Icing on the cake: Can the Top-Floor Units serve as a status good and an investment simultaneously?

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Icing on the cake: Can the Top-Floor Units serve as a status good and an investment simultaneously?[Γ]

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Abstract:

Situated atop condominium buildings, 'top floor units' (TFU) offer unparalleled views and privacy, courtesy of accessible roofs. This paper empirically examines this status symbol and finds that: (1) TFUs interact with the macroeconomy differently from ordinary units, (2) when considering the liquidity factor, TFUs should not be included in the portfolio, (3) the trade-off between holding period and annualized return for TFUs significantly differs from ordinary units, suggesting alternative investment strategies are employed for TFUs, and (4) the liquidity of the TFU segment is less stable than ordinary units, potentially deterring short-term speculators.

Keywords: top floor units; peer group effect on consumption; speculation; submarkets; Markov switching model

JEL Classification Number: D10, G10, R21

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1. Introduction

Continuous urbanization drives a global surge in high-rise buildings, particularly in popular cities, despite slower population growth rates in many countries (Council on Tall Buildings and Urban Habitat, 2019; Rohrmann, 2018). From 1885 to 2000, the number of completed high-rise buildings (200 meters or taller) increased significantly from 261 to 1382, spanning beyond Asia (Al-Kodmany, 2020; Sayigh, 2017). This upward trend is illustrated in Figure 1. However, limited formal economic analysis exists regarding the top-floor units (TFU) in these buildings, creating a research gap.

(Figure 1 about here)

This paper contends that TFUs in high-rise residential buildings represent a distinct market segment due to several unique characteristics. First, the supply of TFUs is highly inflexible, as adding floors to an existing high-rise building is nearly impossible. Second, residents of high-rise buildings share elevators, making the identity of top-floor residents "visible" to others. Finally, TFUs offer additional consumption value, including better city views, air quality, privacy, and a quiet environment compared to ordinary units. Consequently, TFUs function as inelastically supplied and locally visible status goods.[1]

Thus, this paper naturally connects with the literature on "conspicuous consumption," where individuals consume goods to signal their wealth (Bagwell and Bernheim, 1996; Veblen, 1899). Economists have identified such "status-seeking" incentives through aggregate data (Bertrand and Morse, 2016; Charles et al., 2009), micro-data (Bricker et al., 2020), field experiments (Bursztyn et al., 2018), social circles (Georgarakos et al., 2014), and neighbors (Agarwal et al., 2020). In our case, since TFU are traded in the secondary market, it allows us to infer the corresponding price premium.[2]

We also stress that while both art and TFU in high-rise buildings carry both investment and conspicuous consumption value (Mandel, 2009), TFU and art differ in

[1] We will use the term “non-TFU” and “ordinary units” interchangeably. We have also checked that there is no “penthouse” in our sample. On the other hand, we cannot rule out the “structural differences” (such as higher ceilings or bigger windows) that are unobservable to researchers. This is a limitation of this paper. Thanks to an anonymous referee for this point.

[2] We consider the effects related but distinct from the "comparison utility" in the macro literature (Carroll et al., 1997). The section on literature review provides more discussion.

several key ways. Firstly, the definition and supply of art can be controversial. Secondly, art is often affordable only to the top percentile of the population, whereas this paper focuses on comparing TFU with ordinary units *within the same building*, making affordability a secondary concern. Thirdly, art may not be frequently traded, making it difficult to find comparable units for price comparison. In contrast, housing units are more frequently traded, allowing for *more meaningful comparisons between TFU and ordinary units within the same buildings*.

This paper also contributes to the growing body of literature on submarkets in real estate and urban economics, which examines the distinct behaviors within a city's housing market (Bourassa et al., 1999, 2003; Goodman and Thibodeau, 1998, 2003; Huang et al., 2018; Yiu et al., 2013).[3] Specifically, this literature often compares how the relationship between house prices and housing attributes differs across different geographical segments within a city. In contrast, our paper highlights the unique behavior of TFU, suggesting that there could be different submarkets *within high-rise buildings*.[4] Understanding these differences can potentially improve the city planning, the accuracy of house price predictions and evaluations of housing policies (Bourassa et al., 1999, 2003; Gong and Leung, 2024).

