# The Impact of Gains and Losses on Homeowner Decisions*

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**Abstract**

Using unique data on condominium transactions that allow for accurately-measured capital gains and losses, we examine the impact of these gains and losses on homeowner decisions. As predicted by the disposition effect, owners with a capital gain have higher sell propensities, sell for lower prices, list their properties for sale at lower prices, and accept lower rents from tenants. These effects are often sensitive to the magnitude of gains, which is consistent with realization utility. Our findings indicate that the disposition effect and realization utility, both of which originate from prospect theory, influence homeowner decisions. Alternative explanations such as financing constraints, informed trading, and mean reversion cannot explain our results.

Keywords: Disposition Effect; Realization Utility, Prospect Theory; Real Estate

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# 1 Introduction

The greater tendency for investors to sell assets with capital gains compared to those with capital losses, known as the disposition effect, has been found in the stock trades of retail investors (Odean, 1998) and in experimental markets (Shefrin and Statman, 1985; Weber and Camerer, 1998). The usual economic explanation for the disposition effect is prospect theory (Kahneman and Tversky, 1979). Specifically, capital gains correspond to a concave portion of the value function where individuals are risk averse and consequently less willing to continue holding a risky asset. Conversely, capital losses correspond to a convex portion of the value function where individuals are risk seeking and consequently more willing to continue holding a risky asset.

We examine whether capital gains and losses impact homeowner decisions regarding residential real estate. Unlike transactions by retail investors in the stock market or by subjects in an experimental market, a property purchase is typically the largest financial transaction undertaken by a household. Thus, households have stronger incentives to act rationally in order to avoid any negative implications arising from a behavioral bias such as the disposition effect. Real estate transactions are also conducted during a lengthy escrow period, which affords an opportunity to reflect before finalizing the decision. Consequently, one may expect deviations from expected utility theory to be less prevalent in real estate. Conversely, households may be more emotionally invested in real estate decisions given their implications for household wealth. Barberis and Xiong (2012) assert that every property purchase is likely to comprise an investing episode with a salient reference price and distinct mental account.[1] From this perspective, the disposition effect may affect real estate transactions. Therefore, whether the disposition effect impacts real estate transactions is ultimately an empirical question.

An empirical investigation of the disposition effect requires the accurate measurement of capital gains. This requirement poses a challenge to empirical tests since the market value of unique properties is unobservable. Indeed, even adjacent properties are often too dissimilar to accurately infer a property's current market value. Our unique data from Singapore's condominium market (almost 280,000 transactions) overcomes this problem since condominiums

[1] With stock investments, the ability to buy and sell a different number of shares over time at different prices complicates the reference price (historical cost for example). Grinblatt and Han (2005) estimate reference prices in the equity market using a combination of prior volume and prices.

in Singapore consist of standardized units within multi-unit developments. This commonality allows unit-level market prices, and hence capital gains, to be estimated using transactions within the same development.[2] In our sample, a hedonic model that includes only the size and floor level of each unit explains 90% of the variation in unit-level prices within a typical development.

We first examine a unit's probability of sale conditional on its capital gain. Following Odean (1998), we compute the sell propensity for gains, and then divide this percentage by the sell propensity for losses across the universe of condominium units. In a typical cross-section, units with gains are twice as likely to be sold as those with losses. Probit specifications extend this result by controlling for a multitude of unit-level and market-level characteristics. The probit results confirm the disposition effect's importance to unit-level sell propensities, even for units with a small gain or loss.

We then analyze sale prices, listing prices, and rental prices conditional on unit-level capital gains. This analysis is unique to real estate. In the stock market, prices and dividends are largely exogenous with respect to retail investors. However, the selling price and "dividend" yield of a property result from owner negotiations with buyers and tenants, respectively. Consequently, we are able to test whether sale and rental prices vary across comparable units depending on the owner's capital gain.

The disposition effect predicts that owners with a capital loss demand higher prices than owners of comparable units with a capital gain since the additional dollar obtained by the former results in higher marginal utility. As predicted by the disposition effect, units with capital gains are associated with lower sale prices than comparable units with capital losses. This effect increases with the magnitude of a unit's capital gain, as predicted by realization utility (Barberis and Xiong, 2009, 2012). Realization utility, which is also motivated by prospect theory, predicts a burst of utility from selling an asset with a gain that is proportional to its magnitude. Frydman, Barberis, Camerer, Bossaerts, and Rangel (2014) find experimental support for realization utility.

We find further support for the disposition effect and realization utility using listing prices. For each unit listed for sale, we compute the listing premium as the percentage the list price of a unit exceeds its estimated market price. We report that capital gains are negatively related

[2]Giglio, Maggiori, and Stroebel (2013) utilize this data in their study of long-term discount rates.

to the listing premium as larger gains are associated with a lower listing premium. Intuitively, owners with a capital loss demand higher prices when listing their unit for sale, and eventually obtain a higher selling price than owners of comparable units with a capital gain. The higher prices demanded by owners with a capital loss is consistent with the lower sell propensity of their units.

In general, about 2% of units with a capital gain are sold each quarter compared to 1% for those with a capital loss. Although sales are twice as likely for units with a gain, the majority of owners do not sell their unit. Instead, owners either occupy their unit or become a landlord.[3] Therefore, we use data on rental contracts to examine if rental income varies according to a unit's capital gain. Our analysis indicates that landlords whose units have a capital loss obtain higher rents. This finding is consistent with the disposition effect as these landlords exhibit risk-seeking behavior by assuming higher vacancy risk. Indeed, landlords with a capital loss appear willing to gamble on finding a tenant willing to pay higher rent instead of accepting a lower rental offer. Conversely, the marginal value of additional rent is lower for landlords whose units have a capital gain given the concavity of their value function.[4]

Our empirical support for the disposition effect in real estate is robust to alternative explanations. In Stein (1995), financing constraints can lead to the appearance of the disposition effect. Specifically, the existing property of a potential repeat buyer represents a large fraction of their wealth that is financed through leverage. With a decline in its price, leverage reduces the equity available to finance an additional property purchase. As mortgages in Singapore are standardized with government-mandated minimum down-payments and common mortgage rates, we estimate a homeowner's paid-in equity by aggregating their initial down-payment with their subsequent principal payments. Paid-in equity is independent of a unit's capital gain. We also use another unit-level proxy for household financing constraints that is unique to Singapore; whether the owner used to reside in public housing. However, all our

[3]In Singapore, the supply of condominium units for rent is provided by individuals, not corporate landlords. In 2012, 20% of the units had a rental contract within the prior three years.

[4]There is no capital gains tax in Singapore to inhibit the sale of units with capital gains or encourage their owners to find a tenant instead of a buyer. The decision to become a landlord rather than immediately sell a unit with a capital gain does not contradict prospect theory. Realization utility (Barberis and Xiong, 2012) justifies this decision for units whose expected return is sufficiently high. Rents also increase with property prices, allowing a higher rental income to partially realize a unit's larger capital gain.

results are robust to controlling for financing constraints.

We also rule out other alternative explanations for the disposition effect such as informed-trading and mean reversion. For stock investments, informed investors sell a stock once their positive private information has been incorporated into its price and produced a capital gain. Unlike the equity market, informed trading and private information in Singapore's real estate market is less important since unit-level prices are determined primarily by market-level prices. In comparison to the equity market, portfolio rebalancing also provides a less credible explanation since housing is indivisible and expected returns are highly correlated among individual units. Moreover, the autocorrelation in market-level returns is positive. Thus, there is no evidence of mean reversion in housing returns that could justify holding units with a capital loss. Instead, short-term price continuation imposes an economic burden on owners with a capital loss that are reluctant to sell.[5]

Our study is related to Genesove and Mayer (2001) who examine 5,785 property listings in Boston from 1990 to 1997. Their analysis of loss aversion finds that condominium owners with a capital loss demand higher prices when listing their unit for sale.[6] However, capital gains are difficult to estimate in Boston due to unobservable property attributes and renovations. Genesove and Mayer (2001) provide a detailed discussion of these complications. More important, their data does not contain condominiums that are not listed for sale. Thus, sell propensities (Odean, 1998) that specifically test the disposition effect cannot be estimated. Instead, the majority of properties listed for sale in Genesove and Mayer (2001) had a capital loss. Although this high percentage may be representative of widespread weakness in Boston's housing market during their sample, the disposition effect would predict the majority of for-sale listings are condominiums with a capital gain.[7] An additional advantage of our data is that residents of the city-state Singapore can change employers without relocating.

[5]The disposition effect imposes an economic loss on equity investors who trade against price momentum. However, price momentum requires cross-sectional return variation that is minimal in Singapore's property market.

[6]An earlier study by Genesove and Mayer (1997) examines whether homeowner equity in a unit affects the time taken to sell the unit. Their sample of Boston condominiums in this study consists of 2,381 observations from 1990 to 1992.

[7]The higher listing price associated with a capital loss could still satisfy the disposition effect's prediction that condominiums with a capital loss have a lower sell propensity.

In contrast, property transactions in the US may be driven by relocations due to variation in metropolitan labor markets. Chan (2001) as well as Ferreira, Gyourko, and Tracy (2010) examine the relationship between household mobility and property prices but neither study the disposition effect.

A related paper on the disposition effect is Crane and Hartzell (2010), who examine the property investments of 266 Real Estate Investment Trusts (REITs) and find that REIT managers are subject to the disposition effect. However, their results regarding professional managers in commercial real estate are more difficult to disentangle from informed trading, especially by REIT managers with a broad investment mandate and portfolios containing multiple properties. We also provide sharper tests of the disposition effect by investigating capital gain discontinuities at zero, as in Ben-David and Hirshleifer (2012).

Our findings have important economic implications. Despite the importance of housing transactions to household wealth, homeowners exhibit a strong disposition effect. The economic costs of this bias are non-trivial as owners with a capital gain accept sale prices and rental prices that are 2% lower on average. These findings are consistent with prospect theory. The disposition effect also has implications for transaction volume in the real estate market. In particular, decreasing prices lower transaction volume, inducing a positive price-volume relation in the real estate market as a consequence. For policy-makers attempting to alleviate the low volume associated with declining property prices, housing inflation may be more effective than allowing lower lending standards to weaken household financing constraints.

# 2 Data

Our data is from Singapore's private property (condominium) market. A typical condominium development in Singapore consists of 200-300 units located in several high-rise buildings. The average building height is 15 floors in our sample and each unit is approximately 1,300 square feet. Units are largely homogeneous within the same development although they can differ in terms of their size and floor level. For example, homeowners require approval to remove any walls, and are not allowed to install windows and doors that differ from the condominium's original design. Therefore, as unobservable attributes exert a minimal impact on unit-level prices per square foot (PSF), we can accurately estimate capital gains based on PSF selling

prices within the same development.

