

# Testing the heterogeneity of real estate sellers

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14.10.2015  
GAMES Seminar

- Introduction
- Literature review
- Data description
- Methodology
- Results
- Conclusion

- Heterogeneity of consumers are widely studied;
- Different pricing strategies over types of sellers: realtors and individuals;
- Individuals are more patient?
- Possible types of data:
  - Data on transactions: Actual sales price vs. No dynamics of price, Can not control on unobservables;
  - Data from MLS: Dynamics of the price vs. Nonrandom attrition, Absence of selling price.

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  - Broker sold houses, no FSBO;
  - Impact of seller's motivation on selling prices and duration of sale by  
 $Price_i = f(Prop.char._i, Mark.cond._i, Seller's\ motivation_i)$   
 $Mark.Time_i = g(Prop.char._i, Mark.cond._i, Seller's\ motivation_i)$
  - Motivation measures:
    - Negotiating Pad (percentage difference between the listing price and the value of the property estimated as of the time of listing);
    - Eager (1 indicating the seller "is motivated, is anxious, or must sell");
    - Relocated (1 indicating the seller has been transferred or otherwise relocated);
    - Selling Bonus (1 indicating the seller is willing to pay additional compensation to the selling broker for either a timely sale or for meeting a specified price);
    - Foreclosure (1 indicating a house with a foreclosure history);
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  - All realtors listings in county but no FSBO, 10 years, 100000 obj.;
  - Fact of sell, Sell price and Time to sale (if sold);
  - Real estate agents sell their own houses, on average, 3.7% more expensive and 9.5 days longer than houses of their clients;
  - Private individuals may be less patient:
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 $Prob.(Change\ of\ list\ price_i) = f(Mark.\ Time_i, Markup_i, Vacant_i, Motivated_i, Price_i);$
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## Raw data:

- Source: Metrosphera (MLS)
- Secondary market, flats only, Perm only
- Daily observations
- Period of observation 27.10.2014 - 01.02.2015 (98 days)
- 18037 unique objects
- 585494 observations
- Unbalanced panel

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## Transformation of the data:

- Weekly data (14 weeks)
- Delete objects with initial listing before 27.10
- Delete outliers (outside  $\pm 3\sigma$  from price for each room number and price per  $m^2$  distributions, area  $> 170m^2$ , number of rooms  $> 5$ )
- 13113 unique objects
- 55375 observations

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Panel A. Characteristics of offers.

Variable	All types (55375 obs.)		Realtors (51317 obs.)		Individuals (4058 obs.)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Price per $m^2$	53014	13048	52990	12974	53313	13948
$\Delta$ price per $m^2$	-105.0	340.3	-105.6	341.2	-98.0	328.7
Av. monthly price	56030	1394				
ln sale	0.785	0.410	0.794	0.404	0.672	0.469
Shows	1307.1	2932.3	1373.9	2994.8	461.8	1773.5
Upping	0.0002	0.015	0.0002	0.013	0.0007	0.027
Changes	1.41	0.80	1.42	0.81	1.38	0.73

# Data description

Panel B. Characteristics of property.