The paper proceeds with several analyses of the TFU market. First, it examines the top-floor premium (TFP) for TFUs and demonstrates it is significantly positive, and varies dramatically over time. Surprisingly, the relationship between TFP and macroeconomic and financial activities *differs* from that of the general housing market. Second, it investigates whether TFUs play a role in investment portfolios (Fischer and Stamos, 2013; Pelizzon and Weber, 2008; Sa-Aadu et al., 2010). Our findings suggest that TFUs would *not be included* in an optimal investment portfolio once *liquidity* factors are considered. Third, the paper compares the trading activities of TFUs with ordinary units. Within the sample, *TFUs do not stochastically dominate ordinary units*, and *significant differences exist* between the annualized returns and holding periods of TFUs and ordinary units.

[3] An aggregation bias might exist in the city-level housing price index (Hanushek et al., 1996; O'Neill, 1967).
[4] See the appendix for more detailed literature review.

Liquidity and hedging effectiveness also differ between the TFU and ordinary unit market segments.

The underlying intuition behind these results is straightforward. In comparison to ordinary units, TFUs offer *additional conspicuous consumption value*, which may justify lower investment returns and liquidity. Consequently, TFUs may not be included in investment portfolios.

While these ideas apply to other cities with high-rise developments, the paper selects Hong Kong as a case study. Hong Kong's population of seven million resides in a primarily hilly land area of 1,106 km², necessitating vertical real estate development. High-rise residential buildings have become iconic in the city, with 1,453 of the 9,600 high-rise buildings classified as skyscrapers.[5] Figures 2a and 2b illustrate that while most newly completed housing estates include TFUs, *their relative share remains small*, typically not exceeding 6% of all completed units in a given year. TFUs are scarce but provide tenants with better living standards and prestige, as they are accompanied by accessible roofs. The focus is on private residential buildings where occupancy is *voluntary*, and Hong Kong's stringent regulations on additional structures on rooftops mitigate the "option value" of adding another floor to the top.[6]

(Figure 2 about here)

In general, Hong Kong is relatively stable, with fixed boundaries, a fixed exchange rate with the U.S. dollar, and a simple tax system (Goetz, 2021; Richardson, 2006). Additionally, the city offers reliable financial market data measures as an international financial center. Examining the housing market in Hong Kong provides insights into an alternative institutional setting. Unlike the United States, Hong Kong does not practice "fiscal federalism," and all local public goods are financed from the same public revenue

[5] For details, please visit https://www.emporis.com/city/101300/hong-kong-china. In Hong Kong, skyscrapers include both commercial buildings and residential properties.
[6] For details, please visit the website of the Building Department, HKSAR Government https://www.bd.gov.hk/doc/en/resources/pamphlets-and-videos/rubw.pdf , https://www.bd.gov.hk/en/safety-inspection/ubw/UBW-in-private-premises/index_ubw_private_rooftop.html.

pool.[7] The dominant mortgage type is adjustable-rate mortgage (ARM), tied to a publicly observable "prime rate." The loan-to-value (LTV) ratio is tightly controlled and monitored by the Hong Kong Monetary Authority, minimizing mortgage heterogeneity. Finally, ample micro-data on Hong Kong is available, facilitating our empirical analysis.

The paper's remaining sections are structured as follows: Section 2 explains the dataset, computes TFP, and examines its relationship with the macroeconomy. Section 3 compares the performance of investing in TFUs versus non-TFUs. Section 4 analyzes the trading patterns of the TFU market segment versus ordinary units. The paper concludes after presenting robustness checks. The appendices contain additional results.

2. The Dataset and the Top floor premium

In Hong Kong, developers offer a unique product called top-floor units (TFU), which consists of a standard housing unit and an accessible roof, providing exceptional views and increased privacy. Due to the limited supply of TFUs, we anticipate that they will be traded at a premium. To obtain accurate estimates of this premium, we gather a substantial number of "comparable transactions" within the same timeframe. Consequently, our analysis focuses on 32 frequently traded, large-scale real estate developments (RED) in Hong Kong, encompassing a total of 918 residential buildings, 166,980 ordinary housing units (non-TFU) and 3,024 TFUs.[8] The mean and median height of those buildings are approximately 26 and 27 floors respectively. Figure 3a demonstrates significant variation in the number of units across different buildings. Our formula for calculating the top floor premium (TFP) of TFU transactions is straightforward.[9]

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[7] Fiscal federalism would dramatically change the residential location choice and hence the housing market. See Hanushek and Yilmaz (2011, 2022) for a literature review.

