Estimating Liquidity Effects in the Housing Market

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Abstract

Where trade is decentralized and information is imperfect, an urban housing market should be organized into separate market segments. Units in more active market segments should sell at a premium if households value asset liquidity. Evidence from the Hong Kong housing market strongly supports the joint hypothesis of market segmentation and transaction-based liquidity effects in the housing market in the cross-section. Units in housing developments with a greater turnover rate sell at a substantial premium. On average, 9.2% of the percentage difference in the prices of two given housing units in our sample can be attributed to liquidity effects. Contrary to conventional wisdom, the size of the housing development is not in general positively related to the rate of turnover and thus asset liquidity, while a less obvious candidate factor – the quality of the housing units seems to matter.

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1. Introduction

Given that individual housing units could differ considerably with respect to locations, structural attributes, and neighborhood qualities, among perhaps many more dimensions, the housing market in a city or a region should tend to be organized into separate market segments. Where trade is decentralized and information is imperfect, the extent of market segmentation should only be strengthened further. Now if some market segments are more active than other segments, housing units in the more active segments should sell at a premium if households value the asset liquidity in these submarkets.

In the financial market, the delineation of market segments is straightforward. Since any two shares of a given firm are exactly alike, there is a well-defined market for the outstanding shares of each individual firm. The stocks of a more actively traded firm should then be deemed more liquid assets. The validity of these arguments and the amount of the transaction-based liquidity premium investors are willing to pay can readily be subjected to empirical investigations as the trading volume of a stock is both a familiar object and a piece of commonly available information. The large literature in this tradition by and large confirms that transaction-based liquidity premium exists and can be an important determinant of variations in the rates of returns and stock prices in the cross-section.[3, 4]

If liquidity is an important consideration for investors of financial assets, liquidity should be an even more important consideration for investors of real estates, for which no centralized market exists and where no two units are exactly alike. Indeed, this insight has motivated numerous theoretical studies that model how prices are formed in markets where the matches between households and housing units are *iid* draws from some known distribution and where the meetings of buyers and sellers are governed by random search on the part of either buyers, sellers or both.[5] On the other hand, empirical studies

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[3] See Klugger and Stephan (1997) and the references therein. Pagano (1989) is a notable theoretical treatment.

[4] An alternative tradition argues for measuring liquidity effects by the bid-ask spread of a stock, where presumably a larger spread indicates a less liquid asset. For a theoretical treatment see Grossman and Miller (1988). In the absence of specialist market makers and observable bid-ask spreads in the housing market, the latter measure is apparently not relevant for measuring liquidity for real estate assets.

[5] See among others Arnott (1989), Wheaton (1990), Williams (1995), and Krainer (2001).

on identifying and estimating transaction-based liquidity effects on house prices in the *cross-section* have been far and between. We believe that this gap in the literature is due to the difficulty in empirically defining market segments in an urban housing market, apart from the crudest and not particularly informative definitions.

The problem is not insurmountable though. In this paper, the point of departure is that housing units located in the same building or in nearby buildings belonging to the same development that share common designs and floor plans and other amenities should be sufficiently close substitutes to compete intensely against one another. True the units are not the same but they can be rather similar. Arguably then the units should constitute different varieties of one category of differentiated products and well-defined market boundaries can be drawn to encompass the units making up the development but not any other units. This immediately suggests that the liquidity of the units in the development can be measured by the aggregate volume of trade in the development within a given time period.

Considerations of thick market externalities suggest that larger submarkets could be more active.[6] Then a case can be made to also measure liquidity by the size of the development in terms of the number of units making up the development.[7] We choose not to emphasis such measures of liquidity since it is not clear what additional dimensions of liquidity that the size of the development may measure if we already measure the extent of trading activities. After all, a market segment is liquid only because the units in it are actively traded but not because the segment is larger per se.

The Hong Kong housing market is ideally suited for implementing our proposed transaction-based measure of asset liquidity. In the dense urban Hong Kong, practically all owner-occupied homes are units in high-rise buildings and multi-building developments of various scales have been commonplace in the last few decades. Besides, trades in many market segments are very active on a continuous basis. Specifically we put together a dataset of a cross-section of second-hand home sales in a moderate-size district in Hong Kong in the first seven months of 2005. In our hedonic

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[6] Gan and Li (2004) model how the matching function can be subject to increasing returns because of indivisibilities along the line of an example suggested by Arrow (1971, pp.132-133).
[7] In the literature on financial assets, some writers also choose to measure asset liquidity by the market value of the outstanding shares of the firm. See the references cited in Klugger and Stephan (1997).

price regressions, we control for the usual observable characteristics of the transacted units to isolate the effect of the volume of trade on housing price.

In our basic specification, we do succeed in finding a positive effect of transaction volume on price. When the number of buildings that the development comprises also enters the hedonic price regression, the effect of trading volume on price weakens considerably, however. Furthermore, when trading volume is also instrumented by the number of units in the development in the two-stage least squares estimation, the coefficient estimate turns negative altogether.

