HETEGOGENEITY OF SELLERS IN HOUSING MARKET: DIFFERENCE IN PRICING STRATEGIES[1]

Evgeniy M. Ozhegov [†], Aleksandra S. Sidorovykh [††]

The present study analyzes Perm, Russia residential housing market supply focusing on sellers' heterogeneity. Many indicators of heterogeneity were considered in the previous research, and all of them were proved to have a great impact on housing prices and time on the market. However, the gap exists in evaluating sellers' pricing strategies in dynamics mostly because of unavailable data. Current study clears out the effect of time on price using data on asking price dynamics. We employ semiparametric sample selection estimation procedure which accounts for the unobserved property characteristics and non-random selection of objects out of the sample. We consider two main types of sellers: real estate agents and property owners, and show that real estate agents appear to be more impatient compared to property owners. Specifically, they set a lower asking price initially and are more likely to revise it over time if the object is not sold.

Keywords: real estate, heterogeneity, motivation, pricing, semiparametrics.

JEL classification: C14, C30, C51, R31, R32.

[1]The article was prepared within the framework of the Academic Fund Program at the National Research University Higher School of Economics (HSE) in 2015 (grant №15-05-0063) and supported within the framework of a subsidy granted to the HSE by the Government of the Russian Federation for the implementation of the Global Competitiveness Program

[†]National Research University Higher School of Economics (Perm, Russia). Senior lecturer, Department of Economics and Finance. E-mail: eozhegov@hse.ru

[††]National Research University Higher School of Economics. Graduate student. E-mail: a.sidorovykh@gmail.com

1 Introduction

The housing market is a market with heterogeneous sellers trading durable goods. Like in any other market, the state of the housing market is determined mostly by its agents' behavior. The literature related to housing demand is extensive, while much less attention has been paid to the research of the supply side. In this paper, we expand on the existing literature by focusing on sellers' motivation.

The residential housing market is driven by two main types of sellers: private individuals (property owners) and real estate agents. The degree of sellers' motivation may depend on various factors. Some people want to sell a property faster for different reasons: due to a job change, or because they have already found a new place of residence, etc. Such impatient owners usually hire real estate agents to make a deal as fast as possible. Other sellers are ready to wait longer, for instance, when they want to change residence to have better living conditions and did not find an appropriate alternative yet. Also, owners may not hurry with the sale when they get an apartment in the inheritance and want to sell it to receive money. In this cases, owners are likely to sell the property themselves.

Consequently, sellers are heterogeneous in motivation and have different selling strategies. This hypothesis is partially supported by preceding papers. Levitt and Syverson (2008) give evidence on the different motivation of real estate agents depending on whether they sell their own houses or provide services for sale to others. Authors also discuss the possible difference in selling strategies of private individuals and real estate agents, however, they do not have an opportunity to test these suggestions empirically as they lack the data on FSBO sales.

The fact that the behavior of real estate agents differs from that of property owners is supported by Hendel, Nevo and Ortalo-Magne (2009). In particular, empirical results reflect that time on the market is not the same for properties sold by real estate agents and private individuals. However, the dynamics of prices is not considered hence there is no evidence of a difference in pricing strategies across time between these groups of sellers.

Our research is based on the assumption that a seller has an option to revise the list price according to market reaction to the initial asking price. The crucial hypothesis is that

different types of sellers have different incentives to sell, therefore, have different pricing strategies when a property is unsold. Since real estate agents are selling a property for the commission from both owner and buyer they tend to drop the price faster to shorten the marketing time and increase the number of deals. While more patient owners who sell a property by themselves drop the price slower to obtain a higher revenue from the deal. In order to test this difference we use the data on the dynamics of asking prices, that is expected to reflect sellers' motivation. We contribute to the literature on sellers' behavior in the housing market by collecting the unique data set. It contains information about flats on sale in Perm secondary residential housing market for the period October 2014 – February 2015, so we observe the dynamics of every advertisement from placement till removal.

Another distinctive feature of this paper is that the analysis of behavior is conducted simultaneously for two groups of sellers – real estate agents and private individuals, whereas the majority of papers typically consider only one of these groups. Unlike the Hendel et al. (2009) we use the offers listed on the same MLS by different types of sellers which makes the comparison of types cleared from the effect of listing platform size. The two-step model used for estimation takes into account endogeneity of property (offer) characteristics and nonrandom withdrawal of offers from the sample. The main result of the research shows the difference in dynamics of asking prices across two main types of sellers, i.e. we evidenced the heterogeneity of sellers in terms of their pricing strategies.

The remaining part of the paper is organized as follows. The second section presents literature overview of academic work on the housing market, especially sellers' behavior. Then we discuss the data. In next section the econometric specification of the model is presented along with the estimation procedure. Empirical results are shown in the fifth section. The last section concludes.

2 Theoretical background

There are numerous studies that analyze the supply side of the housing market. In these field the three topics are prevailing: determination of the optimal asking price (Arnold, 1999); examination of the relationship between asking price, selling price, and

time on the market (Anglin et al., 2003; Horowitz, 1992); identification of the influence of sellers' characteristics on prices and time on the market (Carrillo, 2011; Gan, 2013; Knight, 2002; Piazzesi and Schneider, 2009; Springer, 1996).

Setting the price for real estate is an important decision for sale because asking price affects the number of interested buyers (Arnold, 1999). The decision about asking price determines the success of the sale, considering time and price of the sale. On the one hand, setting a low asking price will attract many buyers, but the sale price may be low (Horowitz, 1992). On the other hand, a high asking price may attract buyers who are willing to pay more, but the probability of receiving a higher bid may be much lower (Yavas and Yang, 1995, Merlo, Ortalo-Magne and Rust, 2015).

Although asking price is a key factor affecting the probability of sale, there are other factors that may have an impact on it. For instance, the probability of sale may depend on the distribution of buyers' offers, seller's reserve price, and time on the market, i.e. duration of the sale (Thanos and White, 2014; Yavas and Yang, 1995).

Some of the studies consider that sample of houses that are sold more frequently than others is not random (Gatzlaff and Haurin, 1997; Hwang and Quigley, 2004; Jud and Seaks, 1994). These papers indicate that the probability of sale is not the same across houses with different characteristics. In particular, the probability of a sale for small houses is, on average, the highest. Consequently, when evaluating real estate prices it is necessary to use the correction for non-random selection and attrition of observations.

Some of the papers related to the research of housing market are devoted to the study of sellers' behavior in terms of the choice of reserve and asking prices (Anglin et al., 2003; Horowitz, 1992). The main conclusion obtained in these studies is that seller's reserve price and asking price have a significant impact on sale price and duration of the sale. However, these studies are based on the assumption that the optimal price is the same for all sellers. In other words, they do not consider the heterogeneity of sellers, which can have a considerable effect on sellers' strategic decisions.