[8] The RED employed by this study includes Allway Garden, Amoy Garden, Belvedere Garden, Chi Fu Fa Yuen, City Garden, City One Shatin, Fanling Centre, Heng Fa Chuen, Kingswood Villas, Kornhill, Laguna City, Lei King Wan, Luk Yeung Sun Chuen, Mei Foo Sun Chuen, Miami Beach Towers, Nan Fung Sun Chuen, Pokfulam Garden, Riviera Garden, Sceneway Garden, Serenity Park, South Horizons, Sun Tuen Mun Centre, Taikoo Shing, Tai Hing Garden, Tai Po Center, Tak Bo Garden, Telford Garden, Tsuen King Garden, Tsuen Wan Center, Tuen Mun Town Plaza, Uptown Plaza, and Whampoa Garden. Altogether, these estates take a share of 14.2% of the total housing stock in Hong Kong. This list is also comparable to previous studies. In our sample, the number of transactions is comparable to the number of transactions. From 1993Q1 to 2017Q2, there are 2,827 TFU transactions and 302,191 non-TFU transactions.

[9] An alternative approach is to include ordinary units and TFU in the same hedonic regression and add a TFU dummy to capture the TFP. While it is convenient, such an approach presumes that the pricing of ordinary units and TFU is the same, except that TFU are located at the top. Our approach implicitly allows

$$TFP = \frac{Actual\ transacted\ price\ of\ TFU - Predicted\ price\ of\ corresponding\ ordinary\ housing\ unit}{Actual\ transacted\ price\ of\ TFU}$$

The numerator attempts to capture the premium of owning an accessible roof, and TFP is expressed in percentages for comparison across periods. If TFUs behave like ordinary units, then TFP should be on average zero.

To obtain the "predicted price of corresponding ordinary units," we estimate a hedonic pricing model for ordinary units in *each quarter* to avoid time aggregation bias.

$$\ln(price_t) = X\beta_t + u_t, u_t \sim N\left(0, (\sigma_t)^2\right). \quad (1)$$

The hedonic pricing model is standard. The functional form follows Malpezzi (2003).[10] The list of variables X follows Leung et al. (2014), including the structural, locational, and neighborhood attributes as independent variables.[11] Specifically, we expect the coefficients of floor level (*floor*), gross area (*grossarea*), swimming pool (*swp*), and estate scale (*scale*) to be positive and statistically significant structural attributes. Regarding the locational attributes, *hk* and *kln* are dummies for the estates in Hong Kong Island and Kowloon, respectively, and their coefficients are expected to be positive. Distance to the central business district (*cbd*) hurts housing prices; hence, the corresponding coefficient is expected to be negative. If the unit is farther away from a mass transit station (*mtr*) and community facilities (*market, hospital, and library*), its house price will be negatively affected. We also include dummy variables for the major developers.[12] Table 1 provides a summary of statistics.

[Table 1, Figures 3 are about here]

for differential pricing mechanisms for ordinary units and TFU. Also, the number of TFU is disproportionally smaller than the ordinary units. The hedonic estimates would hence be dominated by the ordinary units. Our current approach mitigates some of these issues.

[10] See also Leung (2023) for a discussion.

[11] The transaction records come from the EPRC. In addition, many other variables are collected based on an extensive internet search.

[12] They include Sun Hung Kai (*shk*), Henderson Land (*hen*), Cheung Kong (*ck*), New World Development (*nwd*), and Sino Land (*sino*). See Leung et al. (2020a) for details.

An important deviation from the literature is the hedonic equation being *estimated independently in each quarter* t, allowing the coefficient of the attributes β_t, often interpreted as the "implicit prices of attributes," to be *time-varying*. It captures the idea that, as an international financial center, Hong Kong experiences significant fluctuations in the real economy and financial markets, and the valuation of housing and its attributes could change over time (Chang et al., 2013; Kwan et al., 2015, Sin, 2015).[13] Hence, our approach offers an *alternative* to the conventional method, which typically assumes that the implicit prices of attributes (β) remain constant over time and includes time-fixed effects,

$$\ln(price) = X\beta + (time\ fixed - effects) + u, u \sim N\left(0, (\sigma)^2\right). \qquad (2)$$

Comparing (1) and (2), the conventional method effectively assumes that for all period t,

1. $\beta_t = \beta$.
2. $(\sigma_t)^2 = (\sigma)^2$.