	All types (13113 obs.)	Realtors (11672 obs.)	Individuals (1441 obs.)	Price (th.rub.)	Pr. per $m^2$ (th.rub.)	MT (weeks)
Area	54.8 (23.1)	54.9 (23.2)	54.7 (20.7)		<i>Mean</i>	
Rooms				2929.2	54.2	3.41
1	4211 (32.1%)	3725 (31.9%)	486 (33.7%)	2075.9	59.1	3.02
2	4731 (36.1%)	4219 (36.1%)	512 (35.5%)	2588.1	51.9	3.46
3	3533 (26.9%)	3171 (27.2%)	362 (25.1%)	3721.3	51.6	3.76
4	590 (4.5%)	515 (4.4%)	75 (5.2%)	5053.7	52.4	4.14
5	48 (0.4%)	42 (0.4%)	6 (0.4%)	6897.0	55.3	3.04
Material						
Bricktop	6723 (51.3%)	5976 (51.2%)	747 (51.8%)	2793.9	54.9	3.43
Panels	5905 (45.0%)	5294 (45.4%)	611 (42.4%)	2967.2	53.9	3.41
Wood	485 (3.7%)	402 (3.4%)	83 (5.8%)	2311.3	47.5	3.24
Number of floors						
Missed	2485 (19.0%)	2222 (19.0%)	263 (18.2%)	2456.8	49.8	3.57
2-3	690 (5.3%)	621 (5.3%)	69 (4.8%)	3067.8	52.6	3.54
4-5	4255 (32.4%)	3830 (32.8%)	425 (29.5%)	2262.1	52.5	3.25
6-10	3690 (28.1%)	3236 (27.7%)	454 (31.5%)	3201.9	57.1	3.42
11-15	469 (3.6%)	394 (3.4%)	75 (5.2%)	4003.1	62.1	3.15
16-27	1524 (11.6%)	1369 (11.7%)	155 (10.8%)	5249.8	64.2	3.90
First floor						
Yes	2546 (19.4%)	2274 (19.5%)	272 (18.9%)	2366.4	55.1	3.52
No	10867 (80.6%)	9669 (80.5%)	1198 (81.1%)	2979.0	50.3	3.39



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	<i>Mean</i>					
<b>District</b>				2929.2	54.2	3.41
Lenininskiy	576 (4.4%)	509 (4.3%)	67 (4.6%)	4553.6	68.6	3.31
Sverdlovskiy	2245 (17.1%)	1993 (17.1%)	252 (17.5%)	3674.5	60.0	3.59
Dzerzhinskiy	1918 (14.6%)	1693 (14.5%)	225 (15.6%)	3295.9	58.3	3.37
Motovilikhinskiy	1827 (13.9%)	1591 (13.6%)	236 (16.4%)	3092.1	57.6	3.26
Industrial'nyi	1873 (14.3%)	1670 (14.3%)	203 (14.1%)	2988.5	58.2	3.31
Kirovskiy	1918 (14.6%)	1765 (15.1%)	153 (10.6%)	2416.6	48.8	3.64
Ordzhonikidzevskiy	1466 (11.2%)	1298 (11.1%)	168 (11.7%)	2221.8	45.5	3.15
<b>Type of building</b>						
Len (1920-1932)	338 (2.6%)	308 (2.6%)	30 (2.1%)	2335.2	51.0	3.31
Stal (1930-1960)	975 (7.5%)	857 (7.4%)	118 (8.2%)	2430.4	45.2	3.64
Hr (1957-1973)	2305 (17.6%)	2074 (17.8%)	231 (16.0%)	2148.3	53.8	3.30
Br (1972-1985)	2228 (17.0%)	2021 (17.3%)	207 (14.4%)	2260.7	51.3	3.20
GP (1978-1990)	751 (5.7%)	644 (5.5%)	107 (7.4%)	2879.9	54.0	3.37
MS (1980-1987)	372 (2.9%)	340 (3.0%)	32 (2.2%)	1686.1	56.9	3.64
UP (1985-2000)	3127 (23.8%)	2744 (23.5%)	383 (26.6%)	3186.5	56.1	3.38
IP (1995-present)	2296 (17.5%)	2094 (17.9%)	202 (14.0%)	4637.7	60.6	3.73

$$d_{it} = \begin{cases} 1, & g(y_{it}, x_{it}, t, \text{type} = j) + \eta_{it} \geq 0 \\ 0, & g(y_{it}, x_{it}, t, \text{type} = j) + \eta_{it} < 0 \end{cases}$$

$$y_{it}^* = f(x_{it}, t, \text{type} = j) + \alpha_i + \epsilon_{it} \quad (1)$$

$$y_{it} = \begin{cases} y_{it}^*, & \text{if } d_{it-1} = 1 \\ \text{is unobserved,} & \text{if } d_{it-1} = 0, \end{cases}$$

where

$d_{it}$  is a binary indicator of the probability of listing a property  $i$  in a week  $t$ ,

$y_{it}$  is a listed price of property  $i$  in a week  $t$ ,

$x_{it}$  are the property  $i$ 's characteristics and market conditions at time  $t$ ,

$j \in \{\text{Realtors}, \text{Individuals}\}$  is a seller's type,

$\alpha_i$  is unobserved property  $i$ 's characteristics,

$\eta, \epsilon$  are unobservables with joint distribution  $f_{\eta, \epsilon}(\cdot)$ .

