Search and Matching in the Housing Markets

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Introduction

- Housing markets clear not only through price but also through the time that a buyer and a seller spend on the market.
- This paper contributes to the understanding of housing markets by
  - Studying how demand shocks affect time on the market for buyers and sellers and number of home visits.
  - Developing and testing a random matching model in housing markets.

Literature Review (I): Time on The Market

- Recent literature has explored the individual determinants of time on the market in the housing market:
  - Seller time on the market: Haurin (1988), Glower, et al. (1998), Genesove and Mayer (1997) (2001), Anglin, Rutherford and Springer (2003), Levitt and Syverson (2005), Hendel, Nevo and Ortalo-Magne (2009), Bernheim and Meer (2008)
  - Buyer time on the market: Baryla and Zumpano (1995), Anglin (1997), Elder, Zumpano and Baryla (2000), D'Urso (2002)
- Missing from the existing literature is a **panel** analysis of the **market** determinants of the buyers' and sellers' search behavior in an **integrated** fashion.

Literature Review (II): Matching

- Matching models in labor markets:
  - Theoretical studies: Diamond (1982), Mortensen (1986), Pissarides (1990), Hosios (1990), Coles and Smith (1994), Shi (2009)
  - Empirical studies: Pissarides (1996), Coles and Smith (1996), Blanchard and Diamond (1989, 1990), Anderson and Burgess (1999)

- Matching models in housing markets:
  - Theoretical studies: Wheaton (1990), Krainer(2001), Albrecht, Axel,Smith and Vroman (2007), Novy-Marx (2007), Caplin and Leahy (2008), Ngai and Tenreyro (2009)

- Missing from the existing literature is an **empirical** investigation of matching models in housing markets.

What's new in this paper?

- Provides a search-matching theoretical analysis to examine the demand effects of market determinants on home buyer and seller time on the market.
- Constructs a unique panel dataset on both buyers' and sellers' search and matching behavior.
- Finds that an increase in demand has large negative effects on seller time on the market and number of home visits by buyers in the short run, but much smaller effects in the long run. This is consistent with a dynamic extension of the matching model where sellers react to demand shocks with a lag.

A Simple Real Estate Matching Model

- Matching (contact) function: $m(B, S)$
  - B: number of buyers; S: number of sellers
  - m: number of contacts;
  - q: seller contact hazard; $q = m/S$
  - h: buyer contact hazard; $h = m/B$
- Constant returns to scale:
  - $\theta = B/S$: market tightness
    - $q(\theta) = m(B, S)/S = m(\theta, 1)$, $q'(\theta) > 0$
    - $h(\theta) = m(B, S)/B = m(1, \theta)$, $h'(\theta) < 0$
    - Special case: $h'(\theta) = 0$

A Simple Real Estate Matching Model

- Acceptance:
  - V: value of a specific home-buyer match
    - $V \sim 1 - G(V - \nu)$
    - ν: a location parameter
  - V^B: value of continued searching a home for the buyer
  - V^S: value of continued searching a buyer for the seller
  - Efficient Bargaining: Transaction occurs iff $V \geq V^B + V^S \equiv y$
    $\Rightarrow$ acceptance rate: $G(y - \nu)$

- Additional notation:
  - P: transaction price
  - β: seller share of surplus
  - Searching costs: c^B, c^S

Complete the Model

- Equilibrium asset equations:

$$\begin{aligned}
\text{(Seller) } rV^S &= -c^S + q(\theta)G(y-\nu)\beta E\{(V|V \geq y) - y\} \\
\text{(Buyer) } rV^B &= -c^B + h(\theta)G(y-\nu)(1-\beta)E\{(V|V \geq y) - y\} \\
\text{(Price) } EP &= \beta E\{(V|V \geq y) - y\} + V^S
\end{aligned}$$