This thesis is confirmed in later papers. The issue of sellers' heterogeneity and its impact on market parameters was investigated using Texas data on broker sales (Springer, 1996). The behavior of sellers was defined according to various characteristics and comments listed in the MLS (Multiple Listing System). Evaluation of the system of equations, which

includes two linear hedonic functions for the sale price and the duration of the sale, revealed that sellers' motivation has a significant impact on sale prices. In particular, sellers with the highest desire to sell, on average, sell a property cheaper. The conclusion is very straightforward: the desire to sell an apartment quickly forces sellers to sacrifice their profit. In addition, empirical results show that the reduction of the asking price allows selling an apartment quicker. However, this study has an important drawback: cross-sectional data do not allow to consider changes in market conditions and sellers' motivation. Moreover, duration of the sale is an endogenous along with the sale price, because the model does not take into account asking price, which affects both the time on the market and the sale price. For this reason, obtained results can not be considered as consistent.

The issue of the influence of sellers' characteristics on their behavior was addressed in many papers using different indicators of sellers' heterogeneity. Gan (2013) and Genesove and Mayer (2001) studied the relationship between sellers' attitude to risk and their strategies. Carrillo (2011) considers the attitude to risk and bargaining power as measures of sellers' heterogeneity. Knight (2002) argues that sellers' motivation is determined by the markup, different comments in the advertisement, and whether a house is vacant. Optimism about housing market conditions and economy as a whole can be also regarded as a motivation indicator (Piazzesi and Schneider, 2009). Thus, measures of heterogeneity can be different, but all of them have a great impact on sale prices of property.

It is difficult to evaluate motivation by the use of quantitative data, therefore survey is often conducted to get necessary data (Glower et al., 1998; Piazzesi and Schneider, 2009). Glower et al. (1998) revealed the following indicators of sellers' motivation: the desired number of days before removal, scheduled date of removal, relocation because of a job change, already made a purchase of a new house. According to the results, these measures of a heterogeneity influence sale price and time on the market of the property, but not the markup. However, the study takes into consideration only FSBO sales. In Piazzesi and Schneider paper (2009) sellers' behavior is explained from the point of view of how they are optimistic about the economic situation and state of the housing market, for example, how they assess the conditions of receiving a loan, current prices, future price dynamics, etc. The results indicate that even a small fraction of people, who estimate current market conditions as favorable, can have a considerable effect on the average prices of real estate.

All the above-mentioned studies use the information about sale price, time on the

market of the property, and the initial asking price. Only a few studies take into account the dynamics of asking price (Knight, 2002, Merlo et al., 2015). Knight (2002) argues that the reduction of asking price may reflect a change in seller's reserve price. Consequently, asking price can be regarded as a signal: reducing the price in the advertisement, a seller gives a signal that she is willing to agree to a lower price of the apartment. Empirical results of the paper indicate that list price revision depends mostly on time on the market of the property and the markup. The author assumes that more impatient sellers revise the list price more often if they fail to sell the apartment quickly. Hence, this paper confirms our presumption that list price revision serves as an indicator of sellers' impatience in the housing market. Specifically, we can conclude that more impatient sellers set a lower markup and revise the list price more often. Merlo et al. (2015) having information on buyer's side considers the model of the dynamic setting of the asking price conditional on received bids.

The study, which is in contradiction with the rest papers about supply in the housing market, is a paper by Glower et al. (1998). According to the results of this study, sellers' motivation does not affect the asking price and sale price but influences the only duration of the sale of the apartment. The reason is that more motivated sellers simply accept buyers' offers faster. Authors suggest that motivation may also influence the list price revision, but it was not possible to test this hypothesis because of lack of data.

Hendel, Nevo and Ortalo-Magne (2009) having the data from two separate marketing platforms, real estate agents MLS and FSBO website, empirically test the sales price and time difference. They found no evidence of different sales prices between real estate agents sales and FSBO but found the higher duration of sales for FSBO that is mainly explained by the low number of listings on FSBO website. Another paper that studied the difference in behavior of real estate agents when selling an own property or providing services of sale to others is a paper by Levitt and Syverson (2008). The reason for the difference in behavior is that real estate agents use informational advantages about the housing market for their own purposes. They have incentives to convince customers to sell a house cheaper and, therefore, faster to sell more houses and get a higher profit. Results show that real estate agents sell their own houses, on average, 3.7% more expensive and 9.5 days longer than houses of their clients. The systematic difference in the prices and duration of the sale is explained by the fact that real estate agents have a higher patience. Authors argue that

private individuals may be less patient than real estate agents when they relocate due to a job change, which limits their time of sale.

As we aimed in this research to test the difference in the selling behavior between real estate agents and owners, we will follow the dynamic approach by Merlo et al. (2015) and consider that revision of asking price is determined by the received offers from the demand side. Moreover, we consider that the price change with the lack of appropriate offers depends on the level of seller's patience. Thus, different types of sellers may show the different speed of price decrease when the property is not sold.

3 Data description

The main assumption in current work is that frequent list price revision may indicate lower patience of a seller. Consequently, we need to observe list price dynamics. Such data can be obtained from the listing systems. We use the real estate marketing platform Metrosphera as the most popular source for Perm, Russia residential housing market. A number of ads placed on it per day is approximately twice as large as on the second most popular website. Although, any type of seller may list a property using this platform. Key features of Metrosphera includes:

1. Only two advertisements from one account are allowed to be posted for free;
2. Any part of the advertisement may be edited;
3. Advertisements are posted for a week. After each week a user should log into system and prolong the advertisement;
4. There are paid services: posting the ad on the first page of the website (upping) and increasing the number of ads from one account (for real estate agents).

The following information is available from the offer: date of placement, list price, district, address, number of rooms, floor, number of floors in a building, total area, living area, kitchen area, type of a building, material of construction, balcony type, comments, contact person, her phone number, number of clicks to ad, whether the advertisement was

placed on the first page of the website using paid service, type of seller (FSBO or real estate agent[2]). There are no costs for potential buyer except government fee when dealing with owners. The mean seller cost of operating through real estate agent is 4% from the property selling price. This includes services from agent such as finding a buyer, listing the property and paperwork. Buying a property from an agent costs 2% from a final price for a potential buyer and also include finding an object and paperwork.

All advertisement available on the website were downloaded on a daily basis in the period from 27th October 2014 to 1st February 2015. We have daily data which forms unbalanced panel. The initial sample consists of 58495 observations with 18037 unique objects. We restrict the data to the secondary real estate market within the city of Perm and to flats only.

Since every week a user should visit the website and prolong the advertisement, we know precisely the week when the ad was removed from the website. Preliminary analysis of the data revealed that the variation of price within a week is insignificant (3% of total price variation within an offer) and most of the price variation is between weeks. This means that sellers tend to revise the price when they prolong the ad (after each 7 days). In order to control for non-random withdrawal of observations from the sample, we aggregated the data by weeks calculating the mean weekly price in an ad.