The appendix shows that both hypotheses are *rejected*, justifying our time-varying regression approach.

Another concern is whether we include too many variables to "over-fit" the hedonic model. To ease such a concern, we employ LASSO to check whether these variables are "essential" in *each* period. Table 1b shows that our variables are *essential* most of the time if not all. Hence, we can confidently employ this hedonic model.

Figure 3b demonstrates that our hedonic pricing model consistently achieves a high adjusted R^2 value, indicating a strong fit of the model. Consequently, utilizing the estimated hedonic models, we are able to predict the prices of standard housing units and calculate the top floor premium (TFP) for all 2,827 TFU transactions.[14] The quarterly TFP is then determined using a simple average method. As depicted in Figure 3c, the TFP exhibits fluctuations ranging from 5% to 15% throughout the sampling period. Despite the

[13] After we circulate the initial version of this paper, we become aware of Zabel (2015), which also highlights the time-varying feature of the hedonic pricing model with the U.S. data. The research focus of that paper and this paper are very different.
[14] Details will be available upon request.

significant challenges such as the Asian Financial Crisis (AFC), the SARS epidemic, and the Global Financial Crisis (GFC), the affluent home buyers in Hong Kong remained willing to pay a relatively stable premium for housing units with an accessible roof.

We now explore the relationships between the TFU market and the macroeconomy. Motivated by the literature, our analysis includes the real housing price index for the mass market (*RHP*), real GDP (*RGDP*), real Hang Seng Index (*RHS*), international trade volume in real terms (*RTRADE*), term spread (*TERM*), and ted spread (*TED*) as macroeconomic variables (Table 2a).[15] In the first step, we conduct the Augmented Dickey-Fuller Test to assess the stationarity of the series. Table 2b reveals that all variables require first differencing to achieve stationarity, except for *TFP* and *TERM*.

In the second step, we employ a vector autoregressive (VAR) model for these seven variables. The Akaike Information Criterion (AIC) selects a lag length of 4, resulting in the estimation of 203 parameters, which are too complex to present comprehensively.[16] Our VAR model allows us to perform variance decomposition, which measures the proportion of forecast error variance for each variable attributed to innovations in other variables (Lutkepohl, 2007). Given the importance of variable ordering in Cholesky's decomposition, we adopt two orderings. In order I, the variables are arranged according to the descending order of exogeneity: *TERM*, *ΔTED*, *ΔRTRADE*, *ΔRGDP*, *ΔRHS*, *ΔRHP*, *TFP*. For robustness checks, it takes the opposite to obtain order II. Table 2c shows that the shock to the *TFP* accounts for around 80% of its variation, suggesting that the demand structure for TFU, designed for higher-income people and signaling "social status," may differ from that of the ordinary units. As a result, the standard macroeconomic variable may not sufficiently capture the variations observed in the TFU market.

[Tables 2 are about here]

Table 2d presents the findings of the Granger Causality test, which examines the long-run relationship between the housing market and the macroeconomy. Here are the notable results. First, unidirectional causality exists from *ΔTED* to *TFP* at a 5% significance level. An increase in *ΔTED* indicates a rise in credit risk in the United States,

[15] Among others, see Chang et al. (2013), Leung (2004), Leung et al. (2006), and Leung and Ng (2019).
[16] Details are available upon request.

which negatively impacts the credit market in Hong Kong. Consequently, the demand for TFU decreases, leading to a decline in *TFP*. Second, unidirectional causality runs from *ΔRHP* to *TFP* at a 5% significance level. The mass housing market, being more extensive than the TFU market, contains valuable information. An increase in *ΔRHP* signifies improving housing returns, resulting in an increase in *TFP*. Third, *ΔRHP* and the macroeconomy (*ΔRGDP, ΔRTRADE*) exhibit *bi-directional causality*. Shocks to the macroeconomy affect the housing market and vice versa. Hong Kong, being a small open economy, sees international trade and GDP improvements impacting the demand for mass housing. Additionally, a decrease in house prices affects borrowing capacity, leading to decreased consumption and investment (Chen and Leung, 2008; Kiyotaki and Moore, 1997).