Sale transactions involving private property are reported to a government agency in Singapore known as the Urban Redevelopment Authority (URA). URA will list the details on a public website within two weeks. As a result, homeowners can use past transactions to infer the market price of their unit and consequently compute its associated gain or loss.

We obtain sale transactions data from URA's Real Estate Information System, a subscription service known as REALIS. This database records the transaction date, development name, transaction price, unit size, street address, floor level, and unit number. Unlike studies of the disposition effect that have to estimate historical purchase prices (e.g., Grinblatt and Han, 2005), the URA data provides a nearly complete set of historical transactions in Singapore.

Our URA data begins in 1995 and ends in 2012. We exclude property developments with less than 50 transactions in this sample period. A total of 282,920 transactions remain after imposing this filter. For certain units, we find a discrepancy in their size across different transaction dates. Therefore, we exclude units with more than a 2% size discrepancy. After this filter our sample contains 277,856 transactions involving 1,104 developments and 185,383 unique units.

We also obtain listings and rental data from the Singapore Real Estate Exchange (SRX). Listings and rental data begin in 2006 and 2008, respectively, with both time series ending in 2012. SRX is a consortium consisting of the following real estate agencies: PropNex, HSR, DWG, OrangeTee, ERA, ECG, C&H, DTZ, ReMax, Savills, and Hutton. The listings and rental data cover the majority of the market because the consortium includes the largest real estate agencies in Singapore. The listings and rental coverage increased over time as agencies joined the consortium in stages. For the listings data, complete data from member companies are provided to SRX since 2011 (fewer member companies submit listings data to SRX in 2006-2010). We report later in Panel B of Table 2 that SRX member companies collectively cover the majority of rental transactions in Singapore.

The property listing data from SRX has 48,639 observations including both for-sale and for-rent listings. However, only 8,029 listings contain an actual asking price and a detailed address, of which 7,180 also have records in the URA data. Agents often omit unit numbers from their listings to prevent other agents from approaching their clients. After matching

listings with URA records using unit numbers, our listings sample contains 5,905 for-sale listings and 1,275 for-rent listings. We focus our listings analysis exclusively on the for-sale listings since they comprise the majority of the sample.

Our sample of rental contracts is larger than our listings sample because unit-level addresses are typically available in the rental contracts recorded by real estate agencies. The SRX rental data contains 113,282 rental transactions within 1,104 developments. We remove duplicate entries that are likely due to submissions by both the landlord's agent and the tenant's agent, resulting in 96,520 observations. We then remove 1,834 observations with monthly rent below $1,000 Singapore dollars (SGD), rent per square foot (RSF) below $1 SGD or above $15 SGD as these likely result from erroneous data entry. We then report in Panel B of Table 2 that, on average, this sample covers 53.4% of Singapore's rental market during the 2008-2012 period. This coverage estimate is based on rental summary statistics from URA that list the number of rental contracts signed for each project each quarter, provided the project has more than ten transactions in the respective quarter. The median quarterly RSFs in our sample also parallels those in URA's summary statistics. Thus, our sample of rental contracts in representative of the broader market.

## 2.1 Capital Gain Estimation

To examine if capital gains and losses influence homeowner decisions, we require capital gains since purchase to be measured. The simplest method to estimate a unit's capital gain is to use the PSF of recent transactions within the same development. This method controls for development-specific characteristics such as location, age, facilities, and quality. To demonstrate the ability of this simple method to accurately price units, we estimate a pricing model within each development by regressing the transaction PSF on quarterly dummies. A development is excluded from the regression if the number of transactions within the development is less than twice the number of quarters with available data. In a second specification, each unit's size (in square foot) and floor level are included in addition to quarterly dummies,

$$\mathrm{PSF}_{i,t} = \sum_{t=\mathrm{Q1\ 1995}}^{\mathrm{Q4\ 2012}} \beta_t \,\mathrm{QUARTER}_{i,t} + \beta_{\mathrm{S}}\,\mathrm{SIZE}_i + \beta_{\mathrm{f}}\,\mathrm{FLOOR}_i + \epsilon_{i,t}\,. \tag{1}$$

The coefficients for both models are estimated within the entire 1995 to 2012 sample period for each individual development. We then report the distribution of the coefficients across the developments. Panel A of Table 1 reports an average $R^2$ of 74% for the first pricing model, which contains only quarterly dummy variables. Hence, the average price in the development explains nearly three-quarters of the variation in unit-level prices.

The inclusion of size and floor characteristics in the second pricing model increases the average $R^2$ to 88%. The distribution of $R^2$ is right-skewed as the median is 93% in this full model. According to Panel A of Table 1, the average $\beta_S$ coefficient is -0.13 (average $t$-statistic of 8.90) across all quarters and developments. Thus, large units sell at a discount in terms of their PSF. This discount is consistent with less demand for larger more expensive units due to financial constraints. The average $\beta_f$ coefficient is 7.15 (average $t$-statistic of 6.13). Thus, there is a price premium for units on higher floors.

Overall, the results from Equation (1) show that unobservable unit-level attributes exert little impact on property prices and that cross-sectional variation in prices is mostly determined by common development characteristics.

For the remainder of the paper, we compute capital gains using two methodologies. The baseline approach determines a unit's capital gains at a quarter-end using the average PSF for sale transactions within its development during a six-month horizon centered at the quarter-end. For example, a unit's valuation at the end of March 1998 is computed using property sales within the same development from January 1st to June 30th. The second method uses fitted values from the hedonic model in Equation (1) to predict a unit's PSF based on transactions within the same development during the same quarter and developments with a hedonic $R^2$ of less than 70% are dropped.

Unreported results confirm the high correlation between unit-level capital gains computed using the two methods.[8] Nonetheless, prices from Equation (1) are utilized in unreported robustness tests that produce similar results. In some cases, the hedonic model produces stronger results than those reported in later tables.

[8]For capital gains whose absolute magnitude is between 5% and 10% according to transaction prices during a six-month horizon, this correlation equals 0.69, which increases to 0.88 for units whose capital gain is between 10% and 20% in absolute magnitude. For the largest absolute capital gains (above 20%) the correlation is 0.98 between the two methods.

We start the capital gains estimation at the end of the first quarter of 1998 for all units that appear in the URA database from January 1st 1995 to March 31st 1998. For units that have been sold more than once in this period, we focus on their most recent purchase price to compute their underlying capital gain. Using the baseline approach, the capital gain of a unit is the average PSF of all transactions within its development during a six-month window centered at March 31st 1998, less the unit's most recent purchase PSF.

We continue to compute capital gains every quarter in the same way, using all sale transactions from the beginning of 1995 to the next quarter-end date. The number of units with a capital gain estimate increases over time as more units are sold and enter the URA records. Table 2 describes our sample each quarter from 1998 to 2012. We also compare our sample to the complete housing stock in Singapore, and report the relevant sample coverage estimates in Table 2.[9] By the end of 2012, our sample coverage is nearly 83%. Coverage does not reach 100% because of units purchased before 1995 that are never sold between 1995-2012, units that are never sold by developers, and developments that had no sell transactions within a six-month horizon (thus preventing the estimation of capital gains).

## 2.2 Prices and Volume in Singapore's Real Estate Market

Figure 1 illustrates the time-series variation of the market-level PSF along with transaction volume. The quarterly market-level PSF is computed by first averaging the PSF of all transactions within each development and then averaging these development-level PSF averages across all developments. Consistent with the well-documented positive price-volume relation in real estate, the correlation between this quarterly market-level PSF and transaction volume is 0.684 in our sample.

We also estimate the autocorrelation of price changes at both the annual and quarterly frequencies in Panel B of Table 1. Price change are defined as quarterly percentage changes in the market-level PSF. At a quarterly frequency, the autocorrelation coefficient for the first lag is positive. For other lags, the coefficients are mostly insignificant. At an annual frequency, no autocorrelations are significant. Thus, market-level price changes in Singapore are not mean reverting. Instead, the positive quarterly autocorrelation implies that selling a unit with a

[9]We estimate the total housing stock using the website http://www.propertyguru.com.sg/ that records the total number of units in each condominium development.

gain or holding a unit with a loss is not an optimal strategy for homeowners.

Figure 1 and Table 2 both illustrate a generally upward trend in Singapore property prices that coincides with considerable price volatility. The average price of a residential condominium unit in a typical quarter is $1,046,226 SGD, which is equivalent to $666,386 USD using the average exchange rate of 1.57 SGD per USD during the 1998-2012 period. The average PSF equals $804 SGD (equivalent to $512 USD).

In Panel B of Table 2, we report summary statistics of our listings and rental sample. There are a total of 5,409 listings in our sample. On average, units are listed for sale at a 7.7% premium above their market PSF estimated at the end of the prior quarter. For the rental sample, the average RSF is $3.55. Thus, for a 1,000 square feet apartment, the typical rent would be $3,550 per month.

## 2.3 Financing Constraints

Stein (1995) proposes an alternative explanation for the appearance of the disposition effect based on financing constraints. A repeat buyer's existing property, which is typically debt-financed, represents a large fraction of their wealth. A price decline in this property reduces the sale proceeds available to finance the down-payment on an upgrade. Thus, the price decline tightens the financing constraints of a repeat buyer, especially when the equity in their existing property is low.

We obtain a proxy for household financing constraints that is not directly related to a unit's capital gain by first aggregating the owner's down-payment with their subsequent monthly principal payments. This sum is then normalized by the unit's estimated market price to create a measure of paid-in equity. While this paid-in equity is not directly related to unit's capital gain, it can alleviate a repeat buyer's financing constraint.

We assume that the down-payment equals the government-mandated minimum, based on the prevailing maximum loan-to-value ratio at the purchase date.[10] Mortgages in Singapore are standardized with a maturity of 30 years and an adjustable rate that references the three-month interbank offer rate in Singapore (SIBOR), with the actual mortgage rate typically

[10]The Singapore government frequently adjusts this maximum loan-to-value ratio to inflate or deflate the housing market. We manually collect data on these policy changes from various government websites and newspaper articles.

being one percent above SIBOR.[11] Data on SIBOR is obtained from the Monetary Authority of Singapore (www.mas.gov.sg). This standardization enables monthly principal payments to be aggregated depending on an owner's holding period and the relevant SIBOR time series.[12] We begin the loan three months after the unit's purchase date since housing transactions usually require twelve weeks to complete in Singapore. Although SIBOR is negatively correlated with property prices, variation in the actual mortgage rate above SIBOR is small compared to time-series variation in SIBOR. Indeed, as mortgages in Singapore are recourse and default rates are correspondingly low, the premium above SIBOR is relatively constant across time and across households.