For the estimation purposes discussed further, we remain only the objects with known initial listing price i.e. we restrict the dataset to ads which were posted after the first day of downloading the data (we exclude 3844 objects). We also remove the outliers[3]. Moreover, Hendel et al. (2009) argued that some owners may switch to selling by real estate agents if they lack offers while Salant (1991) theoretically showed that high selling cost for the owner may also cause her switch to selling using agent in some week of market time. We found and exclude 87 cases when the same object in the sample was listed by different types of sellers. This are the cases of owner switching from selling as FSBO to real estate

[2]Not all real estate agents specify real estate agencies, which they represent. For those who did it, the type was assigned automatically, and for those who did not – type of real estate agent was assigned if they listed more than one object.

[3]We remove objects with the total list price and price per m^2 lie outside the $\pm 3 s.d.$ from the mean of price distribution for each number of rooms. We excluded property with the total area less than $20m^2$ and more than $170m^2$ and number of rooms higher than 5. The total number of excluded outliers is 1123 objects.

agent. We exclude this oservations by the reason of its tiny number (6% from the number of FSBO offers) and different behavior compared with remaining sample. The final sample was reduced to 13113 unique objects and 55375 weekly observations.

The sample contains sellers who increased the list price during the period under review. Most likely, this is due to the change in economic conditions, namely, the depreciation of the rouble during the reporting period. In order to control for market fluctuations, we collect average market price for secondary residential housing for a certain week, in thousand roubles per m^2. The average price reached a maximum in the second half of December 2014, amounting to 58.83 thousand roubles per m^2, which represented a 10% increase compared to October. By the beginning of February 2015, the price has slightly stabilized, and the total growth compared to the initial level was about 5.5%.

Table 1. Descriptive statistics.

Panel A. Characteristics of offers.

	All types (55375 obs.)		Real estate agents (51317 obs.)		FSBO (4058 obs.)		Difference (Agents - FSBO)	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	t-stat	p-value
Price per m^2, th.rub.	53.0	13.0	53.0	13.0	53.3	13.9	-1.44	0.15
Δ price per m^2, rub.	-105.0	340.3	-105.6	341.2	-98.0	328.7	-1.35	0.17
Av. monthly price, th.rub.	56.0	1.39						
In sale	0.785	0.410	0.794	0.404	0.672	0.469	18.2	0.00
Time on market, weeks	4.33	3.50	4.52	3.53	2.83	2.84	29.7	0.00
Clicks	1307.1	2932.3	1373.9	2994.8	461.8	1773.5	19.1	0.00
Upping	0.0002	0.015	0.0002	0.013	0.0007	0.027	-2.34	0.02

Panel B. Characteristics of sellers.

	All types (13113 obs.)		Real estate agents (11672 obs.)		FSBO (1441 obs.)		Difference (Agents - FSBO)	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	t-stat	p-value
Initial price per m^2, thou. rub.	54.2	12.5	54.0	12.5	55.2	13.1	-3.31	0.00
Initial price, mln. rub.	2.85	1.49	2.86	1.50	2.85	1.31	0.02	0.98
Changes of price	0.41	0.80	0.42	0.81	0.38	0.73	1.78	0.07
Changes per week	0.19	0.48	0.19	0.48	0.20	0.48	-0.75	0.46
At least one price change	0.23	0.42	0.24	0.43	0.17	0.38	5.90	0.00

Table 1. Descriptive statistics (cont.).

	All types (13113 obs.)	Real estate agents (11672 obs.)	FSBO (1441 obs.)	Agents - FSBO *t*-stat	Agents - FSBO *p*-value	Price (th.rub.)	Price per m^2 (th.rub)	Time on market (weeks)
Panel C. Characteristics of property.								
Area	54.8	54.9	54.7	0.35	0.72		*Mean*	
	(23.1)	(23.2)	(20.7)			2929.2	54.2	4.33
Rooms								
1	4211 (32.1%)	3725 (31.9%)	486 (33.7%)	-1.39	0.16	2075.9	59.1	3.77
2	4731 (36.1%)	4219 (36.1%)	512 (35.5%)	0.44	0.65	2588.1	51.9	4.29
3	3533 (26.9%)	3171 (27.2%)	362 (25.1%)	1.66	0.09	3721.3	51.6	4.89
4	590 (4.5%)	515 (4.4%)	75 (5.2%)	-1.38	0.16	5053.7	52.4	5.22
5	48 (0.4%)	42 (0.4%)	6 (0.4%)	-0.33	0.73	6897.0	55.3	4.47
Number of floors								
Missed	2485 (19.0%)	2222 (19.0%)	263 (18.2%)	0.64	0.52	2456.8	49.8	4.79
2-3	690 (5.3%)	621 (5.3%)	69 (4.8%)	1.22	0.22	3067.8	52.6	4.60
4-5	4255 (32.4%)	3830 (32.8%)	425 (29.5%)	2.52	0.01	2262.1	52.5	4.10
6-10	3690 (28.1%)	3236 (27.7%)	454 (31.5%)	-3.03	0.00	3201.9	57.1	4.21
11-15	469 (3.6%)	394 (3.4%)	75 (5.2%)	-3.53	0.00	4003.1	62.1	3.82
16-27	1524 (11.6%)	1369 (11.7%)	155 (10.8%)	1.35	0.17	5249.8	64.2	4.47
First floor								
Yes	2546 (19.4%)	2274 (19.5%)	272 (18.9%)	0.54	0.59	2366.4	55.1	4.24
No	10867 (80.6%)	9669 (80.5%)	1198 (81.1%)	-0.54	0.59	2979.0	50.3	4.72

Table 1. Descriptive statistics (cont.).

Panel C. Characteristics of property.								
	All types (13113 obs.)	Real estate agents (11672 obs.)	FSBO (1441 obs.)	Agents - FSBO t-stat	p-value	Price (th.rub.)	Price per m^2 (th.rub)	Time on market (weeks)
Material of constuction								
Bricktop	6723 (51.3%)	5976 (51.2%)	747 (51.8%)	-0.45	0.65	2793.9	54.9	4.36
Panels	5905 (45.0%)	5294 (45.4%)	611 (42.4%)	2.08	0.04	2967.2	53.9	4.28
Wood	485 (3.7%)	402 (3.4%)	83 (5.8%)	-4.40	0.00	2311.3	47.5	4.58
Type of building								
Lenin (1920-1932)	338 (2.6%)	308 (2.6%)	30 (2.1%)	1.24	0.21	2335.2	51.0	4.27
Stalin, PG (1930-1960)	975 (7.5%)	857 (7.4%)	118 (8.2%)	1.07	0.28	2430.4	45.2	5.04
Hruschov (1957-1973)	2305 (17.6%)	2074 (17.8%)	231 (16.0%)	1.66	0.10	2148.3	53.8	4.12
Brezhnev (1972-1985)	2228 (17.0%)	2021 (17.3%)	207 (14.4%)	3.43	0.00	2260.7	51.3	4.02
GP (1978-1990)	751 (5.7%)	644 (5.5%)	107 (7.4%)	-2.98	0.00	2879.9	54.0	4.15
MS (1980-1987)	372 (2.9%)	340 (3.0%)	32 (2.2%)	1.32	0.18	1686.1	56.9	4.68
UP (1985-2000)	3127 (23.8%)	2744 (23.5%)	383 (26.6%)	-2.58	0.01	3186.5	56.1	4.19
IP (1995-present)	2296 (17.5%)	2094 (17.9%)	202 (14.0%)	3.67	0.00	4637.7	60.6	4.65
District								
Lenininskiy	576 (4.4%)	509 (4.3%)	67 (4.6%)	-050	0.61	4553.6	68.6	4.31
Sverdlovskiy	2245 (17.1%)	1993 (17.1%)	252 (17.5%)	-0.39	0.69	3674.5	60.0	4.27
Dzerzhinskiy	1918 (14.6%)	1693 (14.5%)	225 (15.6%)	-1.12	0.26	3295.9	58.3	4.29
Motovilikhinskiy	1827 (13.9%)	1591 (13.6%)	236 (16.4%)	-2.83	0.01	3092.1	57.6	3.83
Industrial'nyi	1873 (14.3%)	1670 (14.3%)	203 (14.1%)	0.22	0.82	2988.5	58.2	3.31
Kirovskiy	1918 (14.6%)	1765 (15.1%)	153 (10.6%)	4.54	0.00	2416.6	48.8	4.01
Ordzhonikidzevskiy	1466 (11.2%)	1298 (11.1%)	168 (11.7%)	-0.62	0.53	2221.8	45.5	4.03
Perm surroundings	1290 (9.8%)	1153 (9.9%)	137 (9.5%)	0.81	0.43	1831.1	38.6	5.33