We believe that there is a measurement issue, as well as good theory, for why the variable trading volume apparently fails to capture any positive effect of asset liquidity on housing price. First, because of scale economies in land use, developments on a sizeable plot of land and made up of numerous buildings tend to be provided with better facilities and amenities and most importantly more open space than single-building developments. This, coupled with the fact that there tends to be more trades in a larger development, suggests that any positive effect of trading volume on price may partly capture this quality effect, which vanishes when the missing variable – the scale of the development is brought back into the hedonic price regression. This is a measurement issue. Besides, the use of trading volume to measure asset liquidity can also be problematic from a theoretical point of view. The variable is a sensible measure of liquidity insofar as in a more active market segment, prices should be less volatile and owners could expect a fair price whenever they wish to dispose of their units. That there is a sizeable volume of trade in each time period, however, does not guarantee that a unit on the market can be sold off quickly if there are also a large number of similar and therefore competing units on the market.

Obviously then, a better measure is trading volume normalized by the number of units on the market. We do not have information on the number of units on the market in our dataset. But since there should only be a larger number of units on the market at a point in time in a larger development, we can instead normalize trading volume simply by the number of units in the development – a variable usually referred to as the rate of turnover. Measuring liquidity effects via turnover rate is not only theoretically appealing but also attractive on empirical grounds as there is no compelling reason for turnover rate to be positively correlated with the size of the development and it turns out that they are not in our sample. In this case, there would be no confounding of liquidity and quality effects.

Not surprisingly, we find that turnover rate does exert a positive effect on housing price in the cross-section. More importantly, the positive effect of turnover rate on price also survives the inclusion of variables measuring the size and scale of the development. The liquidity effects we find are not only statistically but also economically significant. In particular, housing prices can differ by as much as two times because of the difference in turnover rates. On average transaction-based liquidity effects account for 9.2% of the percentage difference in price between two given units in our sample.

Our transaction-based approach to measure asset liquidity in the housing market complements the traditional approach that emphasizes the observed *time on the market* (TOM) of individual housing units as a measure of asset liquidity.[8] TOM is a measure of asset liquidity in the housing market in that the liquidity of a housing unit can be defined as the time that it takes to sell it at a fair price.[9] In this case, when a sale is completed with a shorter TOM, the house should be a more liquid asset and sell at a higher price, other things equal. The evidence, however, is mixed. In most cases, TOM is instead found to be positively correlated with the listing price. In some instances, a positive relationship also exists between TOM and the sale price. These findings are usually interpreted as reflecting the notion that more patient or less liquidity constrained sellers being able to wait longer for more satisfactory bids for their units. The use of TOM to identify and measure liquidity effects in the housing market is ingenious in that it explicitly recognizes the dynamic nature of the concept of asset liquidity. But it can also confound characteristics of the given housing unit and the characteristics of the seller until better data are available to disentangle the two sets of characteristics.

This paper is also related to the literature on analyzing the *time series* relationships between changes in aggregate trading volume and changes in average house price at different frequencies in a given housing market, usually defined to be a city or

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[8] Forgey, Rutherford and Springer (1996), Genesove and Mayer (1997), Leung, Leong and Chan (2002), Anglin, Rutherford and Springer (2003), and Merlo and Ortalo-Magnè (2004), among others.
[9] See Lippman and McCall (1986) and Anglin (2004) for theoretical treatments.

the national economy.[10] This literature asks the question of how prices and quantities respond over time to shocks to housing demand where housing supply is close to if not completely inelastic.

Our paper is closest to Ho (2003) who also takes a transaction-based approach to measure asset liquidity in the Hong Kong housing market by analyzing how the price differential between units in single-building developments and units in multi-building developments depends on the differential in aggregate transaction volumes between the two types of development. Our study is different from Ho (2003) in two important ways. First, we control for many observable characteristics of the transacted units the most important of which is the age of the building.[11] Second, instead of grouping housing units into just two broadly defined market segments based on the mode of development, our market segments are more finely defined. Precisely because we do not force the definitions of market segments by the mode of the development a priori, our results are markedly different from those of Ho (2003) in that we find that units in larger developments are not as a rule more valuable.

The next section explains the composition of the dataset and presents the results of the empirical analysis. Section 3 presents calculations on the quantitative importance of liquidity effects implied by our estimates. Section 4 concludes by discussing the relationships of our results with existing models of price formation in the housing market and suggests further empirical and theoretical investigations.

2. Analysis

2.1 Data

We collect data on the sales of owner-occupied housing units in Hong Kong from the website of Centaline Property Agency – the largest local realtor,[12] which in turn

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[10] Berkovec and Goodman (1996), Hort (2000), Leung, Lau, and Leong (2002), Leung and Feng (2005), and Follain and Velz (1995), among others. Like us, Leung et. al. (2002) and Leung et. al. (2005) use disaggregate data but the emphasis remains on the time series relationships.

[11] Multi-building development is a more recent phenomenon. On average, the units in such developments are younger and embody better housing capital.

[12] http://www.centadata.com/.

collected the data from the Hong Kong Land Registry. The dataset is made up of the population of sale transactions of second-hand housing units on the eastern part of Hong Kong Island – one among 18 administrative districts in Hong Kong, over a seven-month period from January to July 2005. Restricting attention to one moderate-size area serves to hold constant commuting effects in the hedonic price regression,[13] whereas keeping the sample period to a seven-month interval should help minimize business cycle, as well as growth, effects.

Over the sample period there were 3448 sale transactions in the district, all of which are transactions of units in high-rise buildings. Indeed, in the densely populated Hong Kong urban center, three is virtually no single-family home nor semi-detached house. Furthermore, an individual property development in Hong Kong, often though not always, is made up of numerous buildings of similar designs and floor plans, constructed in contagious plots of land and completed in a period of time not more than two to three years apart – what is known as a housing estate in Hong Kong.

