
Data (net change 1995–2004)	22%	35%	31%	34%	9%

Notes: Figures in brackets are the short-run effects. The combined effects are not the sum of the individual effects because the model is

Quantitative results: discussion

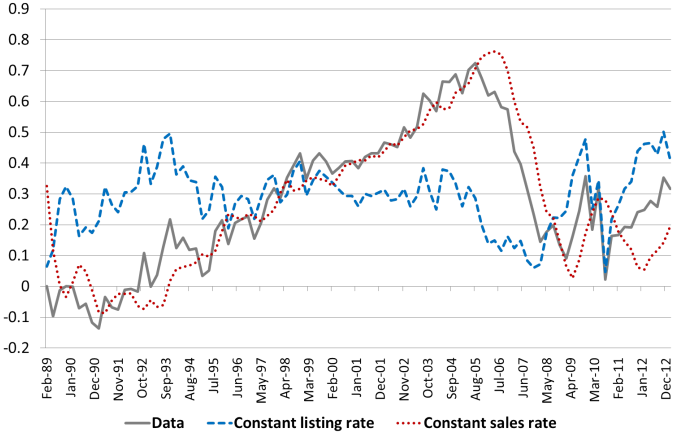
- The long run responses of average match quality to the three shocks are 3%, 1%, 2%, and 6% in total.
- The long run responses of average transaction price are 134%, 38%, 3% and 233% in total. The large effect are due to direct impact of r% and ξ%.
- The moving rate display significant overshooting because of transitional dynamics in the distribution of match quality following changes in the moving and transaction thresholds
  - There is no overshooting in teh sales rate because the distribuion of existing match quality is irrelevant for buying decision
- The magnitude of overshooting depends on what happends to the transaction threshold.
  - A decrease in the transaction threshold means that the improvement in match quality due to moving is smaller, thus cleansing remains important for longer, so there is less overshooting. [compare effects of mortage rate vs productivity]

Conclusions

- Cannot understand variation in sales volume without understanding changes in the moving rate
- Build a analytically tractable model that endogenizes moving
- Comparative statics of the model help to understand aspects of housing market activity during 1995–2004 that pose a challenge to models with exogenous moving
- The model also has interesting dynamic properties that differ from models with exogenous moving

The importance of the moving rate (out of steady-state)

- Construct two series using the definitions and the stock-flow accounting identity (and initial condition for inventories)



Correlation w/ sales data: const. listing rate (0.11); const. sales rate (0.89)

Efficiency

Given the moving threshold x_t and transactions threshold y_t, the average Q_t of match quality across the distribution of matches at time t evolves according to:

$$\dot{Q}_t = s_t \left(\frac{u_t}{1 - u_t} \right) \left(\frac{\lambda}{\lambda - 1} y_t - Q_t \right) - (a - n_t) \left(Q_t - \frac{\lambda}{\lambda - 1} x_t \right)$$

The efficient moving and transactions thresholds are the solutions of the following problem:

$$\max \int_{t=0}^{\infty} e^{-rt} \left((1 - u_t) Q_t - F u_t - C s_t - M \right) dt$$

subject to the laws of motion for s_t, n_t, u_t, and Q_t.

Efficiency

- The equilibrium is Pareto efficient
- Perhaps surprising given that search models usually feature externalities:
  - Congestion externality: Do not take account of increased difficulty of others in finding a match
  - 'Hold-up' problem: Search is costly, but since costs will be sunk, some match surplus will be appropriated by the other party after bargaining
- But here:
  - Enter on both sides of the market simultaneously: no congestion externality.
  - Although some surplus will be extracted by others, can also extract surplus from others: these net out to zero resulting in no hold-up problem