We construct variable "In sale" as an indicator of listing the object in next week and "Time on market" as the number of weeks on the market for those ads that were withdrawn from the sample. For the last week in the sample we observe all offer characteristics except "In sale" indicator for the next week.For the ads posted near the end of the sample we do not have the date of withdrawal then these ads were excluded from the calculation of time on market. Description of variables and descriptive statistics of variables that were used in the model are shown in Table 1.

Some withdrawn offers may be actually sold but som may be removed because of lack of buyers' offers or change in market conditions. Anyway, we do not know the exact reason why objects are not prolongated but one should consider it as a nonrandom decision of a seller that may be contingent with her pricing strategy. Since this decision is not the main point of interest of the paper we only account for nonrandom attrition in the econometric model. However, canvas calling of the random subsample (50 agents and 30 owners) of withdrawn offers showed that more than 90% (45 agents out of 50 and 28 owners out of 30) of objects was actually sold while others said that they are not in sale anymore. We may treat most of the attrition cases as sales, but actually, this is a decision to withdraw the offer. This are minor points for the research since we need to identify the pricing equation. According to the statistics, 89% of objects are listed by real estate agents and only 11% as FSBO. Despite the fact that private individuals amount to a small fraction of sellers in Perm housing market, we have enough data for estimation of its difference comparing with real estate agents due to the size of the dataset.

Average time on the market and price of flats varies greatly across objects with different characteristics. However, while there is a very low difference of property characteristics across types of sellers, FSBO offers have substantially higher probability of attrition (shorter time on market) and being sold despite of the higher initial listing price (2.1% higher for price per m^2) and lower average price difference between weeks (slower price decrease). However, the real list price should account for 2% cost for potential buyer through real estate agent. This makes the difference between the initial list price negligible from the point of buyer. Also, the number of price revisions (changes of price) was calculated for each flat in the sample, which is one of the indicators of sellers' patience, shows that real estate agents are relatively more impatient. They also have the higher fraction of sellers who has at least one price change. The price in the advertisement changes in a quarter

of ads during the whole period of sale, though it varies from 0 to 10 times. Paid posting of the advertisement on the first page of the website (upping) potentially increases the probability of sale, but this option was used by less than 1% of sellers.

4 Empirical specification and econometric issues

4.1 The model

As was mentioned in (Gatzlaff and Haurin, 1997; Hwang and Quigley, 2004), the sample of listed objects is biased by different probability of selling a property. Then the model of setting the asking price will be as follows:

$$
\begin{aligned}
d_{it} &= \begin{cases} 1, g(y_{it}, X_{it}, t, type_i = j) + \eta_{it} \geq 0 \\ 0, g(y_{it}, X_{it}, t, type_i = j) + \eta_{it} < 0 \end{cases} \\
y^*_{it} &= \phi(X_{it}, t, type_i = j) + \alpha_i + \epsilon_{it} \\
y_{it} &= \begin{cases} y^*_{it}, & \text{if } d_{it-1} = 1 \\ \text{is unobserved}, & \text{if } d_{it-1} = 0, \end{cases}
\end{aligned} \tag{1}
$$

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 per m^2 of property i in a week t,

X_{it} is a vector of property i's characteristics and market conditions at time t,

$type_i = j$ where $j \in \{Real\ estate\ agent, Owner\}$ is a type of seller i,

α_i is unobserved property (offer) i's characteristics,

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

We account for nonrandom withdrawn of offers from the sample because most of them were sold during the observation period due to an appropriate list price (Merlo et al., 2015). The identification discussed in the next part is based on the existence of a variable that explains the mean probability of attrition but not the price. This may not include all the possible reasons for a withdrawal as discussed in the previous part.

The reason for introducing the unonbserved characteristics of a property is to capture all unobserved variables related to a property (property and building conditions,

characteristics of surroundings) and offer (cost of selling a property, seller's tastes). Identification of the model with unobserved characteristics possibly correlated with observed variables is provided in the next section.

4.2 Identification

Identification of model (1) faces several econometric challenges such as sample selection at any week t, endogeneity of property (offer) characteristics and arbitrary correlation of unobservables η, ϵ due to various reasons of sample attrition.

In the model, we need to account for a nonrandom attrition of an offer out of the sample for the reasons of a probability of selling dependence on the characteristics of property and transaction costs of selling for different types of sellers as well as on the price listed in the offer.

Accounting for the presence of individual effect α_i is important for the reasons of capturing hidden variables of an offer (property and surroundings, seller and owner). Firstly, the property conditions may affect the price and be correlated with observed characteristics. Secondly, the attractiveness of property location may also be correlated with some observed property characteristics and affect the price. Thirdly, seller and/or owner impatience, reserve price and her cost of selling affect the pricing strategy and the initial choice of using a broker. Introducing the individual effect as well as accounting for its correlation with observed variables is crucial for the identification purposes.

In order to drop out the price property-specific unobservable term α_i and its potential correlation with property characteristics X_{ijt} we use the differencing approach. Let us define a differencing operator Δ^t as a difference between the data in week t and the data in initial listing (at first week of listing, $t = 1$):

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

Then we may difference out the unobservable time-invariant property characteristics α_i from price equation (1). Partial linearizing of $\phi(\cdot)$ along with differencing separately for each type of seller $j \in \{Real\ estate\ agent, Owner\}$ will give the price difference equation:

$$\Delta^t y^*_{ijt} = \varphi_j(t) + (X_{ijt}, \Delta^t X_{ijt})\beta_j + e_{ijt} \tag{2}$$

where:

$X_{ijt}, \Delta^t X_{ijt}$ are property and offer i characteristics and their change in time t for the seller of j-th type,

$\varphi_j(t)$ is price decrease strategy of seller which is not explained by property (observed and unobserved) characteristics and their changes as well as by the change of market conditions,

e_{ijt} is unobservable term jointly distributed with η with joint density $f_{\eta,e}(\cdot)$.