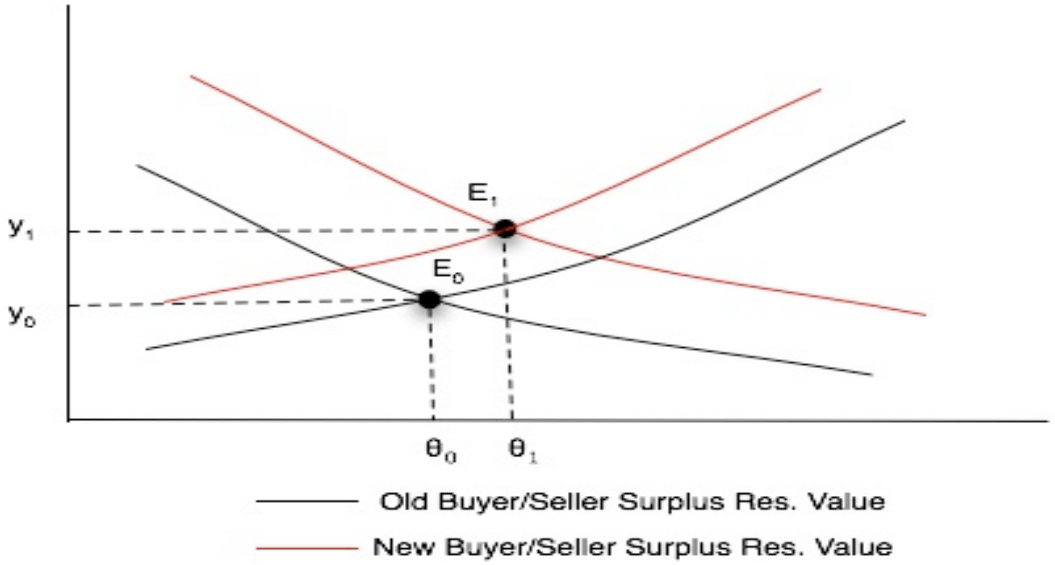
- Assume $\overline{V}^B$ constant, and rewrite:

$$\begin{aligned}
ry &= -(c^S - r\overline{V}^B) + q(\theta)G(y-\nu)\beta E\{(V|V \geq y) - y\} \\
0 &= -(c^B + r\overline{V}^B) + h(\theta)G(y-\nu)(1-\beta)E\{(V|V \geq y) - y\}
\end{aligned}$$

Equilibrium Condition

$$
\begin{aligned}
ry &= -(c^S - r\overline{V}^B) + q(\theta)G(y-\nu)\beta E\{(V|V \geq y) - y\} \\
0 &= -(c^B + r\overline{V}^B) + h(\theta)G(y-\nu)(1-\beta)E\{(V|V \geq y) - y\}
\end{aligned}
$$