In addition to paid-in equity and SIBOR itself, another financing constraint proxy available in the URA data is whether the household previously resided in public housing. A unique feature of Singapore's housing market is its segmentation into public units and private (condominium) units. Public units are reserved for lower-income households, who usually intend to upgrade to a private condominium property once their financial circumstances permit.[13] Compared to buyers who were already residing in a private unit when they purchased their current private unit, former residents of public housing are more likely to be financially constrained.

# 3 Results

This section describes the results from our empirical tests involving unit-level sale propensities, selling prices, listing prices, and rental prices. Specifically, the influence of gains and losses on homeowner decisions regarding each of these four variables are examined.

## 3.1 Sale Propensities

As in Odean (1998), the disposition effect is identified by the following ratio

$$\mathrm{R} \;=\; \frac{PGR}{PLR} = \frac{\text{Probability of Realizing a Gain}}{\text{Probability of Realizing a Loss}}. \tag{2}$$

[11] There are no fixed-rate mortgages in Singapore.

[12] Genesove and Mayer (1997) make similar assumptions regarding the common maturity and borrowing rate underlying mortgages when estimating homeowner equity.

[13] Although our sample does not contain the sale of public units, the data indicates whether the owner was residing in public housing when they initially purchased their current (first) private property.

The numerator, PGR, represents the probability of a realized gain, which is defined as the percentage of units with capital gains that are sold in the next quarter. This percentage is computed by normalizing the number of units sold with capital gains by the total number of units in the housing stock with a capital gain. Similarly, the denominator, PLR, represents the probability of a realized loss, which is defined as the percentage of units with capital losses that are sold in the next quarter. While capital gains are estimated at the end of a quarter, PGR and PLR are determined in the subsequent quarter conditional on their sign. In unreported results, R averages 1.70, which indicates the presence of the disposition effect. A $t$-statistic of 2.43 for this ratio is computed from the distribution of its time series across the whole sample period.

Following Ben-David and Hirshleifer (2012), Figure 2 plots the sale probability of each unit conditional on the unit's return relative to its purchase price. In order to plot these sale probabilities, we sort each quarter-unit observation into 1%-return bins. These bins are imbalanced since lower returns are more frequent. We exclude return bins with fewer than 100 observations. For each bin, we compute the percentage of the observations that are sold next quarter and plot these sale probabilities. One line denotes the sale probability conditional on a positive return, while another line is for the non-positive returns. The lines are fitted based on the predicted values from a fifth-degree polynomial. We observe a clear discontinuity in the sell propensities surrounding a capital gain of zero. The probabilities of sale become scattered and decline for the largest returns. However, these extreme returns are based on few observations. A later statistical test finds that the magnitude of a unit's capital gain does not have a negative impact on the sale probability.

To formally examine the relation between unit-level capital gains and sell probabilities, we estimate a probit model that can also control for several unit-level and market-level characteristics. The dependent variable in these specifications equals one if a unit is sold in the quarter following the estimation of its capital gain.

Unit-level characteristics include the indicator function GAIN Dummy (one if a unit's capital gain is positive and zero otherwise). We also include a continuous capital gain variable, GAIN Magnitude, which is the percentage change in the unit's estimated market price relative to its purchase price if this percentage is positive, and zero otherwise. Control variables are the length of the unit's holding period (HOLD), the log of the unit's square footage (Size),

an indicator function that equals one if the unit's owner lived in public housing at the time of its purchase (Public), as well as the unit's paid-in equity (Paid-in Equity). Market-level independent variables include the SIBOR rate in the prior quarter, and the minimum required down-payment (DOWN). This DOWN variable is expressed as a percentage (e.g. 0.20 denotes a 20% required down-payment). We also include a unit's floor level as this variable is known to have pricing implications based on the results from Equation (1). For ease of interpretation, Floor is the floor level divided by 100, which effectively magnifies its impact by 100. Thus, we will see later that while the Floor coefficients are often statistically significant, their economic significance is far less important.

Table 3 contains the results of the probit based on the entire sample of units. For continuous independent variables, we report the marginal impact on the probability that a unit is sold when the variable changes by one standard deviation (half a standard deviation below to half a standard deviation above its mean). For binary independent variables, the reported marginal effect is the difference in the sell probability when this variable changes from zero to one. Standard errors in the estimation are clustered by calendar quarter.

Observe that the coefficient for GAIN Dummy is positive in every specification. For example, the GAIN Dummy coefficient of 0.012 ($t$-statistic of 14.15) indicates that units with a capital gain are 1.2% more likely to be sold than those with a capital loss during the same period. For comparison, the unconditional sell propensity is 1.70%. The inclusion of proxies for financing constraints have no influence on the magnitude of the GAIN Dummy coefficient, which remains at 1.2% and significant in every specification. Also, GAIN Magnitude has an insignificant coefficient in each specification. Thus, owners appear to condition on the sign of their unit's capital gain more than its magnitude in the full sample of capital gains.

The coefficient for HOLD is positive, which indicates that a longer holding period is associated with a greater sell propensity. This finding is consistent with a longer holding period enabling the owner to reduce their mortgage principal, hence weakening their financing constraints when acting as a repeat buyer. Also consistent with financing constraints is the result that larger units, which are more expensive, have lower sell propensities. The positive coefficient for SIBOR can be explained by higher mortgage rates corresponding with lower property prices, and therefore lower required down-payments. Indeed, higher down-payments reduce unit-level sell propensities as buyers require more cash to purchase a unit, which ac-

counts for the negative coefficients corresponding to DOWN. The negative coefficients for the Public indicator function are also consistent with financially constrained households having a lower sell propensity since they are less likely to be able to finance a further upgrade. With down-payments accounted for by DOWN, paid-in equity exerts an insignificant impact on unit-level sell propensities. A positive coefficient for paid-in equity would be consistent with the financing constraint channel as greater homeowner equity weakens a household's financing constraint and facilitates upgrading.

To further analyze the importance of GAIN Magnitude, we estimate the probit in a subsample of units whose small capital gains and capital losses are within 5% of their purchase price. This analysis parallels the sign test in Ben-David and Hirshleifer (2012), who argue that because the disposition effect predicts a preference for positively-signed returns, there should be a discontinuity in sell propensities at zero returns. A plot of these results is shown in the bottom portion of Figure 2 (returns within 30% of the purchase price). The probability of selling increases smoothly after returns past zero with no clear discontinuity.

Probit specifications are also estimated for the subset of gains and losses within 5% of the purchase price. The coefficients for GAIN Dummy remain positive, while the coefficients for GAIN Magnitude become positive. These results indicate that small gains are more likely to be sold than small losses, indicating that homeowners have a sign preference. Therefore, these results continue to support the disposition effect. They also indicate support for realization utility since larger capital gains around zero are associated with higher sell propensities. In Barberis and Xiong (2012), investors receive a burst of utility when they realize a gain, with the amount of utility depending on the size of the gain realized.

In robustness tests, the predicted market prices from Equation (1) offer an alternative estimation of unit-level capital gains. Using the full pricing model with size and floor characteristics to estimate capital gains, we re-estimate the probit specification in a smaller subset of developments with higher turnover. We exclude developments whose hedonic model $R^2$s are less than 70% and units whose predicted PSF from the hedonic model deviates from their sale PSF by more than 50%. Unreported results based on the full pricing model parallel those in Table 3. This similarity is consistent with the relative homogeneity of housing in Singapore as per square foot prices are largely determined by development characteristics.

Overall, gains and losses exert a significant impact on a unit's probability of being sold since

units with a capital gain are more likely to be sold than those with a capital loss. Nonetheless, gains and losses cannot completely account for variation in homeowner sell decisions. Indeed, only a small percentage of homeowners each quarter sell their unit, and many of our control variables have significant coefficients that are consistent with financing constraints. Moreover, Barberis (2013) cautions that prospect theory alone cannot provide a complete description of investor behavior since wealth levels ultimately determine consumption.

## 3.2 Selling Prices

We next examine the selling price of units that eventually are sold. Unlike the stock market where selling prices are largely exogenous with respect to the seller, the real estate market enables selling prices to depend on owners who can either accept or reject a prospective buyer's offer. Therefore, we examine whether their gain or loss influences the selling price that is accepted.

For each sale transaction that occurs in the next quarter, we compute the unit's selling price premium as its observed sale price normalized by its estimated market price at the end of the current quarter. This selling price premium is the dependent variable in our next empirical specification.

A negative $\alpha_1$ coefficient in the following unit-level regression

$$\frac{\text{Selling Price}}{\text{Estimated Price}} = \alpha_0 + \alpha_1 \,\text{GAIN Dummy} + \alpha_2 \,\text{GAIN Magnitude} + \gamma\, X + \epsilon \qquad (3)$$

is evidence of the disposition effect, which predicts risk-seeking behavior by homeowners with a capital loss. Specifically, the disposition effect causes owners with a capital loss to continue holding the risky asset (condominium) instead of lowering their selling price to realize the loss. This finding is also predicted by realization utility. An additional prediction of realization utility is the relevance of a capital gain's magnitude. The inclusion of GAIN Magnitude, which is the percentage change in the unit's estimated market price relative to its purchase price if this percentage is positive, and zero otherwise, enables us to test this prediction. Specifically, a negative $\alpha_2$ coefficient supports realization utility as larger capital gains lead to further reductions in selling prices. The $X$ vector includes a multiple of control variables, most of which are proxies for financing constraints that are included in the earlier probit specifications. As before, the standard errors in the estimation are clustered by calendar quarter.

The coefficients in Table 4 support the disposition effect and realization utility as both the $\alpha_1$ and $\alpha_2$ coefficients are consistently negative in Equation (3) for the full sample of gains and losses. Therefore, owners with a capital loss obtain a higher price for their unit, although they are less likely to sell their unit (perhaps as a consequence of requiring a higher price). Specifically, the -0.015 coefficient ($t$-statistic of 2.85) for GAIN Dummy in Equation (3) signifies that owners with a capital gain have selling prices that are 1.5% lower than comparable units with a capital loss. Furthermore, the magnitude of a capital gain is relevant since its -0.058 coefficient ($t$-statistic of 9.90) is also negative, and larger in absolute magnitude.

Figure 3 provides a visual illustration of the sensitivity of selling prices to unit-level returns. These returns are computed as the percentage change in a unit's estimated market price relative to its purchase price. Each point in this figure represent the average selling price premium for a particular 1%-return bin (return-bins with fewer than 10 observations are excluded). Observe that selling prices are higher for units with a negative return in comparison to those with a positive return.

Within the subsample of small gains and losses, both the $\alpha_1$ and $\alpha_2$ coefficients are consistently insignificant. Thus, gains and losses exert a greater impact on the sale probability (volume of transactions) than prices when gains are near zero.

The proxies for financing constraints have coefficients that are generally inconsistent across the different specifications. However, larger units sell for a discount while units on higher floors sell for a premium, which confirm the results in Panel A of Table 1 for the pricing model in Equation (1).