When the construction for a development is just completed, the developer could command considerable market power as the sole owner of all units in the development. How many units should be offered for sale in each batch and the prices to charge would be important strategic variables for the developer. The relationship between sales and prices could be fundamentally different from the corresponding relationships for units in developments completed years ago in which the ownerships are widely dispersed among individual owner-occupiers. To prevent the first-hand transactions from diluting the results, we exclude them, as well as transactions of units in buildings that were completed for less than a year from the analysis. Our final sample is made up of 2891 observations of transactions of second-hand owner-occupied housing units completed for at least a year at the time of contract signing.

The main variables of interest are trading volume and turnover rate of the development in the sample period to which the unit belongs. Specifically, we run hedonic price regressions controlling for

[13] More precisely, we exclude transactions of units in the western end of the district, an area known as North Point, from our dataset. While areas to the east of North Point are primarily residential, North Point is an older area in which commercial and residential developments intermix. In this way, its character is rather different from the rest of the eastern district of Hong Kong Island.

- the number of units in the development (*NUnit*),
- the number of buildings in the development (*NBldg*),
- the size of the unit in sq. ft. (*USize*),
- the floor of the unit (*Floor*),
- the age of the building (*Age*),
- the week of the sample period in which the transaction took place (*Week*),
- equal to 1 in case the unit is on the top floor and that the unit is sold with a rooftop terrace and 0 otherwise (*Roof*),
- equal to 1 if there are clubhouse facilities in the development and 0 otherwise (*Club*),[14]
- equal to 1 if the unit is located in the eastern part of the district and 0 otherwise (*District*),

to isolate the effects of liquidity, as measured by the number of units in the development that are bought and sold in the sample period (*TV*) and the rate of turnover defined as *TV/NUnit* on the price/sq. ft. of the housing unit (*Price*).

During the first five months of the seven-month sample period, housing price in Hong Kong was on a mild upward trend before falling slightly in the final two months, while over the entire period, the mean monthly growth rate was 1.5 percent.[15] The variable *Week* serves to capture such effects on individual transaction prices. The eastern district of Hong Kong, though not particularly sizeable, is certainly not a homogeneous neighborhood to the fullest extent. The general impression is that the western part of the district is a wealthier neighborhood. To control for any possible neighborhood effects, we use the discrete-valued variable *District* to designate whether the unit is on the western or the eastern part of the district.[16]

Table 1 presents selected sample statistics. Even though the sample is restricted to just one moderate-size district, the observations are drawn from a diverse collection of

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[14] This information is obtained from the websites of Midland holdings Limited and Ricacorp Properties Limited, both of which are major real estate realtors in Hong Kong.
[15] Source: Centa-City Index from http://www.centanet/cci.htm/.
[16] *District* is set equal to 0 if the unit is located in the western part of the district that includes the Quarry Bay, Kornhill and Taikoo Shing neighborhoods and equal to 1 if the unit is located in the eastern part of the district that includes the Shau Kei Wan, Chai Wan, and Heng Fa Chuen neighborhoods.

127 developments, with an average number of buildings per development equal to 3.33. There should thus be ample variances in *TV* and *TV*/*NUnit* in the sample to help isolate their effects on prices.

Table 1: Sample Statistics

Variable	Mean	Coefficient of Variation	Min	Max		Variable	Fractions of 1s
Price	3,854	0.33	441	10,084		*Roof*	0.01
TV	222	1.02	1	614		*Club*	0.56
NUnit	4780	0.96	11	12,690		*District*	0.50
TV/NUnit	0.045	0.44	0.002	0.189			
NBldg	24	0.98	1	61			
Floor	16	0.70	1	62			
USize	666	0.28	205	1,356			
Age	19	0.40	2	45			

2.2 Empirical specifications and results

In all specifications we shall analyze in the following, the dependent variable *Price* is entered in log. Among the continuous-valued independent variables, *TV*, *TV/NUnit, NUnit, NBldg, Age* and *USize* are entered in logs, and *Floor* is entered in level and *Week* is entered in level and in square. These choices are made on the grounds that an elasticity interpretation appears more natural for *TV*, *TV/NUnit, NUnit, NBldg, Age*, and *USize*, while a (possible time-varying) growth rate interpretation suits the variable *Week* better. For the variable *Floor*, it seems more appealing to think of how much more a unit one floor up, instead of "one percent up", will sell for.[17]

Our first set of results, presented in table 2, pertains to measuring liquidity effects by aggregate trading volume in the development, while omitting variables measuring the size and scale of the development. The first column shows the results of OLS regression of *Price* on the various independent variables. All estimates carry the expected signs and are statistically significant at the 1% level. With an adjusted-R^2 equal to 0.64, the fit is quite good. In particular, larger and newer units, units on higher floors and with a rooftop terrace, in developments that have clubhouse facilities, and in the western part of the district are sold at higher prices (per sq.ft.). The estimated coefficients for *Week* and *Week-square* imply that prices went up until the 23rd week of the 30-week sample period but went down slightly thereafter, a prediction that agrees well with the trend in the aggregate housing price index over this period of time. Most importantly, units located in developments whose units are traded at greater volumes did tend to sell at higher prices, where the elasticity of *Price* with respect to *TV* is equal to 0.1.