Testable Implications of Demand Shocks: Case (I): Baseline Model

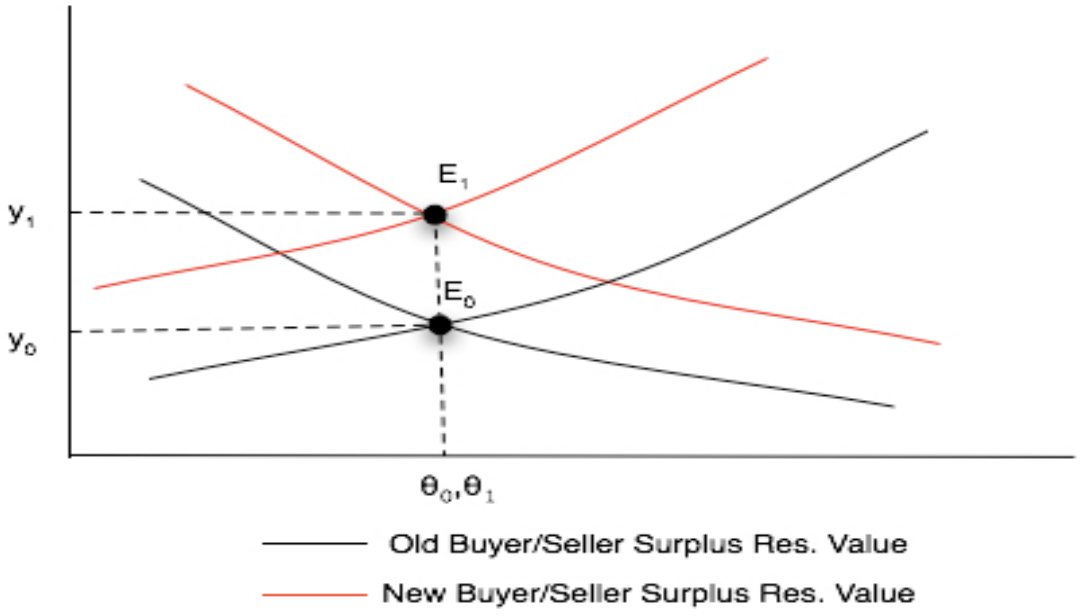


Prediction I

Under a **positive** r, a positive demand shock ($\nu \Uparrow$) leads to

1. $\theta \Uparrow$; $y \Uparrow$ by less than ν
2. $G(y-\nu) \Uparrow \implies$ expected number of home visits $\Downarrow$
3. $q(\theta)G(y-\nu) \Uparrow \implies$ seller time on the market $\Downarrow$
4. $h(\theta) \Downarrow G(y-\nu) \Uparrow \implies$ ambiguous effect on buyer time on the market

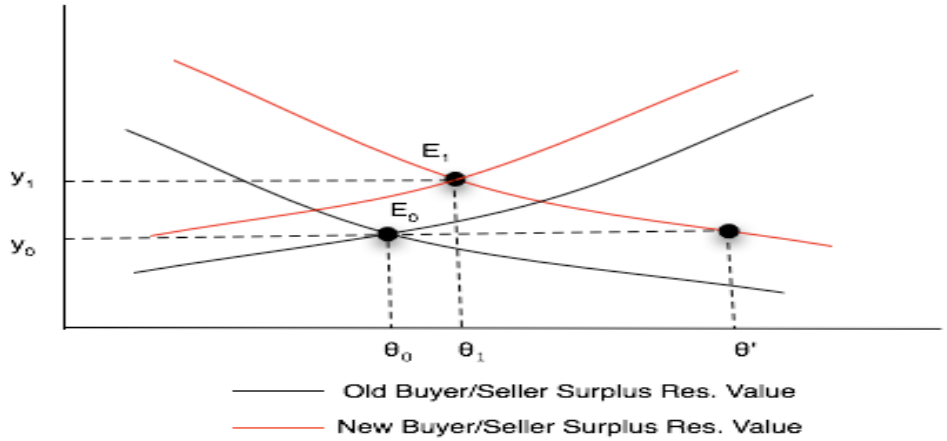
Testable Implications of Demand Shocks: Case (II): Zero Interest Rate



Prediction II

Under a **zero** r, a positive demand shock ($\nu \Uparrow$) increases y one for one; and leaves θ, buyer and seller time on the market and number of home visits unchanged.

Testable Implications of Demand Shocks: Case (III): Lagged Seller Response



Prediction III

Suppose sellers react to the demand shock with a lag. Under a **positive** r, a positive demand shock ($\nu \Uparrow$) leads to

1. y remains the same in the SR and $\Uparrow$ by less than ν in the LR.
2. $\theta \Uparrow$ to θ' in the SR; and then falls to θ_1 in the LR.
3. Both seller time on the market and the expected number of home visits overshoot ($\Downarrow$) in the short run, and then partially recover. The LR and SR effects are in the same direction, but the latter much greater than the former.

Model Extensions

- Allow elastic inflow of buyers.
- Allow buyers to anticipate being sellers in the future.
- Allow sellers to offer a take-it-or-leave-it price to buyers.
- Allow buyers and sellers to make effort to increase the hazard rate.

Elastic Inflow of Buyers

- Buyer Inflow: $a_B + d_b V^B$
- Seller Inflow: $a_S + d_s V^S$
- Stationary State: Buyer Inflow $=$ Seller Inflow
  - V^B and V^S are linear functions of y.

$$(S)\ r\frac{d_B}{d_T}y = con_S + q(\theta)G(y-\nu)\beta E\{(V|V \geq y) - y\}$$

$$(B)\ r\frac{d_S}{d_T}y = con_B + h(\theta)G(y-\nu)(1-\beta)E\{(V|V \geq y) - y\}$$

where $con_S = -(c^S - (a^S - a^B)r/d_T)$

$con_B = -(c^B - (a^S - a^B)r/d_T)$

From the Model to the Data

- Stationary model implies:
  - Expected Seller Time $= 1/qG$
  - Expected Buyer Time $= 1/hG$
  - Expected Home Visits $= 1/G$
- Key Relations:
  - $\ln q = \ln(\text{Homes Visited}) - \ln(\text{Seller Time})$
  - $\ln h = \ln(\text{Homes Visited}) - \ln(\text{Buyer Time})$
  - $\ln \theta = \ln(\text{Buyer Time}) - \ln(\text{Seller Time})$
    - $\theta = \frac{B}{S} = \frac{m/S}{m/B} = \frac{1/hG}{1/qG}$