We may identify $\varphi_j(t)$ as an average price change in week t for sellers of type j which as not explained by X_{ijt} and $\Delta^t X_{ijt}$ and nonrandom withdrawal of offers from the sample at week $t-1$:

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

Definition. $p_{ijt} := E[d_{ijt} = 1 | y_{ijt}, X_{ijt}, t, type_i = j]$.

Assumption (on exogeneity) 1. $E[X_{ijt} | e_{ijt}, \eta_{ijt-1}, t] = X_{ijt}$.

A.1 assumes that there are no idiosyncratic shocks of price (e_{ijt}) and a probability of selling the property at previous week (η_{ijt-1}) that affect market conditions, property and offer characteristics. The assumption may be violated only in the part of the potential correlation between price shocks and offer characteristics, for instance, the contingent decision of seller about upping the listing and decreasing the price. But since the fraction of offers with upping is negligible we may assume that potential bias is insignificant too.

Assumption (on continuity) 2. Joint density of unobservables $f_{\eta,e}(\cdot)$ is continuous on its arguments almost everywhere.

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

$$E[\Delta^t y^*_{ijt} | (X_{ijt}, \Delta^t X_{ijt}, d_{ijt-1} = 1] = (X_{ijt}, \Delta^t X_{ijt})\beta_j + E[e_{ijt} | d_{ijt-1} = 1] = \tag{4}$$

$$= (X_{ijt}, \Delta^t X_{ijt})\beta_j + E[e_{ijt} | \eta_{ijt-1} \geq -g(y_{ijt-1}, X_{ijt-1}, t-1, type_i = j)] =$$

$$= (X_{ijt}, \Delta^t X_{ijt})\beta_j + \int_{-\infty}^{\infty} \int_{-g(y_{ijt-1}, X_{ijt-1}, t-1, type_i = j)}^{\infty} e_{ijt} f_{\eta,e}(s,r) ds dr =$$

$$= (X_{ijt}, \Delta^t X_{ijt})\beta_j + \lambda_j(p_{ijt-1})$$

Assumption (on existence of excluded variables) 3. $\exists v \in \{y_{ijt-1}, X_{ijt-1}, t, type_i = j\} : \frac{\partial E[d_{ijt-1} | X_{ijt}, \Delta^t X_{ijt}]}{\partial v} \neq 0$.

The extension of Heckman (1976) model as well as identification conditions for the case of nonnormal (arbitrary) joint distribution of unobservables is provided in Newey (2009). As in simple Heckman (1976) sample selection model, for the identification of price

equation, we need to have variables that affect the decision to withdraw the offer after previous week (d_{ijt-1}) but not the price change ($\Delta^t y^*_{ijt}$). The natural candidates are price in previous week $t-1$ and time-invariant object characteristics. This assumption is also testable by testing for the absence of multicollinearity between outcome equation right-hand side variables X_{ijt}, $\Delta^t X_{ijt}$ and p_{ijt-1}.

If A.1-3 are met then β_j, λ_j and, consequently, $\varphi_j(t)$ are identified (for formal proof see Newey (2009)).

4.3 Estimation

In order to obtain estimates of price decrease just on marketing time $\varphi_j(t)$ cleared out from the effect of different observed and unobserved characteristics and market conditions we need to estimate equation (4) and then calculate its residuals (equation (3)). Estimation of the equation (4) repeats semiparametric two-step (first two steps of the further estimation procedure) approach provided by Newey (2009). The estimation procedure contains the following steps:

1. Estimation of $\hat{p}_{ijt} := E[d_{ijt} = 1 | y_{ijt}, X_{ijt}, t, type_i = j] = \int_{-g(y_{ijt}, X_{ijt}, t, type_i = j)}^{\infty} \eta_{ijt} f_\eta(s) ds = = \gamma_j(y_{ijt}, X_{ijt}, t, type_i = j)$ using Klein and Spady (1993) semiparametric efficient single-index binary choice model.

2. Estimation of $\Delta^t \hat{y}_{ijt} := E[\Delta^t y^*_{ijt} | X_{ijt}, \Delta^t X_{ijt}, d_{ijt-1} = 1] = (X_{ijt}, \Delta^t X_{ijt})\beta_j + \lambda_j(\hat{p}_{ijt-1})$ aproximating unknown λ_j by power series on $\hat{p}_{ijt-1}$ using least squares.

3. Estimation of $\hat{\varphi}_{ij}(t) := \Delta^t y_{ijt} - \Delta^t \hat{y}_{ijt}$.

4. Smoothing $\hat{\varphi}_{ij}(t)$ over i for each $j \in \{Real\ estate\ agent, Owner\}$.

At the last step we simply average the $\hat{\varphi}_{ij}(t)$ over i for each j and t and calculate its standard errors using bootstrap. In order to have *i.i.d.* replications we reply the sample drawing whole offers history for an object and cluster the data by the day of initial listing to control for possible correlation of objects' unobservables. This method of extracting the dependence of price on time on market is efficient since it is not relied on the assumption on functional form of this dependence.

5 Results

5.1 Preliminary analysis

Firstly, we analyze the determinants of initial list price per m^2 and list price dynamics for mean seller. Table 2 represents the results of OLS regressions of initial price and price difference pooled over the type of seller.

Specification (1) shows the determinants of initial asking price per m^2. All property characteristics have jointly good predictive power for the price of the flat at the first week of listing. One of the significant determinants is the average market price which shifts the individual price up. Real estate agents set the initial price on 641 rub. per m^2 (1.2% to mean price per m^2) lower than property owners which reflects the first part of a difference in pricing strategies across types of sellers. However, one should account for 2% mean cost of buying a flat using real estate agent which makes a real price for FSBO lower and explains shorter marketing time for FSBO.

Further models (2-7) represent the results for price difference equation with different control variables. Generally, offer and property characteristics better explain the price but not the price dynamics. A price in a particular week is closer to the initial one with higher number of clicks to an offer. The difference (absolute value of difference) is higher for upped offers and with a higher average price in a month of listing. Property characteristics explain a significant part of the price difference variation that supports the results of Hwang and Quigley (2004) on the different probability of selling properties with different characteristics and preliminary analysis of raw data. This supports the idea of nonrandom attrition of offers out of the sample and explains the use of sample selection corrected models estimated further.

The inclusion of the set of dummies for a week of time on market (Week dummies) increase the explanatory power of the model proving the idea that sellers decrease the price considering an object's current time on the market. Then we may extract the functional dependence of price on time as residuals of price difference regression on offer and property characteristics controlling for selectivity issues.