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[17] We would like to take Box-Cox transformations and let the data dictate the curvatures of the relationships – a practice widely adopted in the hedonic pricing literature for the housing market. But we would also be running 2SLS to check for robustness. To the best of our knowledge, the statistical properties of non-linear two-stage least square estimation are not well known. We choose linear regressions in order to facilitate comparison across specifications.

Table 2: Trading Volume on Price

Dependent variable: ln *Price*		2SLS (ln *TV* instrumented by ln *NBldg* and ln *NUnit*)
Constant	6.25* (46.58)	6.13* (45.19)
ln *TV*	0.104* (21.89)	0.089* (16.67)
ln *USize*	0.271* (13.98)	0.292* (14.80)
ln *Age*	-0.136* (13.65)	-0.125* (12.39)
Floor	0.002* (3.78)	0.002* (3.89)
Roof	0.121* (2.95)	0.109* (2.64)
Club	0.098* (6.46)	0.131* (8.13)
District	-0.143* (13.45)	-0.142* (13.32)
Week	0.011* (5.14)	0.011* (5.09)
Week-square	-0.0002* (3.38)	-0.0002* (3.34)
Adjusted-R^2	0.64	0.64

Absolute values of t-statistics in parentheses.
*significant at the 1% level.

A possible objection to this inference is that *TV* is endogenous and likely to be positively correlated with the error term in the pricing equation. And there is good theory for how trading volume and housing price in one housing market should move one after another over time in response to shocks to demand.[18] The positive effect of *TV* on *Price* indicated in the estimates in column 1 may thus be spurious in the sense that it is not liquidity per se that makes the units more valuable. Since the size and scale of a development is given once construction is completed, either *NUnit* or *NBldg* can be a valid instrument for *TV*. Besides, it should not be at all difficult to find a high correlation between either variable and *TV* in our sample since there should only be more trades in a larger development, where more units would be on the market at any one time. With the correlation coefficients between ln(*TV*) and ln(*NUnit*) and between ln(*TV*) and ln(*NBldg*) both equal to 0.95, the correlations just fall short of being perfect. In column 2 of table 1, we present the results of the two-stage least square estimation with ln(*TV*) instrumented by ln(*NBldg*) and ln(*NUnit*). The coefficient estimate of ln(*TV*) does fall somewhat, for about 14%, relative to the OLS estimate in first column. Still it remains statistically significant at the 1% level.[19]

The Hausman (1978) endogeneity test for the coefficient estimate of ln(*TV*) yields a t-statistic equal to 6.14, which indicates that the unbiased 2SLS estimate differs significantly from the OLS estimate at the 1% level. As such, the OLS estimate of the effect of *TV* on *Price* apparently overstates the true effect. Where the difference between the two estimates is merely 14%, the bias does not appear to be particularly serious though.

A preliminary conclusion we can reach at this point is that buyers do seem to be willing to pay a premium for units in developments where the units are traded at greater volumes. That is, liquidity effects do seem to operate in the housing market in the cross-section. The validity of the conclusion of course depends on the assumption that *TV* is not correlated with some missing variable in the hedonic price regression. An important set of missing variables in our regressions would be variables measuring the qualities of

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[18] See the studies listed in note 11.

[19] There are no qualitative difference in the results when ln(*TV*) is instrumented by either ln(*NUnit*) or ln(*NBldg*) but not both.

the facilities and the amenities and the amount of open space available in different developments. A potentially damning criticism of our analysis is that since *TV* and the scale of the development are highly positively correlated and there tends to be better facilities and amenities and more open space in larger developments, the positive effects of *TV* on *Price* we have found could possibly be capturing just such effects.

In table 3, we present the results of estimating the effects of *TV* on *Price*, while holding constant the size and scale of the development in terms of the number of units and the number of buildings, respectively, in it under various specifications. In all cases, the coefficient estimates of ln(*NUnit*) are negative and statistically significant while those for ln(*NBldg*) are positive and statistically significant at the 1% level. If a larger submarket should be more liquid because of some thick market externality, the negative and statistically significant coefficient estimates for ln(*NUnit*) would seem like a anomaly. We think that these rather unexpected results are not difficult to understand. The units in a development would be more liquid assets only because these units are actively traded but not because the development is larger per se. Hence, once we control for *TV*, the size and scale of the development in terms of *NUnit* and *NBldg*, respectively, should exert no independent liquidity effects. Then the simple logic of demand and supply would suggest that *NUnit* should only have a negative effect on *Price*. On the other hand, we believe that the positive effect of *NBldg* on *Price* is a quality effect. Because of scale economies in land use, a development made up of numerous buildings is usually provided with better facilities and amenities and most importantly more open space than a single-building development.