Data Sources

Key Variables	**Data Sources**	**Years**
Time on the market for buyers/sellers, number of visits by buyers, online search	NAR Home Buyer and Seller Surveys	1987, 1989, 1991, 1993, 1995, 2001, 2003-2007
Population, Average Income	U.S. Census Bureau	1986-2007
House Prices	OFHEO	1978-2007
Home Sales	HMDA	1990-2007
Broadband Penetration	FCC	2000-2007

NAR Sample Observations

Year	# of Households	# of MSAs
1987	3999	175
1989	4186	160
1991	3725	132
1993	1969	178
1995	1483	153
2001	5617	182
2003	3702	210
2004	8203	253
2005	7550	253
2006	7548	274
2007	9982	279
2008	10053	277
Total	67751	336

Summary Statistics

	Mean	Std	Mean	Std	Mean	Std
	Seller Sample		Buyer Sample		Joint Sample	
Seller Time (Median)	7.32	5.60			7.60	5.73
Buyer Time (Median)			8.18	4.42	8.14	4.25
Homes Visited (Median)			9.96	4.34	9.94	4.27
ln THETA					0.25	0.82
ln AVE.INC	3.45	0.32	3.43	0.33	3.45	0.33
ln POP	14.24	0.94	14.22	0.94	14.27	0.91
Δln AVE.INC	0.041	0.025	0.043	0.024	0.043	0.024
Δln POP	0.012	0.012	0.013	0.013	0.012	0.013
# of Obs. (MSA$\times$year)	1894		2372		1636	

Summary Statistics

	Mean	Std	Mean	Std	Mean	Std
	Seller Sample		Buyer Sample		Joint Sample	
Seller Time (Median)	7.32	5.60			7.60	5.73
Buyer Time (Median)			8.18	4.42	8.14	4.25
Homes Visited (Median)			9.96	4.34	9.94	4.27

What do we learn about interest effect?

- $1/(qG)$ = mean seller time on the market (in days) = $7.32 \times \ln 2 \times 7 \Rightarrow qG = 1.36\%$.
- Levitt and Syverson (2008): daily $r = 0.05\%$
- Our model: $\frac{dy}{d\nu} = \frac{\beta qG}{r\frac{d_B}{d_B+d_S}+\beta qG}$
- Clearly, the interest rate effect is very small!

Test Implications of Demand Shocks (I): Income and Population as Demand Proxies

	Seller Time	Buyer Time	Homes Visited
Population	-1.19	-0.44	-0.50
	(0.49)	(0.15)	(0.18)
Avg. Income	-1.43	-0.09	-0.44
	(0.77)	(0.26)	(0.34)
# of obs.	1894	2372	2372

Test Implications of Demand Shocks (I): Income and Population as Demand Proxies

	Seller Time		Buyer Time		Homes Visited	
Population	-1.19	-1.14	-0.44	-0.43	-0.50	-0.47
	(0.49)	(0.46)	(0.15)	(0.15)	(0.18)	(0.18)
Ave. Income	-1.43	-0.42	-0.09	-0.001	-0.44	-0.25
	(0.77)	(0.78)	(0.26)	(0.29)	(0.34)	(0.38)
ΔPopulation		-14.44		-1.88		-4.01
		(3.53)		(1.17)		(1.79)
ΔAvg. Income		-6.98		-0.46		-0.98
		(1.27)		(0.42)		(0.81)
# of obs.	1894	1894	2372	2372	2372	2372

Test Implications of Demand Shocks (I): Income and Population as Demand Proxies

	Seller Time		Buyer Time		Homes Visited	
Population	-1.19	-1.14	-0.44	-0.43	-0.50	-0.47
	(0.49)	(0.46)	(0.15)	(0.15)	(0.18)	(0.18)
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		(3.53)		(1.17)		(1.79)
ΔAvg. Income		-6.98		-0.46		-0.98
		(1.27)		(0.42)		(0.81)
Short Run Effects						
Population		-15.58		-2.31		-4.48
		(3.55)		(1.14)		(1.83)
Avg. Income		-7.40		-0.46		-1.23
		(1.20)		(0.40)		(0.74)
F-Stat*		0.03		0.10		0.09
(p-val)		(0.87)		(0.75)		(0.77)