## 3.3 Listing Prices

We next examine our sample of 5,905 listings that are matched to units with a capital gain. The composition of our listings data is representative of the distribution of capital gains versus capital losses in the broader housing market. In particular, the percentage of units with a capital gain in our listings sample (September 2006 to September 2012) is 84.31% relative to 80.10% for the broader housing inventory during the same period. Therefore, as predicted by the disposition effect, owners with a capital gain appear more willing to sell their unit.

Listing premiums are regressed on unit-level capital gains as follows

$$\frac{\text{Listing Price}}{\text{Estimated Price}} = \alpha_0 + \alpha_1 \,\text{GAIN Dummy} + \alpha_2 \,\text{GAIN Magnitude} + \gamma\, X + \epsilon\,, \qquad (4)$$

where the listing price premium equals a unit's next-quarter listing price normalized by its estimated market price at the end of the current quarter. This regression determines whether owners with a capital loss actually demand a higher selling price when listing their unit for sale. Once again, a negative $\alpha_1$ coefficient is predicted by both the disposition effect and realization utility, while a negative $\alpha_2$ coefficient supports the additional prediction of realization utility.

For listing prices, both the sign of a unit's capital gain and its magnitude are influential in the full sample of gains and losses. In the first model reported in Table 5, an intercept of 0.198 indicates that homeowners with a capital loss list their units at a 19.8% premium, while those with a capital gain list at a smaller 9.2% premium, after subtracting the -0.106 coefficient ($t$-statistic of 10.05) for GAIN Dummy.

Figure 4 provides a visual illustration of the sensitivity in the listing premium to unit-level returns. These returns are computed as the percentage change in a unit's estimated market price relative to its purchase price. Each point in this figure represent the average listing premium for a particular 1%-return bin (return-bins with less than 10 observations are excluded). In the specification with all the control variables, the coefficient for GAIN Dummy remains economically important at -0.083 ($t$-statistic of 6.55) while GAIN Magnitude has a coefficient of -0.052 ($t$-statistic of 3.40).

Unlike transaction prices, the effect of capital gains is influential in the subset of small gains and losses as the coefficients for the GAIN Dummy remain negative. Thus, the sign preference test confirms the importance of the disposition effect to listing prices. Intuitively, homeowners are reluctant to list their property for sale at a price that would realize a loss. However, the coefficients for GAIN Magnitude are insignificant. Thus, gains within (0%, 5%] do not result in different listing premiums, although these gains are associated with lower listing premiums than losses within [-5%, 0%).

## 3.4 Rental Prices

Beginning in 2008, we are able to identify units that are investment properties using the rental contracts sample provided by SRX. Specifically, we match rental agreements with specific units

and compute a unit's abnormal rent by subtracting one from the ratio of its actual next-quarter monthly rent per square foot (RSF) normalized by its estimated market RSF in the current quarter. This abnormal RSF becomes the dependent variable in our next specification.

The following regression estimates the impact of capital gains and losses on abnormal rent

$$\frac{\text{Actual RSF}}{\text{Estimated RSF}} - 1 \;=\; \alpha_0 + \alpha_1 \,\text{GAIN Dummy} + \alpha_2 \,\text{GAIN Magnitude} + \gamma\, X + \epsilon\,. \quad (5)$$

A unit's market RSF is estimated with the fitted values of a pricing model that parallels the specification in Equation (1) for monthly rental per square foot prices

$$\text{RSF}_{i,t} \;=\; \sum_{t=\text{Q1 1995}}^{\text{Q4 2012}} \beta_t \,\text{QUARTER}_{i,t} + \beta_{\text{S}}\,\text{SIZE}_i + \beta_{\text{f}}\,\text{FLOOR}_i + \epsilon_{i,t}\,. \quad (6)$$

This pricing model is estimated within each development and the average (median) $R^2$ is 58.33% (60.38%). We then remove units located in developments that have a hedonic model $R^2$ below 50%, and units whose predicted RSF deviates from its current RSF by more than 50%. These filters ensure that the estimated market rents are accurate.

As in previous specifications, a negative $\alpha_1$ coefficient in Equation (5) supports the disposition effect and realization utility, while a negative $\alpha_2$ coefficient supports realization utility. Specifically, risk-seeking behavior causes landlords with a capital loss to bear greater vacancy risk by requiring higher rental income.

The results in Table 6 for the full sample as well as the restricted sample of small gains and losses are both consistent with the disposition effect. Specifically, a capital loss leads landlords to obtain an additional 2% to 3% in abnormal RSF, according to the full sample. The sign and magnitude of a capital gain are approximately equal in terms of their economic significance in the full sample. Thus, both the disposition effect and realization utility are relevant in the rental market. However, as with listing prices, the coefficients for GAIN Magnitude become insignificant in the restricted subsample of small gains and losses. Indeed, as expected, evidence of realization utility is difficult to find without variation in the magnitude of gains and losses.

The sensitivity of rental prices to unit-level returns is illustrated in Figure 5, where the returns are computed as the percentage change in a unit's estimated market price relative to its purchase price.

### 3.5 Alternative Explanations

One possible alternative explanation for our results is a belief in mean reversion. However, empirically, at an annual horizon, the autocorrelation in market-level prices is insignificant while only the first lag is positive at a quarterly horizon (according to Panel B of Table 1). Thus, there is no evidence of mean reversion in housing returns that could justify holding units with a capital loss. Price continuation in the Singapore housing market implies that homeowners who have capital gains should not immediately sell their unit.

Informed trading (speculative motive for trading) provides another explanation for the appearance of the disposition effect offered by Ben-David and Hirshleifer (2012). However, unlike the equity market in their study, informed trading in Singapore's real estate market is less important since the overall market PSF, not private information regarding an individual unit, dominates the unit's PSF. Indeed, unit-level prices are highly correlated. Portfolio rebalancing also cannot explain the presence of the disposition effect in our sample since housing is indivisible and expected returns are highly correlated among individual units in Singapore.

Finally, the consumption value of home ownership does not confound our test of the disposition effect. The high correlation among units in Singapore implies that low property prices enable improved consumption value. Indeed, a homeowner is not disadvantaged by selling their current unit at a capital loss to purchase another unit with a similar expected return that better suits their housing preferences.

## 4 Conclusion

The disposition effect and realization utility are both motivated by prospect theory. Prospect theory posits that investors are concerned with changes in their wealth, hence gains and losses. In contrast, expected utility theory operates on terminal wealth levels.

The disposition effect predicts that assets with a capital gain are more likely to be sold than assets with a capital loss. Using data from Singapore's condominium market, where capital gains can be accurately estimated, we find evidence that the gains and losses exert a significant impact on the decisions of homeowners. Homeowners with a capital gain are almost twice more likely to sell their homes than those with a capital loss. Even for gains and

losses within 5% of the purchase price, homeowners with a gain are also more likely to sell their home. These findings support the disposition effect. Despite the economic importance of housing transactions to household wealth, and the non-trivial amount of time and effort spent on these transactions, homeowners are susceptible to the disposition effect.

Real estate transactions enable us also to investigate the prices that homeowners accept when selling or renting their property. While prices are exogenous for retail investors in the stock market, real estate transaction prices depend on the offer a homeowner accepts from a prospective buyer or tenant. We find that homeowners with a capital gain accept lower selling prices and rents than those with a capital loss. Homeowners with a capital gain also list their property for-sale at a lower price. Furthermore, consistent with realization utility, these findings strengthen for homeowners with larger gains. While the disposition effect focuses on the sign of a unit's return since its purchase, realization utility in Barberis and Xiong (2012) allows the magnitude of a gain or loss to influence homeowner decisions. As predicted by realization utility, our results indicate that homeowners often condition their decisions on the magnitude of their unit's gain. Thus, the disposition effect alone does not fully describe the impact of gains and losses on real estate transactions.

While real estate data from Singapore has several advantages over US data, our results can be generalized to residential real estate markets in other locations. Indeed, in every country, real estate transactions are large relative to household wealth, involve salient purchase prices, and are endogenous with respect to owner preferences. Our evidence demonstrates that the likelihood of selling a home, hence transaction volume, is influenced by the disposition effect. Thus, broad gains in the overall housing market are likely to induce selling activity and increase transaction volume. Intuitively, the price-volume relation in real estate markets can be attributed to the disposition effect.

Our findings also have important household wealth implications as the impact of a capital gain reduces selling and rental prices by 2%. For the typical home in our sample, which sells for over $660,000 USD, this decline represents a significant dollar amount in excess of $13,000 USD.

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# Table 1: Correlation of Prices within Developments and Autocorrelation in Market Returns

Panel A summarizes the results from the pricing model in Equation (1) from 1995 to 2012 based on quarterly indicator variables, size, and floor level, $\text{PSF}_{i,t} = \sum_t \beta_t \, \text{QUARTER}_{i,t} + \beta_\text{S} \, \text{SIZE}_i + \beta_\text{f} \text{FLOOR}_i + \epsilon_{i,t}$. This pricing model is estimated for every condominium development. Each observation is a sale of unit $i$ in a condominium development during quarter $t$. Sale transactions are from the URA REALIS database for condominiums in Singapore. Average coefficients across all 1,014 developments are reported along with the distribution of their $R^2$s. Panel B contains the results from regressing market-level returns on lagged returns where returns are based on percentage changes in the market-level PSF every quarter. The quarterly market-level PSF is computed by averaging all transactions within each development during a quarter, and then averaging these development-level PSF averages across all developments. $t$-statistics are in parentheses with *, **, and *** representing the statistical significance of the estimated coefficients at the 10%, 5%, and 1% levels, respectively.