Table 3: Trading Volume and Development Size and Scale on Price

Dependent variable: ln *Price*		2SLS (ln *TV* instrumented by ln *NBldg*)			2SLS (ln *TV* instrumented by ln *NUnit*)
Constant	5.968*	6.269*	7.688*	6.665*	11.728*
	(48.64)	(42.00)	(58.33)	(43.10)	(27.70)
ln *TV*	0.271*	0.567*	0.161*	0.059*	-0.774*
	(33.49)	(30.19)	(18.61)	(5.97)	(13.96)
ln *NUnit*	-0.207*	-0.468*	-0.326*		
	(24.41)	(26.78)	(35.76)		
ln *NBldg*			0.288*	0.064*	0.950*
			(24.53)	(5.33)	(15.83)
ln *USize*	0.413*	0.477*	0.312*	0.231*	-0.059
	(22.22)	(20.88)	(17.98)	(11.14)	(1.38)
ln *Age*	-0.070*	-0.046*	-0.185*	-0.17*	-0.503*
	(7.40)	(4.02)	(18.87)	(14.42)	(16.56)
Floor	0.002*	0.001*	0.004*	0.002*	0.011*
	(4.05)	(2.62)	(11.05)	(4.95)	(10.86)
Roof	0.067	0.069	0.062**	0.127*	0.046
	(1.77)	(1.53)	(1.83)	(3.12)	(0.61)
Club	0.101*	-0.085*	0.034*	0.083*	0.31*
	(7.31)	(4.37)	(2.67)	(5.40)	(9.65)
District	-0.113*	-0.082*	-0.181*	-0.162*	-0.41*
	(11.59)	(6.86)	(19.51)	(14.51)	(15.74)
Week	0.011*	0.012*	0.012*	0.011*	0.012*
	(5.81)	(5.21)	(6.81)	(5.22)	(2.92)
Week-square	-0.0002*	-0.0002*	-0.0003*	-0.0002*	-0.0003*
	(3.71)	(3.21)	(4.52)	(3.47)	(2.26)
Adjusted-R^2	0.71	0.57	0.76	0.65	***

Absolute values of t-statistics in parentheses.
*significant at the 1% level.
**significant at the 10% level.
***not computed because the RSS exceeds TSS.

Now because *TV* is highly positively correlated with *NBldg* and if the variable *NBldg* proxies for the quality of the facilities and amenities and the amount of open space available, there is good reason to be suspicious that the positive and statistically significant effect of *TV* on *Price* that we previously identified could also partly be a quality effect. Table 3 shows that whenever ln(*NBldg*) also enters as an independent variable, the coefficient estimate of ln(*TV*) would fall noticeably. When ln(*TV*) is also instrumented by ln(*NUnit*), its coefficient estimate turns negative altogether. If there is only a measurement problem in that the effect of *TV* on *Price* confounds a liquidity and a quality effects, the coefficient estimate of ln(*TV*) may go down but should not become negative after the missing variable is brought back into the pricing equation. That it does so suggests that measuring liquidity effects in the cross-section by the aggregate trading volume of each development could be problematic. In particular, if the variable *TV* has no connection with asset liquidity or if there were no liquidity effect to speak of, a negative coefficient estimate for ln(*TV*) could easily be rationalized by a standard demand supply analysis.[20]

Perhaps it may not be difficult to see why the aggregate volume of trade in a submarket may not be a foolproof measure of its liquidity. A liquid submarket should be one in which there is a steady stream of potential buyers for the units on the market at all times. That there is a sizeable trading volume, however, does not guarantee that the units on the market can find the right buyers quickly if there are also a large number of similar and therefore competing units on the market in the mean time. A better measure should then be the aggregate trading volume normalized by the number of units on the market. We do not have the latter information in our dataset. A compromise measure could just be the aggregate trading volume normalized by the number of units in the development – a variable usually referred to as the rate of turnover.

[20] Because ln(*NBldg*) and ln(*NUnit*) enter as explanatory variables in the specifications in table 3, we cannot use both variables as instruments for ln(*TV*) at the same time. The Hausman endogeneity test yields a t-statistic of –24.53 for the specification in column 1 when ln(*TV*) is instrumented is by ln(*NBldg*) and a t-statistic of 35.79 for the specification in column 4 when ln(*TV*) is instrumented by ln(*NUnit*).

Table 4: Turnover Rate on Price

Dependent variable: ln *Price*

Constant	5.47* (45.08)	7.688* (58.33)	5.97* (48.64)	7.69* (58.33)
ln (*TV/NUnit*)	0.248* (30.27)	0.161* (18.61)	0.207* (24.41)	0.326* (35.79)
ln *TV*			0.065* (14.00)	-0.165* (16.07)
ln *NUnit*		-0.165* (16.07)		
ln *NBldg*		0.288* (24.53)		0.288* (24.53)
ln *USize*	0.52* (29.79)	0.312* (17.98)	0.413* (22.22)	0.312* (17.98)
ln *Age*	-0.017** (1.87)	-0.185* (18.87)	-0.07* (7.4)	-0.184* (18.87)
Floor	0.002* (4.39)	0.004* (11.05)	0.002* (4.05)	0.004* (11.05)
Roof	0.007 (0.18)	0.062** (1.83)	0.067** (1.77)	0.062** (1.83)
Club	0.23* (21.48)	0.034* (2.67)	0.1* (7.31)	0.034* (2.67)
District	-0.103* (10.22)	-0.181* (19.51)	-0.113* (11.59)	-0.181* (19.51)
Week	0.011* (5.48)	0.012* (6.81)	0.011* (5.81)	0.012* (6.81)
Week-square	-0.0002* (3.48)	-0.0003* (4.52)	-0.0002* (3.71)	-0.0002* (4.52)
Adjusted-R^2	0.69	0.76	0.7	0.76

Absolute values of t-statistics in parentheses.
*significant at the 1% level.
**significant at the 10% level.