Test Implications of Demand Shocks (I): Income and Population as Demand Proxies

	Seller Time		Buyer Time		Homes Visited	
Population	-1.19	-1.14	-0.44	-0.43	-0.50	-0.47
	(0.49)	(0.46)	(0.15)	(0.15)	(0.18)	(0.18)
Ave. Income	-1.43	-0.42	-0.09	-0.001	-0.44	-0.25
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ΔAvg. Income		-6.98		-0.46		-0.98
		(1.27)		(0.42)		(0.81)
# of obs.	1894	1894	2372	2372	2372	2372

Recall Prediction: Negligible Interest Rate + Lagged Seller Response

A positive demand shock leads to

1. Seller time $\Downarrow$ in the SR, and then largely recovers.
2. Buyer time ambiguous if $h'(\theta) < 0$; $\Downarrow$ initially, then largely recovers if $h'(\theta) = 0$.
3. Homes visited $\Downarrow$ in the SR, and then largely recovers.

Test Implications of Demand Shocks (II): Imposing Theoretical Restrictions

	lnq Seller Contact Hazard		lnh Buyer Contact Hazard		lnθ Buyer-Seller Ratio	
Pop.	0.67	0.60	-0.04	-0.02	-0.69	-0.60
	(0.50)	(0.48)	(0.21)	(0.20)	(0.48)	(0.44)
Ave. Inc.	1.36	0.45	-0.47	-0.30	1.82	0.73
	(0.82)	(0.86)	(0.45)	(0.47)	(0.80)	(0.79)
ΔPop.		11.57		-2.96		14.61
		(3.96)		(2.03)		(3.61)
ΔAvg. Inc.		6.45		-1.19		7.64
		(1.50)		(0.92)		(1.35)
# of obs.	1636	1636	1636	1636	1636	1636

Test Implications of Demand Shocks (II): Imposing Theoretical Restrictions

	ln$q$ Seller Contact Hazard		ln$h$ Buyer Contact Hazard		lnθ Buyer-Seller Ratio	
Population	0.67	0.60	-0.04	-0.02	-0.69	-0.60
	(0.50)	(0.48)	(0.21)	(0.20)	(0.48)	(0.44)
Ave. Income	1.36	0.45	-0.47	-0.30	1.82	0.73
	(0.82)	(0.86)	(0.45)	(0.47)	(0.80)	(0.79)
ΔPopulation		11.57		-2.96		14.61
		(3.96)		(2.03)		(3.61)
ΔAvg. Income		6.45		-1.19		7.64
		(1.50)		(0.92)		(1.35)
Short Run Effects						
Population		12.17		-2.98		15.21
		(4.02)		(2.05)		(3.61)
Avg. Income		6.90		-1.49		8.37
		(1.45)		(0.85)		(1.31)
F-Stat*		0.02		0.01		0.66
(p-val)		(0.90)		(0.91)		(0.20)
# of obs.	1636	1636	1636	1636	1636	1636

Test Implications of Demand Shocks (II): Imposing Theoretical Restrictions

	ln$q$ Seller Contact Hazard		ln$h$ Buyer Contact Hazard		lnθ Buyer-Seller Ratio	
Population	0.67	0.60	-0.04	-0.02	-0.69	-0.60
	(0.50)	(0.48)	(0.21)	(0.20)	(0.48)	(0.44)
Ave. Income	1.36	0.45	-0.47	-0.30	1.82	0.73
	(0.82)	(0.86)	(0.45)	(0.47)	(0.80)	(0.79)
ΔPopulation		11.57		-2.96		14.61
		(3.96)		(2.03)		(3.61)
ΔAvg. Income		6.45		-1.19		7.64
		(1.50)		(0.92)		(1.35)

What do we learn about the matching function?