Table 2. Results of regressions pooled over types of sellers without correction on sample selection.

	y_{i1}	$\Delta^t y_{it}$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1(Real estate agent)	-0.64**	-0.002	-0.001	-0.002	-0.007	-0.007	-0.004
	(0.25)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
ln(clicks)	0.07	0.013***	0.013***	0.013***	0.013***	0.013***	0.013***
	(0.05)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
upping	-3.6	-0.29*		-0.29*	-0.28*	-0.28*	-0.32*
	(5.0)	(0.13)		(0.13)	(0.12)	(0.12)	(0.12)
av. monthly price	0.17***	-0.007***		-0.015***	-0.016***	-0.016***	-0.005*
	(0.05)	(0.001)		(0.002)	(0.002)	(0.002)	(0.002)
Δ upping			-0.21				
			(0.11)				
Δ av. monthly price			0.002	0.008***	0.008***	0.008***	0.002
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Property characterstics	*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
Number of parameters	27	5	5	6	28	28	39
R^2	0.52	0.006	0.005	0.007	0.018	0.018	0.025

Notes: In model (1) the dependent variable is initial listing price per m^2, in models (2-7) - the difference between the listing price per m^2 in week t and initial listing price.

OLS estimates in table cells, robust standard errors in parentheses.

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

5.2 Results on corrected models

In order to account for the different speed of price decrease among different types of sellers, we split the sample of offers into two groups: offers for selling objects listed by real estate agents and by owners. We control for a possible nonrandom withdrawal of offers correcting the estimates using Newey (2009) nonparametric two-step procedure. We suppress the first step results for the object's probability of being in sale equation. The results and prediction of the in-sale probability $\hat{p}$ were obtained by Klein and Spady (1993) semiparametric binary response model for each type of sellers. Then we include the series on $\hat{p}$ up to power 3 in price difference equation as a control function $\lambda_j(\hat{p})$. We also test the existense of excluded variables (Assumption 3) which affect $\hat{p}$ but not the outcome $\Delta^t y_{ijt}$. Results of regressions for different sellers types with corrections on λ are presented in Table 3.

Regression results evidence the nonrandom withdrawal of offers by the joint significance of the control function λ parameters for each type of real estate sellers.

We found the different reaction of different types of sellers on offers' characterisitics. Thus, real estate agents slow the price decrease with the increase in the number of clicks on offers. This supports the results showed in (Merlo et al., 2015) that the increase of the number of offer shows for potential buyers (as a proxy for a number of bids) increases the propensity to sell the object and willingness to hold (or even increase) the asking price compared to the initial one. However, property owners react differently on the number of clicks on the offer. This may be caused by several reasons induced by higher costs for sellers: inability to screen the number of clicks or inability to increase the number of meetings with potential buyers with the increase of their interest.

We also found the evidence of different strategy in using the upping option. Along with the higher fraction of sellers among the FSBO type, owners decision to promote the offer to the top is correlated with the price decrease. Real estate agents' decision for the price decrease is not connected with the decision to promote the object.

The reaction of sellers to the average price change differs in the significance on conventional levels. However, the magnitude of the effect of average price on the price difference is statistically the same across types of sellers. Sellers adjust the asking price

Table 3. Results of regressions for different types of sellers with corrections on sample selection.

	Real estate agents			FSBO		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(clicks)	0.013***	0.012***	0.019***	0.002	0.004	-0.001
	(0.001)	(0.001)	[0.001]	(0.005)	(0.005)	[0.001]
upping	-0.20	-0.19	-0.27*	-0.97*	-0.96*	-0.96*
	(0.13)	(0.13)	[0.14]	(0.39)	(0.39)	[0.42]
av. monthly price	-0.015***	-0.015***	-0.011***	-0.015	-0.012	-0.009
	(0.002)	(0.002)	[0.002]	(0.008)	(0.008)	[0.010]
Δ av. monthly price	0.008***	0.009***	0.007***	0.009	0.008	0.007
	(0.001)	(0.001)	[0.001]	(0.005)	(0.005)	[0.006]
Property characterstics	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Control for λ	*No*	*No*	*Yes*	*No*	*No*	*Yes*
p-value for significance of λ	-	-	0.000	-	-	0.018
N	39645	39645	39645	2617	2617	2617
n	8934	8934	8934	724	724	724
Number of parameters	5	27	30	5	27	30
R^2	0.007	0.019	0.024	0.004	0.036	0.040

Notes: The dependent variable is the difference between the listing price per m^2 in week t and initial price. OLS (1,4) and two-step (2-3, 5-6) estimates in table cells. Robust standard errors in parentheses. Panel bootstrap standard errors based on 1000 replications clustered on day of initial listing in brackets.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

codirectionally with the change of market price.

The main point of this research interest is to clear out the effect of time on price dynamics. We obtain the price difference unexplained by offer and property characteristics and nonrandom withdrawal of offers and regress it on the week on the market in a nonparametric way discussed in the estimation section. We average the unexplained price difference over objects for each week and type of seller and then calculate the standard errors for average price difference using bootstrap. Results of the estimated price decrease explained by time on the market only ($\varphi_j(t)$) are shown on Figure 1.

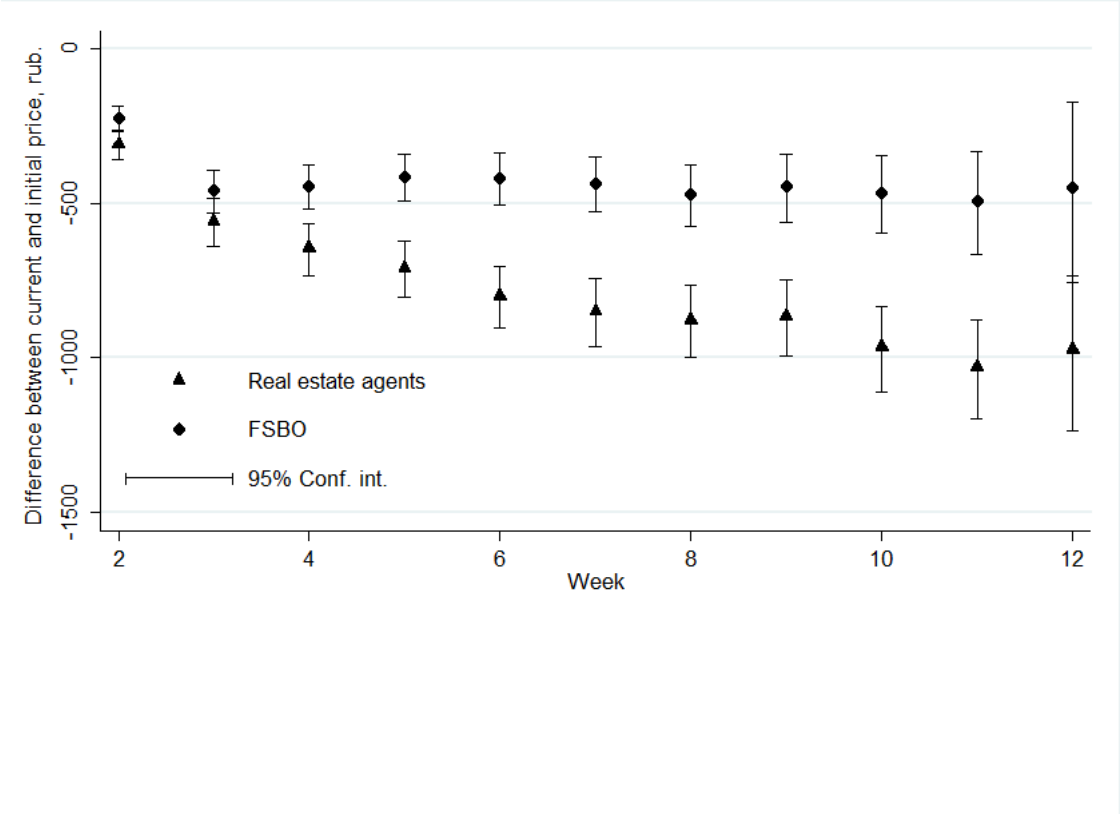

Fig. 1. Plot of price difference for different types of sellers, $\varphi_j(t)$.