It turns out that the two measures – aggregate trading volume and turnover rate do reveal rather different information about the individual developments. Among the 127 developments in our sample there is only a moderately positive correlation between the two variables, with the correlation coefficient between ln(*TV*/*NUnit*) and ln(*TV*) equal to merely 0.36. Among our sample of the 2891 transactions, the correlation coefficient is similarly moderate at 0.39. Besides, the simple correlation between ln(*NBldg*) and ln(*TV*/*NUnit*) at 0.04 is practically zero in the sample of the 127 developments and is merely 0.2 in the sample of the 2891 transactions. The simple correlation between ln(*NUnit*) and ln(*TV*/*NUnit*) even turns out to be negative at –0.34 in the sample of 127 developments, while in the sample of the 2891 transactions, the correlation coefficient at 0.07 is again nearing zero. All this implies that apart from its theoretical appeal, turnover rate is an attractive variable to identify liquidity effects from a measurement point of view.

With this in mind, we regress housing price on turnover rate alone and together with aggregate trading volume under various specifications, some of which also include *NBldg* and *NUnit* as controls. The results are presented in table 4. Whether turnover rate enters the pricing equation alone or with aggregate trading volume and the two measures of development size and scale, the coefficient estimates for turnover rate always carry the expected positive signs and are statistically significant at the 1% percent level.[21] On the other hand, the coefficient estimate for trading volume remains negative when *NBldg* is controlled for.

We recognize that turnover rate is endogenous and a positive correlation with the error term of the pricing equation could not be ruled out a priori. As such, the liquidity effect attributed to the variable could possibly be spurious. We could not, as in the case of measuring liquidity effects by trading volume, resort to two-stage least squares estimation for the lack of valid instruments given the at best very weak correlations between turnover rate and measures of development size and scale in our sample. The validity of the inference must thus be subject to the assumption that the possible

[21] We could not enter ln(*TV*/*NUnit*), ln(*TV*), and ln(*NUnit*) together in one specification because the three variables are perfectly collinear.

endogenous variable bias would not be serious enough to completely overturn the results.[22]

Even so, we believe that the positive effect of turnover rate on housing price indicated in the estimates in table 4 is not entirely spurious. Recall that in the specifications in table 3, when trading volume is instrumented by measures of development size and scale, the qualitative results are never affected nor are the quantitative ones in any important way, so long as *NBldg* is omitted from the specifications. It is only when *NBldg* is also entered as an explanatory variable that the effect of trading volume on price starts to weaken considerably and then turns negative altogether in one case. On the other hand, the last column of table 4 shows that the coefficient estimate for turnover rate actually increases in value when *NBldg* is included in the pricing regression. In sum, two tentative conclusions can be drawn. First, in our sample the positive effects of measures of trading activity on price are likely to survive the usual 2SLS estimation, if not for *NBldg* being included as an explanatory variable. Hence, if the positive and statistically significant effect of turnover rate survives the inclusion of *NBldg* as it does in the specification in column 4 of table 4, it should survive the appropriate 2SLS estimation. We recognize that the supports for these arguments from our analysis are far from rigorous. Nonetheless, the evidence is highly suggestive.

Our final verdict is that liquidity effects in the cross-section driven by the variations in the extents of trading activities do seem to operate in the housing market. Contrary to conventional wisdom, a larger submarket in itself does not appear to make the units more valuable. Besides, the evidence for a positive effect of a greater trading volume in the relevant submarket on price is mixed. It is rather a greater turnover rate, irrespective of the size of the submarket, that makes the units liquid assets and sell at a premium.

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[22] For the specification in column 3, we try out using ln(*NBldg*) and ln(*NUnit*) as instruments for ln(*TV*), and for the specification in column 4, we try out using ln(*NUnit*) as an instrument for ln(*TV*). All 2SLS estimates remain statistically significant at the 1% level and there are no differences in signs between the 2SLS estimates and the corresponding OLS estimates in all cases. Furthermore, the Hausman endogeneity test suggests that in both cases, there is no statistically significant difference between the OLS and the 2SLS estimates at conventional levels of statistical significance.

3. How large is the liquidity premium?

Given that a more liquid real estate asset is a unit located in a development where there is a greater turnover rate, the next logical question to ask is: how much of the difference in housing price may be due to liquidity effects? We think it is most appropriate to base our answers on the specification in column 2 of table 4 as this specification includes the two measures of development size and scale as controls. The apparent drawback of the specification is that it does not include trading volume as an explanatory variable. But if *TV* in itself is not a good proxy for liquidity effects in the first place and if measures of development size and scale have been held constant, the omission is probably immaterial. Figure 1 depicts a partial regression plot based on the chosen specification. Each data points refers to the difference between the observed ln(*Price*) and ln(*Price*) as predicted by the analysis but with the effects of ln(*TV/NUnit*) omitted, whereas the point on the smooth curve refers to the value of ln(*Price*) predicted by ln(*TV/NUnit*) alone.