Panel A: Pricing model summary

| | | |
|---|---|---|
| Number of Developments | 1,014 | 1,014 |
| Quarterly indicator variables | Yes | Yes |
| Average size coefficient | | -0.13 |
| Average $t$-statistic | | (8.90) |
| Average floor coefficient | | 7.15 |
| Average $t$-statistic | | (6.13) |
| Adj. $R^2$ Percentiles | | |
| 1% | 0.004 | 0.363 |
| 10% | 0.182 | 0.716 |
| 25% | 0.666 | 0.864 |
| Median | 0.872 | 0.930 |
| 75% | 0.928 | 0.958 |
| 90% | 0.956 | 0.973 |
| 99% | 0.980 | 0.988 |
| Mean | 0.738 | 0.880 |

Panel B: Autocorrelation in property market returns

| | Quarterly horizon | | | | Annual horizon | | | |
|---|---|---|---|---|---|---|---|---|
| Return t-1 | 0.590*** | 0.714*** | 0.694*** | 0.694*** | 0.160 | 0.208 | 0.251 | 0.454 |
| | (6.03) | (5.93) | (5.61) | (5.47) | (0.61) | (0.75) | (1.04) | (1.35) |
| Return t-2 | | -0.209* | -0.139 | -0.135 | | -0.256 | -0.250 | -0.316 |
| | | (1.74) | (0.92) | (0.88) | | (0.92) | (1.05) | (1.18) |
| Return t-3 | | | -0.105 | -0.115 | | | 0.330 | 0.385 |
| | | | (0.85) | (0.74) | | | (1.33) | (1.38) |
| Return t-4 | | | | 0.013 | | | | -0.172 |
| | | | | (0.10) | | | | (0.59) |
| Intercept | 0.005 | 0.006 | 0.006 | 0.006 | 0.036 | 0.047 | 0.056 | 0.043 |
| | (0.78) | (0.97) | (0.96) | (0.90) | (0.88) | (1.06) | (1.43) | (0.93) |
| Observations | 70 | 69 | 68 | 67 | 16 | 15 | 14 | 13 |
| Adj. $R^2$ | 0.339 | 0.358 | 0.358 | 0.346 | -0.044 | -0.060 | -0.017 | -0.063 |

# Table 2: Quarterly Inventory of Units and Summary Statistics

Panel A reports summary statistics for the historical inventory of units from 1998-2012 where capital gains can be estimated using the 1995-2012 URA data on Singapore's condominium market. Statistics regarding the historical sale price, square footage (SIZE), price per square foot (PSF), years held (HOLD), and number of condominium developments are included. Our coverage is estimated by comparing the units in our sample with the total number of units in each development. The second set of columns pertain to sale transactions in the URA data. Panel B reports summary statistics regarding for-sale price listings and rental data from SRX, which begin in 2006 and 2008, respectively. The listing premium is the percentage the listing price exceeds the market price based on the average PSF within each unit's development. RSF is the monthly rent per square foot. The rental coverage is estimated by comparing our total number of observations with URA's quarterly rental data.

Panel A: Description of property inventory and sale transactions

| | Historical inventory | | | | | | | | Sales | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Avg. Price | Avg. SIZE | Avg. PSF | Avg. HOLD | Develop-ments | Units | Housing inventory | Sample coverage | Avg. Price | Avg. PSF | Units |
| 03/31/1998 | $1,051,727 | 1,368 | $752 | 1.71 | 296 | 25,143 | 74,516 | 33.74% | $915,655 | $646 | 715 |
| 06/30/1998 | $1,032,603 | 1,366 | $741 | 1.85 | 323 | 26,949 | 77,326 | 34.85% | $772,547 | $579 | 1,653 |
| 09/30/1998 | $1,019,267 | 1,367 | $731 | 2.02 | 340 | 28,283 | 79,855 | 35.42% | $731,918 | $520 | 1,404 |
| 12/31/1998 | $981,121 | 1,369 | $701 | 2.02 | 364 | 31,870 | 82,611 | 38.58% | $623,927 | $469 | 3,628 |
| 03/31/1999 | $958,907 | 1,368 | $689 | 2.07 | 393 | 35,630 | 85,739 | 41.56% | $724,518 | $530 | 3,389 |
| 06/30/1999 | $939,276 | 1,370 | $676 | 2.01 | 412 | 40,685 | 88,023 | 46.22% | $825,383 | $589 | 5,694 |
| 09/30/1999 | $937,945 | 1,372 | $675 | 2.08 | 407 | 42,990 | 88,562 | 48.54% | $934,080 | $676 | 3,450 |
| 12/31/1999 | $941,532 | 1,372 | $678 | 2.24 | 399 | 44,035 | 88,328 | 49.85% | $1,069,815 | $747 | 2,169 |
| 03/31/2000 | $938,453 | 1,376 | $675 | 2.39 | 391 | 44,789 | 88,414 | 50.66% | $1,004,589 | $714 | 1,960 |
| 06/30/2000 | $935,370 | 1,378 | $672 | 2.52 | 385 | 45,686 | 90,077 | 50.72% | $975,417 | $685 | 1,949 |
| 09/30/2000 | $941,905 | 1,380 | $675 | 2.64 | 390 | 47,059 | 93,036 | 50.58% | $1,010,087 | $720 | 2,379 |
| 12/31/2000 | $935,637 | 1,380 | $670 | 2.81 | 370 | 46,779 | 91,292 | 51.24% | $988,088 | $685 | 1,712 |
| 03/31/2001 | $931,134 | 1,377 | $669 | 3.00 | 370 | 47,638 | 92,432 | 51.54% | $790,127 | $589 | 1,439 |
| 06/30/2001 | $927,397 | 1,381 | $664 | 3.13 | 392 | 49,267 | 94,011 | 52.41% | $828,095 | $595 | 1,769 |
| 09/30/2001 | $916,256 | 1,377 | $658 | 3.24 | 384 | 50,081 | 93,728 | 53.43% | $756,361 | $572 | 2,456 |
| 12/31/2001 | $916,851 | 1,372 | $663 | 3.39 | 429 | 52,834 | 99,891 | 52.89% | $766,025 | $567 | 1,647 |
| 03/31/2002 | $898,802 | 1,368 | $652 | 3.32 | 459 | 59,460 | 105,266 | 56.49% | $721,795 | $558 | 5,385 |
| 06/30/2002 | $895,175 | 1,367 | $650 | 3.43 | 446 | 60,776 | 106,287 | 57.18% | $813,313 | $605 | 2,665 |
| 09/30/2002 | $885,027 | 1,364 | $644 | 3.52 | 447 | 61,994 | 105,461 | 58.78% | $774,995 | $583 | 3,138 |
| 12/31/2002 | $883,883 | 1,364 | $644 | 3.71 | 435 | 61,918 | 105,266 | 58.82% | $787,355 | $574 | 1,971 |
| 03/31/2003 | $883,958 | 1,366 | $642 | 3.90 | 429 | 62,006 | 105,237 | 58.92% | $752,932 | $547 | 857 |
| 06/30/2003 | $876,354 | 1,360 | $640 | 4.01 | 476 | 66,085 | 112,050 | 58.98% | $708,454 | $580 | 1,738 |
| 09/30/2003 | $869,964 | 1,360 | $636 | 4.12 | 468 | 67,404 | 111,940 | 60.21% | $740,709 | $565 | 2,845 |
| 12/31/2003 | $861,791 | 1,360 | $630 | 4.26 | 450 | 66,865 | 110,306 | 60.62% | $739,946 | $546 | 1,574 |
| 03/31/2004 | $870,933 | 1,364 | $634 | 4.44 | 471 | 68,542 | 111,291 | 61.59% | $794,985 | $563 | 1,686 |
| 06/30/2004 | $868,276 | 1,362 | $634 | 4.53 | 487 | 71,306 | 115,439 | 61.77% | $799,313 | $574 | 2,020 |
| 09/30/2004 | $866,531 | 1,358 | $635 | 4.66 | 515 | 73,874 | 118,957 | 62.10% | $771,742 | $570 | 1,970 |
| 12/31/2004 | $861,485 | 1,362 | $629 | 4.76 | 501 | 74,599 | 119,600 | 62.37% | $860,473 | $648 | 2,543 |
| 03/31/2005 | $865,484 | 1,367 | $629 | 4.89 | 499 | 75,506 | 122,090 | 61.85% | $826,040 | $596 | 1,726 |
| 06/30/2005 | $868,187 | 1,367 | $632 | 4.95 | 533 | 79,349 | 126,513 | 62.72% | $853,361 | $634 | 3,092 |
| 09/30/2005 | $867,566 | 1,367 | $631 | 4.98 | 567 | 83,375 | 129,694 | 64.29% | $891,882 | $624 | 3,659 |
| 12/31/2005 | $874,098 | 1,366 | $638 | 5.02 | 574 | 85,735 | 130,597 | 65.65% | $1,024,978 | $741 | 3,568 |
| 03/31/2006 | $878,802 | 1,367 | $640 | 5.10 | 608 | 88,695 | 134,348 | 66.02% | $997,848 | $677 | 3,028 |
| 06/30/2006 | $886,403 | 1,367 | $644 | 5.11 | 634 | 91,629 | 135,723 | 67.51% | $1,127,044 | $726 | 4,258 |
| 09/30/2006 | $896,503 | 1,368 | $648 | 5.13 | 652 | 94,307 | 137,350 | 68.66% | $1,225,009 | $804 | 4,266 |
| 12/31/2006 | $920,511 | 1,370 | $661 | 5.06 | 685 | 99,567 | 141,590 | 70.32% | $1,283,071 | $866 | 6,682 |
| 03/31/2007 | $946,744 | 1,370 | $678 | 5.00 | 720 | 104,355 | 144,653 | 72.14% | $1,396,710 | $920 | 6,631 |
| 06/30/2007 | $990,053 | 1,369 | $706 | 4.76 | 745 | 110,232 | 148,649 | 74.16% | $1,403,768 | $967 | 11,437 |
| 09/30/2007 | $1,032,989 | 1,365 | $738 | 4.69 | 733 | 113,144 | 148,692 | 76.09% | $1,626,858 | $1,183 | 8,327 |
| 12/31/2007 | $1,034,115 | 1,357 | $743 | 4.80 | 669 | 110,574 | 144,901 | 76.31% | $1,624,330 | $1,124 | 3,877 |
| 03/31/2008 | $1,044,978 | 1,359 | $750 | 4.94 | 662 | 109,491 | 143,833 | 76.12% | $1,289,644 | $993 | 2,386 |
| 06/30/2008 | $1,046,241 | 1,362 | $749 | 5.09 | 673 | 110,234 | 144,428 | 76.33% | $1,300,444 | $958 | 2,875 |
| 09/30/2008 | $1,026,189 | 1,351 | $747 | 5.22 | 632 | 109,173 | 142,509 | 76.61% | $1,224,799 | $916 | 3,595 |
| 12/31/2008 | $1,023,065 | 1,355 | $743 | 5.43 | 559 | 103,747 | 137,774 | 75.30% | $1,056,463 | $891 | 1,375 |
| 03/31/2009 | $1,038,205 | 1,356 | $751 | 5.56 | 734 | 116,614 | 154,979 | 75.25% | $841,425 | $775 | 2,860 |
| 06/30/2009 | $1,063,930 | 1,358 | $767 | 5.48 | 830 | 124,997 | 163,397 | 76.50% | $1,135,040 | $890 | 7,733 |
| 09/30/2009 | $1,087,631 | 1,354 | $786 | 5.28 | 843 | 130,665 | 167,945 | 77.80% | $1,310,650 | $991 | 10,586 |
| 12/31/2009 | $1,106,006 | 1,352 | $804 | 5.32 | 849 | 132,844 | 171,235 | 77.58% | $1,364,717 | $1,065 | 5,638 |
| 03/31/2010 | $1,122,747 | 1,348 | $821 | 5.28 | 869 | 136,638 | 173,590 | 78.71% | $1,416,260 | $1,147 | 7,561 |
| 06/30/2010 | $1,148,100 | 1,345 | $844 | 5.19 | 890 | 141,466 | 177,475 | 79.71% | $1,439,551 | $1,155 | 8,517 |
| 09/30/2010 | $1,149,175 | 1,332 | $856 | 5.19 | 886 | 143,285 | 179,633 | 79.77% | $1,289,427 | $1,129 | 7,043 |
| 12/31/2010 | $1,167,766 | 1,330 | $873 | 5.18 | 892 | 146,318 | 182,752 | 80.06% | $1,393,502 | $1,211 | 7,292 |
| 03/31/2011 | $1,178,641 | 1,322 | $889 | 5.19 | 910 | 149,464 | 190,918 | 78.29% | $1,345,184 | $1,197 | 6,074 |
| 06/30/2011 | $1,194,108 | 1,315 | $908 | 5.16 | 920 | 153,371 | 191,472 | 80.10% | $1,350,494 | $1,217 | 8,026 |
| 09/30/2011 | $1,199,482 | 1,309 | $918 | 5.21 | 890 | 153,745 | 192,440 | 79.89% | $1,351,511 | $1,175 | 6,325 |
| 12/31/2011 | $1,194,563 | 1,300 | $924 | 5.26 | 871 | 156,113 | 194,138 | 80.41% | $1,292,239 | $1,177 | 6,062 |
| 03/31/2012 | $1,187,465 | 1,292 | $927 | 5.34 | 911 | 161,714 | 200,706 | 80.57% | $1,087,204 | $1,149 | 6,116 |
| 06/30/2012 | $1,202,069 | 1,284 | $945 | 5.32 | 973 | 169,696 | 210,450 | 80.64% | $1,274,543 | $1,194 | 8,412 |
| 09/30/2012 | $1,215,034 | 1,282 | $955 | 5.38 | 980 | 172,968 | 212,817 | 81.28% | $1,346,656 | $1,202 | 6,891 |
| 12/31/2012 | $1,217,082 | 1,271 | $966 | 5.35 | 840 | 168,021 | 202,519 | 82.97% | $1,400,292 | $1,245 | 7,505 |
| Overall | $991,691 | 1,355 | $726 | 4.21 | 598 | 89,693 | 131,913 | 64.32% | $1,046,226 | $886 | 249,228 |