- $h = \frac{m}{B} = \frac{kB^{\alpha}S^{1-\alpha}}{B} = k\theta^{\alpha-1} \Rightarrow \ln\theta = a + b\ln\theta + e$, where $b = \frac{1}{\alpha-1}$
- Treating income growth as an IV
  - $\hat{b} = 7.64/(-1.19) = -6.42$
  - $\alpha - 1 = -0.16$ and $\alpha = 0.84$
  - Thus, $h'(\theta) = -0.16$ and $q'(\theta) = 0.84$

Test Implications of Demand Shocks (III): Price as Demand Proxies

	Seller Time		Buyer Time		Homes Visit	
HPI	-0.01	0.58	-0.09	-0.07	-0.22	-0.06
	(0.29)	(0.28)	(0.08)	(0.09)	(0.12)	(0.12)
ΔHPI		-5.57		-0.16		-1.60
		(0.69)		(0.20)		(0.32)
# of obs.	1724	1721	2193	2183	2193	2183

Test Implications of Demand Shocks (III): Price as Demand Proxies

	Seller Time			Buyer Time			Homes Visit		
HPI	-0.01	0.58	0.79	-0.09	-0.07	-0.02	-0.22	-0.06	0.04
	(0.29)	(0.28)	(0.30)	(0.08)	(0.09)	(0.09)	(0.12)	(0.12)	(0.14)
ΔHPI		-5.57	-5.06		-0.16	0.08		-1.60	-1.65
		(0.69)	(0.71)		(0.20)	(0.24)		(0.32)	(0.36)
Population			-0.64			-0.44			-0.20
			(0.55)			(0.18)			(0.19)
ΔPopulation			-2.13			-1.77			-0.41
			(3.61)			(1.32)			(1.66)
Ave. Income			-1.84			-0.22			-0.60
			(0.91)			(0.34)			(0.44)
ΔAge. Income			-2.18			-0.09			0.69
			(1.34)			(0.50)			(0.78)
# of obs.	1724	1721	1721	2193	2183	2183	2193	2183	2183

Technology and Effort

- Assumption: Matching function and search costs at most vary randomly across time and markets.
- Technology in real estate markets:
  - Photography
  - Computerization
  - Internet
- How does this affect the interpretation of our results?
- Distinguish between economically exogenous technological changes and demand induced effort/technological changes.

Technology and Effort

- Economically exogenous, but statistically endogenous:
  - New technology likely to be available in high income markets and large markets.
  - This can explain some results, but cannot explain:
    - ln h: falls in the short run.
    - ln G: the number of home visits decreases
    - Growth variables: no obvious reason why level of technology greater in high growth period.
- Economically endogenous and demand induced:
  - Theoretically likely to magnify demand effects
  - But not so large as to overturn the fall in ln h.
  - Test the importance of technological changes for our estimates by including an Internet proxy.

Test Importance of Technological Changes

	Seller Time		Buyer Time		Homes Visited	
Internet Use		-0.27		0.24		0.30
		(0.25)		(0.11)		(0.12)
Population	-1.29	-1.32	-0.43	-0.40	-0.47	-0.43
	(0.48)	(0.48)	(0.15)	(0.16)	(0.18)	(0.18)
Ave. Income	-0.45	-0.42	-0.002	-0.01	-0.24	-0.26
	(0.81)	(0.80)	(0.29)	(0.29)	(0.38)	(0.38)
ΔPopulation	-14.15	-14.18	-1.88	-1.89	-4.02	-4.03
	3.75	(3.74)	(1.17)	(1.18)	(1.80)	(1.76)
ΔAvg. Income	-7.27	-7.30	-0.46	-0.43	-0.98	-0.95
	(1.35)	(1.35)	(0.42)	(0.42)	(0.81)	(0.80)
# of obs.	1639	1639	2364	2364	2364	2364

Price Discount

	ln(Final Price) - ln(List Price)			
	Seller Sample		Buyer Sample	
Population	0.09	0.08	0.037	0.03
	(0.05)	(0.05)	(0.023)	(0.02)
Ave. Income	-0.04	-0.08	0.02	0.00
	(0.10)	(0.11)	(0.05)	(0.05)
ΔPopulation		0.92		0.44
		(0.50)		(0.24)
ΔAvg. Income		0.31		0.17
		(0.19)		(0.09)
# of obs.	1603	1603	1710	1710

Main Findings

- An increase in demand generally leads to shorter seller time on the market and fewer home visits, while buyer time on the market is much less sensitive to demand.
- Seller time on the market and home visits are much more sensitive to demand growth than its levels, consistent with a lagged seller response.
- A by-product of this work is an estimate of the elasticity of the contact hazard with respect to the buyer-seller ratio.