Sellers show the same average decrease of price on first two weeks after the initial listing. We found the 500 rub. per m^2 (near 1%) average price change on the third week of listing. Starting from the fourth week, sellers show a statistically different decrease of price. While the FSBO offers remain the average price on the level of the third week, real estate agents cut the price on further weeks up to the level of 2% discount to the initial price making the real price of buying the flat from owner and agent equal. This evidences the relative impatience of real estate agents compared to property owners and higher motivation

to sell the property faster in order to generate more profit on the number of deals when the potential buyers are not attracted by addtional agents' services or the characteristics of a property. Figure 2 also shows predicted price per m^2 dynamics for different types of sellers. Real estate agents use the strategy to lower initial price and faster price cut when time on the market exceeds the average one (near 4 weeks for real estate agents). Seller-owned property offers show relative patience and motivation to wait for the proper offer. This allows generating a higher return from selling the particular object for the owner. While real estate agents tend to lower the price and shorten the time on market to obtain a commission from both buyer and seller faster.

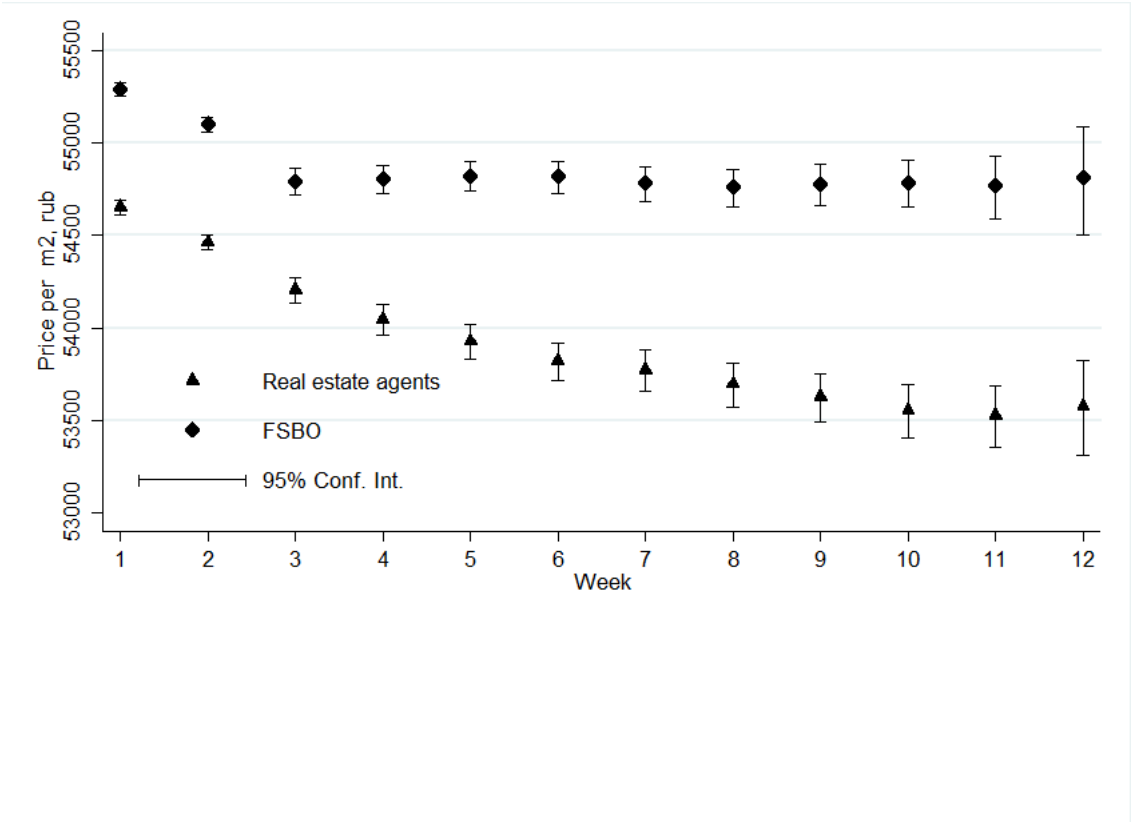

Fig. 2. Plot of price dynamics for different types of sellers, $y_j(t)$.

5.3 Specification check for price difference function

To test the functional form of function of price dependence on the marketing time $\varphi_j(t)$ controlling for all other fixed we estimate three different specifications of the equation (2). First specification for each seller type are parametric one where $\varphi_j(t)$ is estimated as

linear function of price on the week number t. The second specification is also a parametric regression of price difference which includes a set of dummies for each week to control for possible nonlinear dependence of price on time. The last regression for each seller type is a nonparametric regression discussed above. The R^2 for each model contains an explained variation of price difference by both time on market and offer and property characteristics. Estimation results are reported in Table 4.

Results indicate that nonparametric specification have better predictive power compared with parametric ones for each type of sellers. Simple linear regressions of price decrease on time (1) and (4) show that price decreases over time with a mean speed -87.8 rub. per m^2 (0.16%) in each week for real estate agents and -42.9 rub. per m^2 (0.08%) for owners. Thus, the mean price adjustment speed is two times faster for agents compared with owners. Although, comparison of specifications (1) and (4) with (2-3) and (5-6) respectively shows that the speed of price decrease in first 3 weeks is higher for both types of sellers compared with the remaining weeks. This indicates that $\varphi_j(t)$ is better modeled by more flexible functions rather than linear one.

6 Conclusion

The current paper is aimed at the investigation of difference in sellers' behavior, dividing them into two groups: real estate agents and private individuals (property owners). The paper analyzes pricing strategies of real estate sellers focusing on list prices change over time across main types of sellers.

The steady problem of price estimation in the housing market is endogeneity of observed property and offer characteristics in respect to property-specific unobservables. This problem was overpassed by the use of the differencing approach. In order to analyze pricing strategies of sellers over time, we use semiparametric two-step approach, which is the extension of Heckman (1979) model, provided by Newey (2009). The main result of the current study is the estimation of the average price change, which is not explained by property characteristics and their changes, changes in market conditions and a nonrandom probability of offer's withdrawal.