Panel B: Description of listings and rental data

| | Listings | | Rental | | |
|---|---|---|---|---|---|
| Date | Units | Listing premium | Units | RSF | Coverage |
| 09/30/2006 | 50 | 10.05% | | | |
| 12/31/2006 | 103 | 4.78% | | | |
| 03/31/2007 | 101 | 2.64% | | | |
| 06/30/2007 | 140 | 4.32% | | | |
| 09/30/2007 | 283 | 12.05% | | | |
| 12/31/2007 | 378 | 13.10% | | | |
| 03/31/2008 | 310 | 12.01% | 1,924 | $3.68 | 50.2% |
| 06/30/2008 | 275 | 10.48% | 2,462 | $3.53 | 43.6% |
| 09/30/2008 | 248 | 14.67% | 2,573 | $3.59 | 38.4% |
| 12/31/2008 | 149 | 16.97% | 2,018 | $3.28 | 43.6% |
| 03/31/2009 | 96 | 8.71% | 2,789 | $3.01 | 47.2% |
| 06/30/2009 | 115 | 5.23% | 3,101 | $2.86 | 43.0% |
| 09/30/2009 | 253 | 6.91% | 2,944 | $3.10 | 38.0% |
| 12/31/2009 | 213 | 5.88% | 2,803 | $3.18 | 48.9% |
| 03/31/2010 | 214 | 6.25% | 3,156 | $3.33 | 49.9% |
| 06/30/2010 | 228 | 6.04% | 3,679 | $3.41 | 48.2% |
| 09/30/2010 | 239 | 6.11% | 4,022 | $3.61 | 55.6% |
| 12/31/2010 | 194 | 4.16% | 3,679 | $3.58 | 55.2% |
| 03/31/2011 | 187 | 4.17% | 4,825 | $3.73 | 68.6% |
| 06/30/2011 | 346 | 7.05% | 5,048 | $3.81 | 63.7% |
| 09/30/2011 | 538 | 8.37% | 4,852 | $3.96 | 57.0% |
| 12/31/2011 | 284 | 7.23% | 4,284 | $3.91 | 64.2% |
| 03/31/2012 | 106 | 6.04% | 5,050 | $3.93 | 69.4% |
| 06/30/2012 | 137 | 4.96% | 5,531 | $3.94 | 67.4% |
| 09/30/2012 | 222 | 5.97% | 5,898 | $4.08 | 61.6% |
| Overall | 5,409 | 7.77% | 70,638 | $3.55 | 53.4% |

# Table 3: Unit-level Probit for Sale Propensity

This table records the results from a probit panel regression that examines the unit-level sell probability each quarter of our 1998-2012 sample. The dependent variable Sale equals one if a unit is sold in the quarter after its capital gain is estimated. A unit's capital gain is estimated by by subtracting its purchase price from its estimated market price, which is determined from the average selling price per square foot within its development during a six-month interval centered at the end of the relevant quarter. GAIN Dummy equals one if the unit's capital gain is positive and zero otherwise. GAIN Magnitude is the percentage change in the unit's price relative to its purchase price if this percentage is positive, and zero otherwise. The remaining independent variables represent proxies for financing constraints; the number of years since the unit's purchase (HOLD), the square footage of the unit (Size), the prevailing three-month interbank offer rate in Singapore underlying monthly mortgage payments (SIBOR), the prevailing minimum required percentage down-payment (DOWN), an indicator variable that equals one if the unit's owner was a resident of public housing at the time of its purchase (Public). Paid-in equity is defined as the sum of a unit's down-payment and cumulative principal repayments normalized by its market price at the quarter-end. The floor level (divided by 100) of the unit is also included in the probit specification due to its influence on unit-level prices. The specifications are estimated within the full sample, and in a subsample restricted to small capital gains and capital losses that are within 5% of the unit's purchase price. Standard errors are clustered by calendar quarter and $z$-statistics are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

| | All gains and losses | | | | Small gains and losses | | | |
|---|---|---|---|---|---|---|---|---|
| GAIN Dummy | 0.012*** | 0.012*** | 0.012*** | 0.012*** | 0.002*** | 0.001*** | 0.002*** | 0.001*** |
| | (14.15) | (14.69) | (11.61) | (11.59) | (6.44) | (2.68) | (3.98) | (2.78) |
| GAIN Magnitude | | -0.000 | | -0.001 | | 0.047*** | | 0.034*** |
| | | (0.10) | | (0.45) | | (4.17) | | (2.70) |
| HOLD | | | 0.001*** | 0.001*** | | | 0.001** | 0.001* |
| | | | (3.55) | (4.23) | | | (2.01) | (1.74) |
| Log(Size) | | | -0.007*** | -0.007*** | | | -0.005*** | -0.005*** |
| | | | (12.93) | (12.84) | | | (8.58) | (8.56) |
| Lag(SIBOR) | | | 0.002** | 0.002* | | | 0.001 | 0.001 |
| | | | (2.01) | (1.96) | | | (1.39) | (1.41) |
| DOWN (x100) | | | -0.084*** | -0.082*** | | | -0.067*** | -0.072*** |
| | | | (9.80) | (12.14) | | | (2.78) | (2.88) |
| Public | | | -0.002*** | -0.002*** | | | -0.002*** | -0.002*** |
| | | | (4.13) | (4.20) | | | (6.18) | (6.17) |
| Paid-in Equity | | | 0.002 | -0.000 | | | -0.004 | 0.001 |
| | | | (0.39) | (0.06) | | | (0.14) | (0.04) |
| Floor | | | 0.012*** | 0.012*** | | | 0.014*** | 0.014*** |
| | | | (4.84) | (4.99) | | | (7.52) | (7.53) |
| Observations | 5,213,558 | 5,213,558 | 5,012,776 | 5,012,776 | 798,402 | 798,402 | 758,189 | 758,189 |

# Table 4: Transaction Prices

This table records the results from a regression whose dependent variable is a unit's selling price premium based on quarterly observations from 1998-2012. This premium is defined as a unit's selling price normalized by its estimated price based on the average per square foot price of all units sold within the same development during a six-month interval centered at the end of the relevant quarter. A unit's capital gain is then estimated by comparing this price with the unit's purchase price. GAIN Dummy equals one if a unit's capital gain is positive and zero otherwise. GAIN Magnitude is the percentage change in the unit's estimated price relative to its purchase price if this percentage is positive, and zero otherwise. The remaining independent variables represent proxies for financing constraints; the number of years since the unit's purchase (HOLD), the square footage of the unit (Size), the prevailing three-month interbank offer rate in Singapore underlying monthly mortgage payments (SIBOR), the prevailing minimum required percentage down-payment (DOWN), an indicator variable that equals one if the unit's owner was a resident of public housing at the time of its purchase (Public). Paid-in equity is defined as the sum of a unit's down-payment and cumulative principal repayments normalized by its market price at the quarter-end. The floor level (divided by 100) of the unit is also included in the probit specification due to its influence on unit-level prices. The specifications are estimated within the full sample, and in a subsample restricted to small capital gains and capital losses that are within 5% of the unit's purchase price. Standard errors are clustered by calendar quarter and $t$-statistics are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

| | All gains and losses | | | | Small gains and losses | | | |
|---|---|---|---|---|---|---|---|---|
| GAIN Dummy | -0.024*** | -0.003 | -0.015*** | -0.015*** | -0.003 | -0.001 | 0.002 | -0.000 |
| | (5.94) | (0.88) | (2.84) | (2.85) | (0.98) | (0.30) | (0.39) | (0.13) |
| GAIN Magnitude | | -0.056*** | | -0.058*** | | -0.063 | | 0.088 |
| | | (15.42) | | (9.90) | | (0.76) | | (1.23) |
| HOLD | | | -0.002*** | 0.002*** | | | -0.020*** | -0.021*** |
| | | | (4.13) | (4.44) | | | (4.32) | (4.31) |
| Log(Size) | | | -0.058*** | -0.055*** | | | -0.059*** | -0.059*** |
| | | | (13.13) | (12.85) | | | (11.59) | (11.56) |
| Lag(SIBOR) | | | 0.006 | 0.006 | | | 0.008 | 0.008 |
| | | | (1.36) | (1.20) | | | (1.39) | (1.40) |
| DOWN (x100) | | | -0.078*** | 0.032 | | | -0.873*** | -0.887*** |
| | | | (3.68) | (1.17) | | | (4.35) | (4.34) |
| Public | | | -0.001 | -0.001 | | | 0.000 | 0.000 |
| | | | (1.22) | (1.18) | | | (0.09) | (0.08) |
| Paid-in Equity | | | 0.050** | -0.108*** | | | 0.683*** | 0.698*** |
| | | | (2.49) | (4.57) | | | (3.69) | (3.69) |
| Floor | | | 0.190*** | 0.193*** | | | 0.171*** | 0.171*** |
| | | | (15.42) | (15.18) | | | (7.36) | (7.36) |
| Intercept | 0.039*** | 0.039*** | 0.426*** | 0.422*** | 0.046*** | 0.046*** | 0.482*** | 0.481*** |
| | (7.80) | (7.80) | (12.95) | (13.27) | (8.43) | (8.43) | (14.57) | (14.50) |
| Observations | 88,399 | 88,399 | 85,394 | 85,394 | 9,762 | 9,762 | 9,345 | 9,345 |
| Adj. $R^2$ | 0.011 | 0.036 | 0.093 | 0.109 | 0.000 | 0.000 | 0.136 | 0.136 |