In order to drop out the  $\alpha_j$  we use the differencing approach.

**Def.**  $\Delta^t(\cdot)_{it} := (\cdot)_{it} - (\cdot)_{i1}$

Expanding the  $f(\cdot)$  in a Taylor series for each  $j \in \{\text{Realtors}, \text{Individuals}\}$  will give:

$$\Delta^t y_{it}^* = \varphi_j(t) + (X_{ijt}, \Delta^t X_{ijt})\beta_j + e_{ijt} \quad (2)$$

We may identify  $\varphi_j(t)$  as

$$\varphi_j(t) = \Delta^t y_{it} - E[\Delta^t y_{it}^* | d_{ijt-1} = 1, X_{ijt}, \Delta^t X_{ijt}] \quad (3)$$

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**Def.**  $p_{ijt} := E[d_{ijt} | y_{ijt}, X_{ijt}, t, \text{type} = j]$

**Assumption 1.**  $E[X_{ijt} | e_{ijt}, \eta_{ijt}] = X_{ijt}$

**Assumption 2.**  $\exists v \in \{y, X\} : \frac{\partial p}{\partial v} \neq 0.$

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Then we may identify  $E[\Delta^t y_{it}^* | d_{ijt-1} = 1, X_{ijt}, \Delta^t X_{ijt}]$  as

$$\begin{aligned} E[\Delta^t y_{it}^* | d_{ijt-1} = 1, X_{ijt}, \Delta^t X_{ijt}] &= \\ &= (X_{ijt}, \Delta^t X_{ijt})\beta_j + E[e_{ijt} | d_{ijt-1} = 1] = \\ &= (X_{ijt}, \Delta^t X_{ijt})\beta_j + \int_{-\infty}^{\infty} \int_{-g(y_{ijt-1}, X_{ijt-1}, t-1, \text{type}=j)}^{\infty} e_{ijt} f_{\eta, \epsilon}(s, r) ds dr = \\ &= (X_{ijt}, \Delta^t X_{ijt})\beta_j + \lambda_j(p_{ijt-1}) \end{aligned}$$

If **A.1-2** are met then  $\beta_j, \lambda_j$  and, consequently,  $\varphi_j(t)$  are identified [Newey, 2009].

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- 2 Estimation of  $\Delta^t \hat{y}_{ijt} := E[\Delta^t y_{it}^* | d_{ijt-1} = 1, X_{ijt}, \Delta^t X_{ijt}] = (X_{ijt}, \Delta^t X_{ijt}) \beta_j + \lambda_j(\hat{\rho}_{ijt-1})$  approximating unknown  $\lambda_j$  by power series on  $\hat{\rho}_{ijt-1}$ .
- 3 Estimation of  $\hat{\varphi}_{ij}(t) := \Delta^t y_{ijt} - \Delta^t \hat{y}_{ijt}$ .
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# Results. Regressions pooled over $j$ without correction on $\lambda$

	$y_{it}$		$\Delta^t y_{it}$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
type	-648.0** (245.4)	10.49 (6.364)	11.43 (6.366)	9.838 (6.358)	7.584 (6.367)	7.657 (6.367)	11.16 (6.315)
ln(changes)	98.62 (185.4)	-511.3*** (3.711)	-511.2*** (3.712)	-511.7*** (3.707)	-509.5*** (3.739)	-509.5*** (3.739)	-514.2*** (3.713)
ln(shows)	76.26 (49.08)	-0.590 (0.752)	-0.454 (0.753)	-0.448 (0.752)	-0.997 (0.765)	-1.001 (0.765)	2.360** (0.769)
upping	-3591.4 (5039.5)	-62.66 (104.1)		-60.29 (103.9)	-57.24 (103.8)		
av. mon. pr.	0.175*** (0.050)	-0.008*** (0.001)		-0.018*** (0.001)	-0.018*** (0.001)	-0.018*** (0.001)	-0.006*** (0.002)
$\Delta$ upping			-112.1 (94.14)			-112.7 (93.86)	-129.7 (93.07)
$\Delta$ av. mon. pr.			0.002** (0.001)	0.010*** (0.001)	0.010*** (0.001)	0.010*** (0.001)	0.002 (0.001)
Property char.	Yes	No	No	No	Yes	Yes	Yes
Week dummies	No	No	No	No	No	No	Yes
$N$	13113	42262	42262	42262	42262	42262	42262
$n$	13113	9656	9656	9656	9656	9656	9656
Num. of params	28	6	6	7	29	29	40
$R^2$	0.519	0.314	0.313	0.315	0.318	0.318	0.330