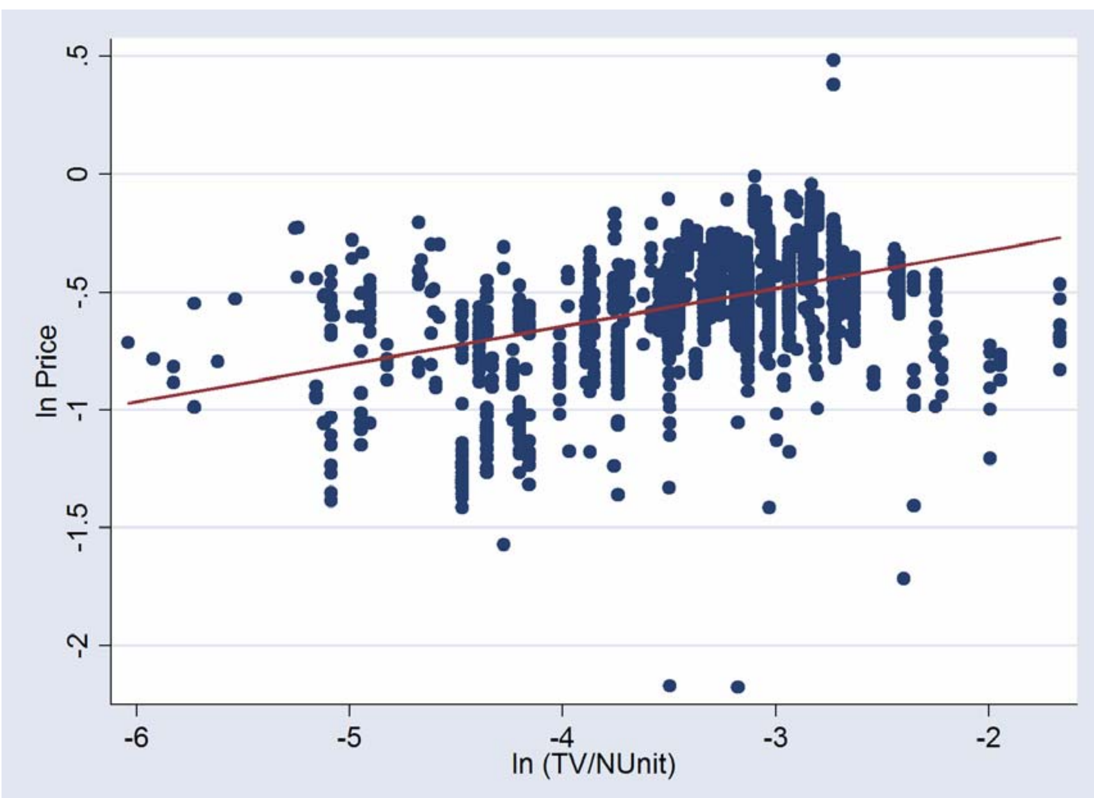

Figure 1: ln(*TV/NUnit*) on ln(*Price*)

While the data points are not exactly very tightly lined-up around the regression line, a positive relationship is evident. Now the maximum difference in *Price* predicted by the difference in *TV/NUnit* is enormous, at around two times.[23] To obtain a more detailed perspective for how much house price differs because of liquidity effects, we first order the 127 developments in our sample by the rate of turnover. Then we calculate by how much the *Price* of a unit in the development in the x^{th} percentile would be above the *Price* of a unit in the development in the y^{th} percentile in the distribution of *TV/NUnit*. The results are presented in table 5. For instance, the cell in the second row and second column shows that the *Price* of a unit in the 90th percentile would be 1.48 times the *Price* of a unit in the 10th percentile in the distribution of turnover rate. A casual examination of table 5 reveals that in many cases, house price can differ very significantly because of liquidity effects, even when attention is restricted to less extreme differences in turnover rate.

Table 5: Predicted difference in price by difference in turnover rate

	Minimum	*10th percentile*	*25th percentile*	*50th percentile*	*75th percentile*	*90th percentile*
Maximum	2.02	1.73	1.51	1.33	1.23	1.17
90th percentile	1.73	1.48	1.29	1.14	1.05	
75th percentile	1.64	1.41	1.23	1.08		
50th percentile	1.52	1.31	1.14			
25th percentile	1.34	1.15				
10th percentile	1.17					

Some of these predicted differences, especially for two units far apart in the distribution of turnover rate, may appear too large to be plausible. In the mean time though, the actual price difference between the two units could be many times larger. Thus, it could be more informative if we turn our attention to decomposing the actual price difference between two given units into individual components, one of which is the effect due to the difference in the rate of turnover. To this end, we first order our sample

[23] The maximum difference in predicted ln(*Price*) shown in figure 1 is around 0.75, which roughly translates to a 2 times difference in *Price*.

of the 2891 observations of transactions by *Price*. Then we can for any two selected transactions calculate the percentage difference in *Price* and then by how much this difference is due to liquidity effects. The results are shown in table 6. For instance, the cell in the second row and second column shows that the unit in the 90th percentile of the *Price* distribution is 162% *more* expensive than the unit in the 10th percentile and 8.76% of this percentage difference (i.e., 14.19% *Price* difference) can be attributed to difference in the rate of turnover between the two units. There are pairs of transactions where for $x > y$, the unit in the x^{th} percentile of the *Price* distribution has a turnover rate not larger than the units in the y^{th} percentile of the *Price* distribution. In such cases, which we indicate with three asterisks in table 6, none of the difference in *Price* can be attributed to the difference in the rate of turnover.