# Table 5: Listing Prices

This table records the results from a regression whose dependent variable is a unit's quarterly listing premium from 2006-2012. This premium is defined as a unit's listing price normalized by its estimated price based on the average per square foot price of all units sold within the same development during a six-month interval centered at the end of the relevant quarter. A unit's capital gain is then estimated by comparing this price with the unit's purchase price. GAIN Dummy equals one if a unit's capital gain is positive and zero otherwise. GAIN Magnitude is the percentage change in the unit's estimated price relative to its purchase price if this percentage is positive, and zero otherwise. The remaining independent variables represent proxies for financing constraints; the number of years since the unit's purchase (HOLD), the square footage of the unit (Size), the prevailing three-month interbank offer rate in Singapore underlying monthly mortgage payments (SIBOR), the prevailing minimum required percentage down-payment (DOWN), an indicator variable that equals one if the unit's owner was a resident of public housing at the time of its purchase (Public). Paid-in equity is defined as the sum of a unit's down-payment and cumulative principal repayments normalized by its market price at the quarter-end. The floor level (divided by 100) of the unit is also included in the probit specification due to its influence on unit-level prices. The specifications are estimated within the full sample, and in a subsample restricted to small capital gains and capital losses that are within 5% of the unit's purchase price. Standard errors are clustered by calendar quarter and $t$-statistics are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

| | All gains and losses | | | | Small gains and losses | | | |
|---|---|---|---|---|---|---|---|---|
| GAIN Dummy | -0.106*** | -0.083*** | -0.078*** | -0.083*** | -0.040** | -0.028 | -0.060** | -0.042* |
| | (10.05) | (8.26) | (6.66) | (6.55) | (2.74) | (1.51) | (2.72) | (1.87) |
| GAIN Magnitude | | -0.058*** | | -0.052*** | | -0.496 | | -0.985 |
| | | (6.22) | | (3.40) | | (0.90) | | (1.66) |
| HOLD | | | -0.003** | 0.002 | | | 0.024 | 0.036 |
| | | | (2.44) | (0.88) | | | (0.83) | (1.16) |
| Log(Size) | | | -0.059*** | -0.056*** | | | -0.056** | -0.059** |
| | | | (8.12) | (7.88) | | | (2.14) | (2.25) |
| Lag(SIBOR) | | | 0.013 | 0.013 | | | 0.001 | -0.000 |
| | | | (1.21) | (1.22) | | | (0.08) | (0.02) |
| DOWN (x100) | | | -0.060 | 0.089 | | | 0.980 | 1.385 |
| | | | (1.04) | (1.08) | | | (1.00) | (1.37) |
| Public | | | -0.014*** | -0.014*** | | | -0.022 | -0.022 |
| | | | (3.02) | (2.91) | | | (1.36) | (1.39) |
| Paid-in Equity | | | 0.131** | -0.092 | | | -1.155 | -1.580 |
| | | | (2.17) | (0.90) | | | (1.03) | (1.36) |
| Floor | | | 0.208*** | 0.207*** | | | 0.075 | 0.079 |
| | | | (4.99) | (4.50) | | | (0.67) | (0.70) |
| Intercept | 0.198*** | 0.198*** | 0.563*** | 0.560*** | 0.180*** | 0.180*** | 0.628*** | 0.653*** |
| | (14.82) | (14.82) | (9.08) | (9.10) | (11.73) | (11.72) | (2.94) | (3.04) |
| Observations | 5,431 | 5,431 | 5,207 | 5,207 | 606 | 606 | 574 | 574 |
| Adj. $R^2$ | 0.068 | 0.081 | 0.110 | 0.114 | 0.009 | 0.008 | 0.039 | 0.040 |

# Table 6: Rental Prices

This table records the results from a regression whose dependent variable is the abnormal rent per square foot (RSF) of a unit in percentage terms. Abnormal rent is computed by subtracting one from the unit's actual rent normalized by its estimated rent in the current quarter-end. Estimated rent is the fitted value from the hedonic model in Equation (6). The sample of quarterly observations is from 2008-2012. Developments whose $R^2$ from the rental model in Equation (6) are below 0.50 and units whose predicted RSF deviates by more than 50% from the average RSF in the development are excluded from the analysis. A unit's capital gain at a quarter-end is determined by its estimated market price relative to the unit's purchase price. A unit's market price is estimated based on the average per square foot price of all units sold within the same development during a six-month interval centered at the end of the relevant quarter. GAIN Dummy equals one if a unit's capital gain is positive and zero otherwise. GAIN Magnitude is the percentage change in the unit's price relative to its purchase price if this percentage is positive, and zero otherwise. The remaining independent variables represent proxies for financing constraints; the number of years since the unit's purchase (HOLD), the square footage of the unit (Size), the prevailing three-month interbank offer rate in Singapore underlying monthly mortgage payments (SIBOR), the prevailing minimum required percentage down-payment (DOWN), an indicator variable that equals one if the unit's owner was a resident of public housing at the time of its purchase (Public). Paid-in equity is defined as the sum of a unit's down-payment and cumulative principal repayments normalized by its market price at the quarter-end. The floor level (divided by 100) of the unit is also included in the probit specification due to its influence on unit-level prices. The specifications are estimated within the full sample, and in a subsample restricted to small capital gains and capital losses that are within 5% of the unit's purchase price. Standard errors are clustered by calendar quarter and *t*-statistics are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

| | All gains and losses | | | | Small gains and losses | | | |
|---|---|---|---|---|---|---|---|---|
| GAIN Dummy | -0.029*** | -0.021*** | -0.019*** | -0.022*** | -0.009** | -0.009* | -0.014*** | -0.012** |
| | (7.03) | (5.91) | (6.04) | (6.00) | (2.70) | (1.78) | (3.36) | (2.23) |
| GAIN Magnitude | | -0.019*** | | -0.022*** | | 0.022 | | -0.074 |
| | | (8.00) | | (5.04) | | (0.16) | | (0.53) |
| HOLD | | | -0.002*** | 0.000 | | | 0.009 | 0.010 |
| | | | (6.27) | (0.98) | | | (1.38) | (1.44) |
| Log(Size) | | | -0.045*** | -0.045*** | | | -0.053*** | -0.053*** |
| | | | (5.18) | (5.16) | | | (5.65) | (5.65) |
| Lag(SIBOR) | | | 0.003* | 0.002 | | | -0.011*** | -0.012*** |
| | | | (1.87) | (1.54) | | | (3.87) | (3.90) |
| DOWN (x100) | | | -0.051** | 0.023 | | | 0.328 | 0.356 |
| | | | (2.30) | (1.54) | | | (1.33) | (1.39) |
| Public | | | 0.002 | 0.002 | | | 0.001 | 0.001 |
| | | | (1.41) | (1.28) | | | (0.39) | (0.37) |
| Paid-in Equity | | | 0.049*** | -0.056** | | | -0.417 | -0.447 |
| | | | (3.37) | (2.38) | | | (1.62) | (1.68) |
| Floor | | | 0.012 | 0.014 | | | -0.061** | -0.061** |
| | | | (0.78) | (0.89) | | | (2.62) | (2.62) |
| Intercept | 0.032*** | 0.032*** | 0.344*** | 0.353*** | 0.028*** | 0.028*** | 0.437*** | 0.438*** |
| | (9.76) | (9.76) | (5.49) | (5.60) | (9.44) | (9.44) | (6.07) | (6.10) |
| Observations | 48,626 | 48,626 | 46,715 | 46,715 | 6,353 | 6,353 | 5,925 | 5,925 |
| Adj. $R^2$ | 0.003 | 0.004 | 0.009 | 0.009 | 0.001 | 0.001 | 0.028 | 0.028 |

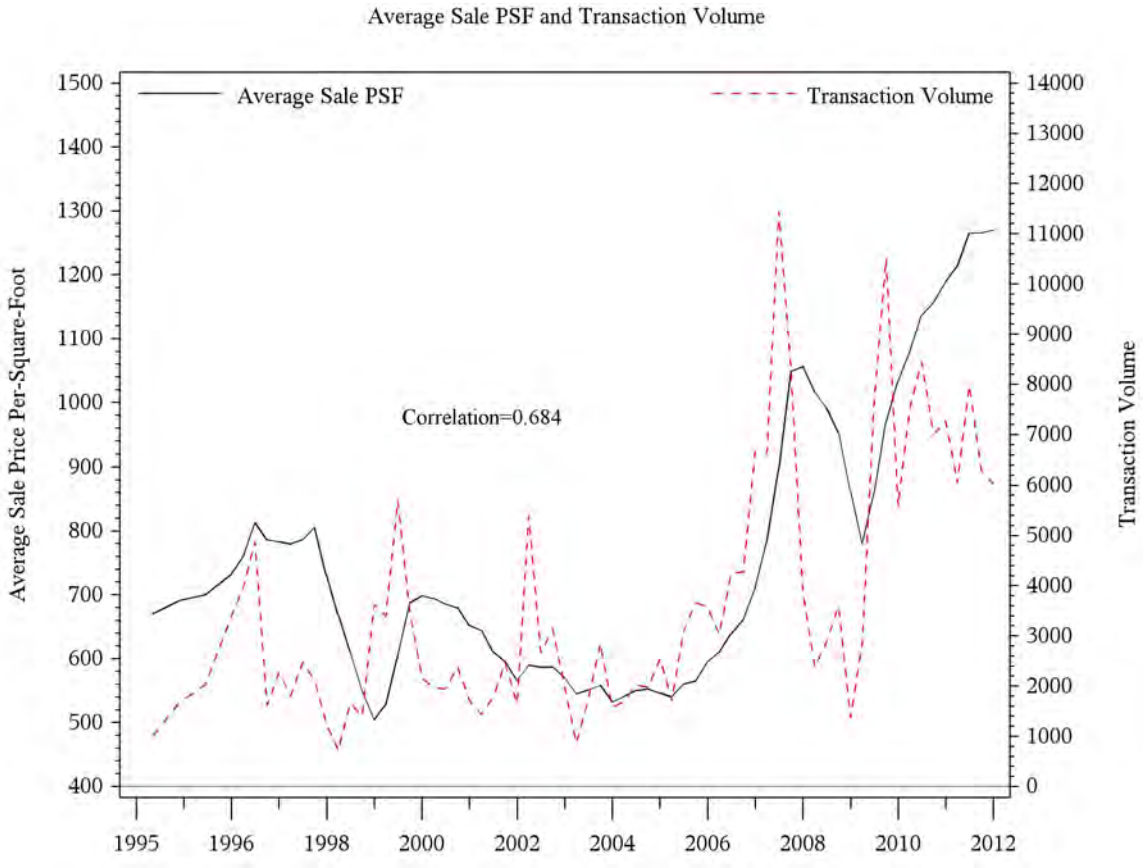


**Figure 1** This figure illustrates the price and volume dynamics in Singapore's condominium market during our sample period. Both the quarterly market-level price per square foot (PSF) of sale transactions and the sale transaction volume are reported. The quarterly market-level PSF is computed by first averaging the PSF of all sale transactions within each development in a quarter, and then averaging these development-level averages across all developments. Sale transaction data is obtained from the URA REALIS database.