An investigation based on the unique dataset including information about offers

Table 4. Regression results for different specification of time function.

	Real estate agents			FSBO		
	(1)	(2)	(3)	(4)	(5)	(6)
week	-87.8***			-42.9***		
	[7.4]			[16.2]		
1(week = 2)		-	-290.5		-	-256.1
			[22.2]			[27.8]
1(week = 3)		-210.5***	-515.2		-206.1***	-492.2
		[28.4]	[18.1]		[29.2]	[20.4]
1(week = 4)		-262.9***	-620.5		-194.4***	-485.2
		[36.4]	[32.1]		[22.6]	[21.1]
1(week = 5)		-381.5***	-722.3		-173.8***	-468.7
		[47.4]	[40.2]		[53.9]	[47.2]
1(week = 6)		-504.7***	-780.5		-176.7***	-469.1
		[51.7]	[42.1]		[50.3]	[47.1]
1(week = 7)		-526.7***	-805.4		-193.4***	-479.9
		[55.8]	[48.2]		[59.4]	[50.2]
1(week = 8)		-563.8***	-825.6		-215.1***	492.8
		[70.4]	[50.2]		[77.3]	[52.2]
1(week = 9)		-546.9***	-815.3		-205.2***	-480.1
		[74.0]	[51.9]		[78.8]	[58.2]
1(week = 10)		-681.8***	-976.2		-214.3***	-491.8
		[59.8]	[65.3]		[77.1]	[70.3]
1(week = 11)		-712.8***	-1035.8		-258.6***	-498.7
		[59.1]	[86.2]		[72.5]	[94.4]
1(week = 12)		-694.7***	-988.4		-236.5***	-467.2
		[68.9]	[121.6]		[80.0]	[130.1]
Control for λ	Yes	Yes	Yes	Yes	Yes	Yes
p-value for significance of λ	0.000	0.000	0.000	0.008	0.015	0.018
N	39645	39645	39645	2617	2617	2617
n	8934	8934	8934	724	724	724
Number of parameters	31	40	30	31	40	30
R^2	0.026	0.033	0.035	0.042	0.052	0.056

Notes: The dependent variable is the difference between the listing price per m^2 in week t and initial price. Two-step estimates in table cells. Panel bootstrap standard errors based on 1000 replications clustered on day of initial listing in brackets. Models (1) and (4) are two-step regressions of price difference including the week number, models (2) and (5) include week dummies, models (3) and (6) are nonparametric regression estimates for $\varphi_j(t)$ equivalent to Fig.1. For models (2) and (5) the estimates represent the difference between the price on certain week and base week (week = 2).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

made in dynamics by both types of sellers on the same marketing platform revealed that real estate agents are more willing to cut the list price during the period of sale rather than property owners when the property is unsold. While private individuals typically stop cutting the list price after the third week of listing, real estate agents continue to decrease the price until sale. This finding is explained by the fact that professional sellers have an incentive to sell as many properties as they can, since their earnings increase with the number of closed deals. Thus, we empirically prove the fact that real estate agents are, on average, more motivated to sell and hence more impatient than property owners, while previous studies just made theoretical assumptions about this characteristic of sellers.

Apart from the scientific novelty, this paper is of practical interest. For buyers it is more advantageous to buy a property from real estate agent because they set lower asking prices initially and tend to cut them greater than sellers who own the property. However, one should account for the commission taking by agents (2% from a value of deal for a mean agent on the market) that makes buying from owner slightly cheaper only when the object from agent is listed for more than 6 weeks.

To sum up, current paper complements the real estate literature by examining sellers' behavior, making a valuable contribution by analyzing the time effects in their pricing strategies.

References

Anglin, P., Rutherford, R., Springer, T. M. (2003). The trade-off between the selling price of residential properties and time-on-the-market: the impact of price setting. *The Journal of Real Estate Finance and Economics* 26(1): 95–111.

Arnold, M. (1999). Search, bargaining and optimal asking prices. *Real Estate Economics* 27(3): 453–481.

Carrillo, P. (2011). To sell or not to sell: measuring the heat of the housing market. *Real Estate Economics* 41(2): 310–346.

Gan, Q. (2013). Optimal selling mechanism, auction discounts, and time on market. *Real Estate Economics* 42(2): 347–383.

Gatzlaff, D., Haurin, D. (1997). Sample selection bias and repeat-sales index estimates. *Journal of Real Estate Finance and Economics* 14: 33-50.

Genesove, D., Mayer, C. (2001). Loss aversion and seller behavior: evidence from the housing market. *The Quarterly Journal of Economics*: 1233-1260.

Glower, M., Haurin, D., Hendershott, P. (1998). Selling time and selling price: the influence of seller motivation. *Real Estate Economics* 26(4): 719-740.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica: Journal of the econometric society*, 153-161.

Hendel, I., Nevo, A., Ortalo-Magne, F. (2009). The relative performance of real estate marketing platforms: MLS versus FSBOMadison.com. *The American Economic Review* 99(5): 1878-1898

Horowitz, J. (1992). The role of the list price in housing markets: theory and an econometric model. *Journal of Applied Econometrics* 7: 115–129.

Hwang, M., Quigley, J. M. (2004). Selectivity, quality adjustment and mean reversion in the measurement of house values. *Journal of Real Estate Finance and Economics* 28(2): 161-178.

Jud, D., Seaks, T. (1994). Sample selection bias in estimating housing sales prices. *Journal of Real Estate Research* 9(3): 289-298.

Klein, R.W., Spady, R.H. (1993). An efficient semiparametric estimator for binary response models. *Econometrica: Journal of the Econometric Society*, 387-421.

Knight, J. (2002). Listing price, time on market, and ultimate selling price: causes and effects of listing price changes. *Real Estate Economics* 30(2): 213–237.

Levitt, S., Syverson, C. (2008). Market distortions when agents are better informed: the value of information in real estate transactions. *The Review of Economics and Statistics* 90(4): 599-611.

Merlo, A., Ortalo-Magne, F., Rust, J. (2015). The home selling problem: Theory and eidence. *International Economic Review* 56(2): 457-484

Newey, W. K. (2009). Two-step series estimation of sample selection models. *The Econometrics Journal* 12(s1): S217-S229.

Piazzesi, M., Schneider, M. (2009). Momentum traders in the housing market: survey evidence and a search model. *NBER Working Paper* w14669.

Salant, S. (1991). For sale by owner: when to use a broker and how to price the house. *The Journal of Real Estate Finance and Economics* 4(2): 157-173.

Springer, T. (1996). Single-family housing transactions: seller motivations, price, and marketing time. *Journal of Real Estate Finance and Economics* 13: 237–254.

Thanos, S., White, M. (2014). Expectation adjustment in the housing market: insights from the Scottish auction system. *Housing Studies* 29(3): 339-361.

Yavas, A., Yang, S. (1995). The strategic role of listing price in marketing real estate: theory and evidence. *Real Estate Economics* 23(3): 347-368.