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

# Results. Regressions for different $j$ with corrections on $\lambda$

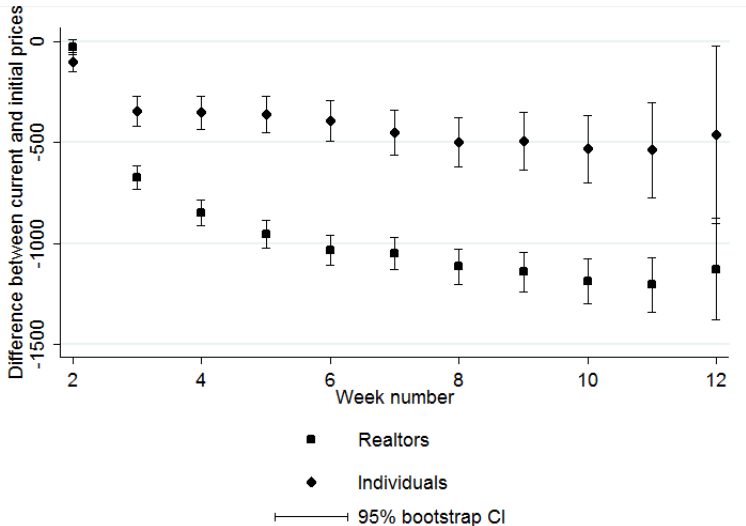
	Realtors			Individuals		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(changes)	-509.2*** (3.821)	-506.9*** (3.856)	-405.5*** [6.131]	-552.1*** (15.36)	-550.7*** (15.62)	-458.0*** [18.26]
ln(show)	-0.604 (0.765)	-1.140 (0.779)	9.553*** [0.931]	5.555 (4.040)	4.927 (4.190)	-2.141 [4.273]
$\Delta$ upping	-79.57 (110.0)	-81.03 (109.8)	-92.77 [112.1]	-191.9 (186.1)	-204.0 (185.3)	-190.2 [182.0]
av. mon. pr.	-0.018*** (0.002)	-0.018*** (0.002)	-0.013*** [0.002]	-0.016* (0.007)	-0.015* (0.007)	-0.011 [0.007]
$\Delta$ av. mon. pr.	0.010*** (0.001)	0.010*** (0.001)	0.008*** [0.001]	0.009* (0.004)	0.009* (0.004)	0.009* [0.004]
Property char.	No	Yes	Yes	No	Yes	Yes
Control for $\lambda$	No	No	Yes	No	No	Yes
$p$ -value for sign. of $\lambda$			0.000			0.000
$N$	39645	39645	39645	2617	2617	2617
$n$	8934	8934	8934	724	724	724
Num. of params	6	28	31	6	28	31
$R^2$	0.314	0.317	0.325	0.332	0.347	0.372

Standard errors in parentheses.

Panel bootstrap standard errors based on 1000 replications clustered on day of first listing in brackets.

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

# Results. Heterogeneity between sellers types in $\varphi_j(t)$



- Model robust to:
  - Sellers and property unobserved characteristics;
  - Nonrandom attrition of offers;
  - Arbitrary dependence of price on time;
- Sellers are heterogeneous in pricing strategy;
- Realtors drops the price faster comparing with individuals.

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# Thank you for the attention!

For any questions e-mail to:  
[tos600@gmail.com](mailto:tos600@gmail.com)