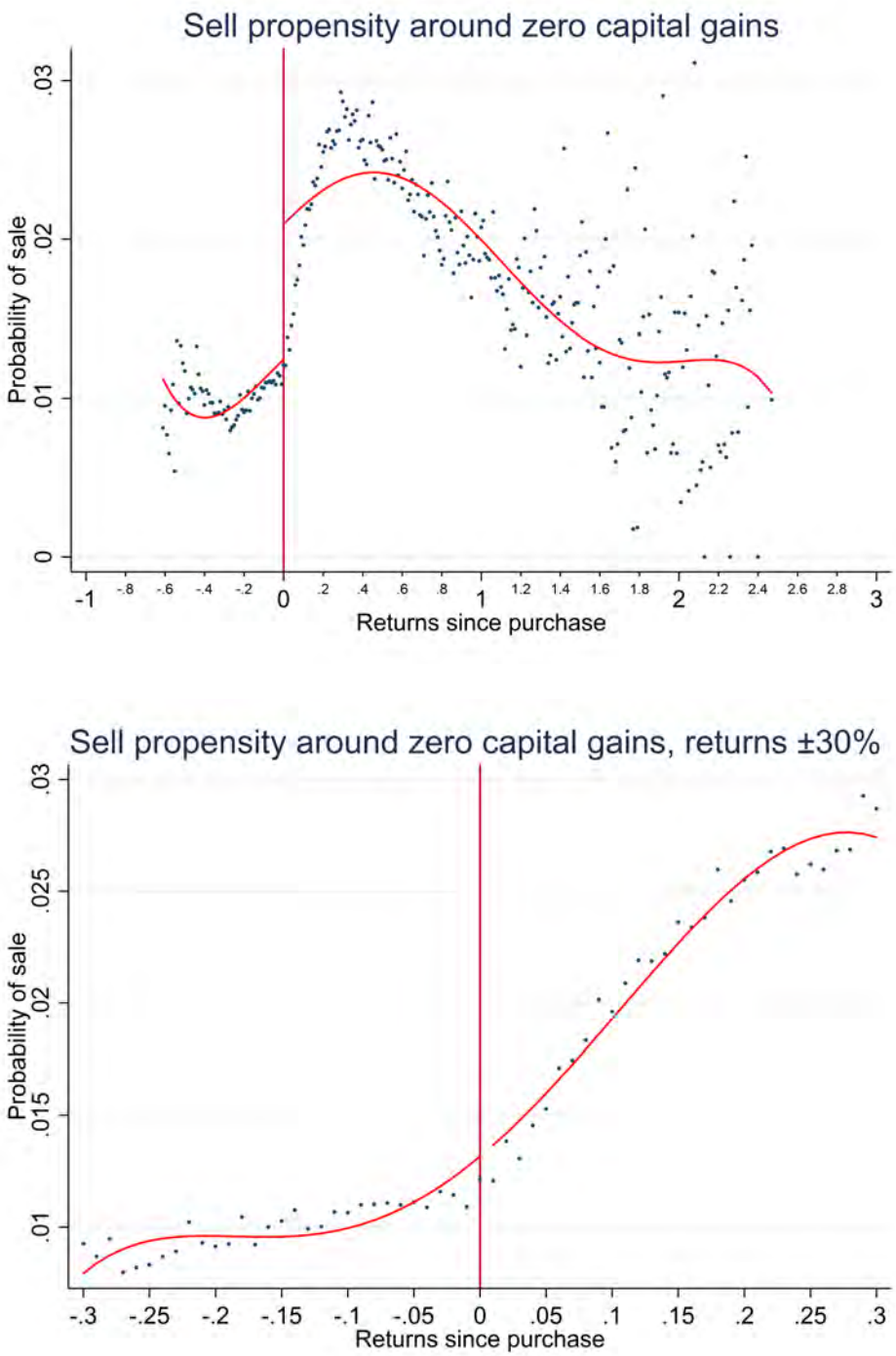


**Figure 2** This figure plots the sale probability of condominium units conditional on their return since purchase. Each quarter-unit observation is sorted into 1%-return bins. We exclude return bins with fewer than 100 observations. For each bin, the percentage of the observations that are sold next quarter are plotted. The lines are fitted separately for positive returns and non-positive returns based on the predicted values from a fifth-degree polynomial. The top portion illustrates the discontinuity in unit-level sell propensities around zero for the full schedule of returns, while the bottom portion focuses on a subsample of returns between -30% and 30%.


**Figure 3** This figure plots the selling premium of condominium units over their estimated price conditional on their return since purchase. Each quarter-unit observation is sorted into 1%-return bins. We exclude return bins with fewer than 10 observations. For each bin, the average selling price premium is plotted. The lines are fitted separately for positive returns and non-positive returns based on the predicted values from a fifth-degree polynomial.

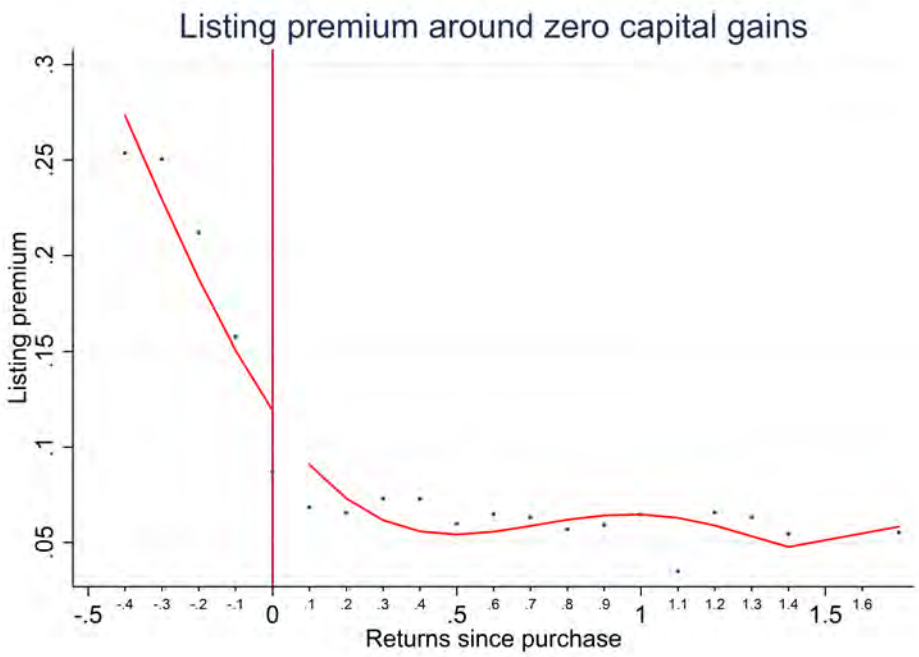


**Figure 4** This figure plots the listing premium of condominium units over their estimated price conditional on their return since purchase. As fewer listings are available than transactions, each quarter-unit observation is sorted into wider 10%-return bins. We exclude return bins with fewer than 10 observations. For each bin, the average listing price premium is plotted. The lines are fitted separately for positive returns and non-positive returns based on the predicted values from a fifth-degree polynomial.

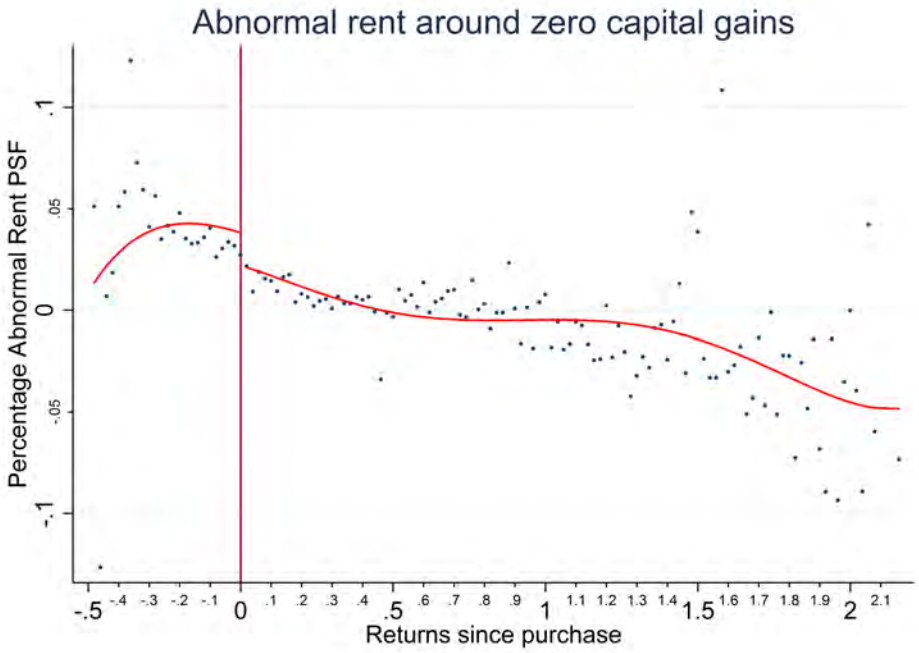


**Figure 5** This figure plots the abnormal rent of condominium units conditional on their return since purchase. Each quarter-unit observation is sorted into 1%-return bins. We exclude return bins with fewer than 10 observations. For each bin, the average abnormal rent is plotted. The lines are fitted separately for positive returns and non-positive returns based on the predicted values from a fifth-degree polynomial.