Table 6: Percentage difference in price attributed to difference in turnover rate

	Minimum	*10th percentile*	*25th percentile*	*50th percentile*	*75th percentile*	*90th percentile*
Maximum	2186.62 0.34	391.18 5.06	245.34 ***	151.60 2.22	114.05 ***	87.47 5.63
90th percentile	1119.73 0.22	162.01 8.76	84.21 ***	34.21 ***	14.18 ***	
75th percentile	968.25 0.92	129.47 16.57	61.34 2.21	17.54 27.28		
50th percentile	808.84 0.49	95.23 16.70	37.26 ***			
25th percentile	562.13 1.33	42.23 46.93				
10th percentile	365.53 ***					

Table 6 shows that in general the nearer two units are in the *Price* distribution, the larger the portion of the percentage difference in *Price* between the two units can be attributed to liquidity effects. This seems reasonable since in such cases, the two units should be rather similar in many dimensions other than possibly the degree of asset liquidity. Then the latter could play a relatively more important role for the observed price difference. Specifically for observations that are not more than 25 percentile apart in the *Price* distribution, the portion of the percentage difference in *Price* that can be attributed to liquidity effects is on average as large as 26.61%. Contrariwise, the overall average, equal to 9.2%, is nonetheless significant by any yardsticks.

4. Discussion and Conclusion

We wish to first point out that the downpayment effect hypothesis proposed by Stein (1995) for a positive correlation between aggregate trading volume and average housing price in a given housing market over time is not quite relevant for our results. Clearly, there is no reason to expect that the effect should operate differently across market segments within an urban housing market in the way that market segments are defined in our study.

Indeed an important lesson from our analysis is that market segmentation, probably the result of decentralized trading and imperfect information, is an important facet of an urban housing market. In the absence of market segmentation and if households did not restrict their search to particular market segments, the extent of trading activities in individual developments should not matter. That they do and in an important way suggests that a given urban housing market is far from being organized as an integrated entity.

On the one hand, we believe that this provides support for the empirical relevance of search theoretic models of the housing market with their emphasis on information imperfection. On the other hand, existing models appear inadequate as a basis to understand our results. In the typical search theoretic model of the housing market, the match between a given household and a given housing unit is an *iid* draw from a known distribution, while the matching between households and housing units is purely random. Implicit in this setup is that the information imperfection notwithstanding, the market is assumed to operate as a single coherent whole, whereby search is wholly undirected and is towards any and all units in the market. We think that this shortfall cannot be easily rectified by merely reinterpreting the models as models of one market segment. Under such an interpretation, the number of buyers searching in the given market segment would be exogenously given. An important objective of the analysis is precisely the endogenous determination of the mass of buyers searching in each market segment.

We envisage a model that would help understand our results would be a model that relaxes both the *iid* match and the purely random search assumptions. Units within a segment are more similar with one another over units between two segments, from which it follows that the match between a household and a housing unit should be made up of an idiosyncratic component and a component that, for a given household, is common across all housing units in a given segment. Furthermore, the decision as to which units to inspect should be a conscious and forward-looking decision. The goal is to understand how turnover rate and housing price can be positively correlated across market segments in the cross-section.

Table 7: Determinants of Turnover Rate

Dependent variable: ln *TV/NUnit*	
Constant	1.79* (3.32)
ln *NUnit*	-0.841* (10.64)
ln *NBldg*	1.053* (8.65)
ln *Age*	-0.482* (4.79)
Club	0.063 (0.27)
District	0.062 (0.48)
Adjusted-R^2	0.54

Absolute values of t-statistics in parentheses.
*significant at the 1% level.

Before such a model is built, an important empirical question yet to be answered is what drives the differences in the turnover rates among the market segments. In table 7, we present the results of regressing ln(*TV*/*NUnit*) on various exogenously given characteristics of the development in our sample of 127 developments. The estimates suggest that the rates of turnover tend to be lower in larger (in terms of *NUnit*) and older developments[24] but *NBldg* is seen to exert a positive effect on turnover rate. The predictions are more or less consistent with the simple correlations we presented earlier. We do not have a good explanation for why a larger market segment is not generally a more active market segment, in defiance of some possible thick market externalities. The positive effect of *NBldg* together with the negative effect of *Age* on turnover do suggest that the quality of the units in the market segment is a potentially important factor for how active the units are traded. Nevertheless, this analysis is best seen as preliminary and indicative instead of as a rigorous analysis. For instance, the sample is censored since developments that recorded no transactions in the sample period are left out.[25, 26]

We have restricted our analysis to one specific manner in which market segments are defined and to one district in one not particularly typical urban housing market. The usual suspect – the size of the development appears not to be positively related to how active the units in the development are traded. A less obvious candidate factor – the qualities of the housing units do seem to matter though. Clearly, more detailed and thorough investigations on how market segments should be defined and on what determines the differences in turnover rates across segments would help further our understanding of the way the urban housing market operates.

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[24] In case of individual buildings in a multi-building development not all of the same age, we calculate the weighted average age of the buildings making up the development.

[25] Collecting information on each and every development even in a moderate-size district presents an enormous task that remains our long-term goal.

[26] A seemingly natural empirical strategy that we could have pursued in this paper is to run three-stage least squares estimation; one equation for *Price*, another one for *TV/NUnit*. In the absence of a theoretical model to suggest cross-equation restrictions, we do not wish to make arbitrary identifying assumptions.

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