Exploring the short-run relationship between the TFU market segment and the rest of the economy, we introduce turnover rates for top floor units (*TO_TOP*) and non-top floor units (*TO_NON_TOP*) as a measure of market liquidity.[17] Figure 4 shows that both turnover rates peaked at 6% in 1997Q2 but declined after the AFC. Examining the effect of turnover rates on price growth in the mass housing market, we employ an augmented VAR model that considers the interactions between TFP, house price growth, turnover rates, and macroeconomic variables, along with time dummies for different sub-periods.[18]

Table 3 presents the results, revealing interesting insights. First, previous period TFP influences the growth rate of city-level house prices, even after controlling other variables. Second, the growth rate of city-level house prices and housing market turnover rate have limited impact on the TFU market, while the volume of international trade influences the turnover rate of the TFU market but not the general housing market. Third, time dummies significantly impact the turnover rate of ordinary units but have no significant effect on TFP or the TFU turnover rate.

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[17] According to the Augmented Dickey-Fuller test, the two series of turnover rates are stationary at levels. Details are available upon request. See Akkoyun et al. (2013), Chen and Leung (2008), Ortalo-Magné and Rady (2006), Stein (1995), among others for more discussion on the housing market turnover.

[18] The augmented VAR setting allows the TFP, the growth rate of the city-level house price, the turnover rates of the TFU, and ordinary units to freely interact with one another while considering the movements of the macroeconomic variables. Moreover, the time dummies for different sub-periods address the concerns that the housing market may behave differently after financial crises.

These findings suggest that *TFU, despite being located within the same buildings as ordinary units*, *behave as if they constitute a distinct sub-market and different from the general housing market*. Given the unique correlation of TFU with the economy, the following section explores whether they provide additional hedging benefits in a portfolio.

[Figure 4 and Table 3 are about here]

3. Profitability for individual investors

This section delves into TFU investment from a household perspective, comparing TFU profitability with non-TFU transactions.[19] More specifically, we envision a household that chooses between a TFU and an ordinary unit, comparing the different profitability. Like other investments, housing market participation is an endogenous choice and is likely to be influenced by factors that econometricians might not fully capture. Therefore, we adopt the matching estimator approach (Huang et al., 2018). More specifically, we consider a TFU bought in period t_1 at the real price p_1 and is resold in period t_2 at the real price p_2. Hence, the real rate of return of trading TFU is given by $r_A = \frac{p_2 - p_1}{p_1}$. We then compute the corresponding return if the household invested in ordinary units instead.[20] To make such a comparison, we construct a "match" by collecting all non-TFU records that involve the *same* buying time t_1 and selling time t_2, and compute their rates of return. μ_A represents the average real rate of return in the non-TFU market. We then repeat this exercise for every TFU transaction in our sample. A comparison between r_A and μ_A highlight the performance differences between the ordinary units and TFU.

As the asset returns could vary with the economic fundamentals and credit market conditions (Chen and Leung, 2008; Longstaff and Wang, 2012), we divide the whole sample into three sub-samples to mitigate such credit market effects. The first sub-sample

[19] In the appendix, we show that including TFU and ordinary housing units in a portfolio is not advisable once liquidity factors are considered, making this recommendation more pertinent for institutional investors rather than ordinary households.
[20] Our approach solely compares the monetary returns from repeated sales, which is an imperfect measure. We lack a direct measure of the consumption benefits of TFU or ordinary units. Additionally, if the units are rented out, the corresponding rents are not included in the government dataset. Similarly, maintenance cost information is not available. We can only acknowledge our limitation and proceed nevertheless.

is 1993Q1 – 1997Q4, between the beginning of our sample and the Asian Financial Crisis (AFC), where credit was relatively "easy." The second sub-sample is 1998Q1 – 2008Q2, where Hong Kong experienced an AFC-driven downturn and a recovery until the Global Financial Crisis (GFC) hit. The third sub-sample is 2008Q3-2017Q2, the recovery period after the GFC.[21]

Here are the results. Table 4a outlines comparable returns between TFU and ordinary housing units, while Figure 5 visually represents their distributions. Stochastic dominance tests summarized in Table 4b reveal that TFU is not distinguishable from ordinary units in terms of mean returns (first-order stochastic dominance, FOSD). However, in the first sub-sample, TFU is riskier and dominated by ordinary units (second-order stochastic dominance, SOSD), suggesting TFU is *not* inherently "better" as an investment compared to ordinary units.

[Figure 5 and Table 4 are about here]

4. Speculation and holding period

We have examined TFU investment from both institutional and individual investor perspectives. Now, we shift our focus to speculation and holding periods, particularly relevant in markets like Hong Kong, where speculation may heavily influence housing prices, especially for prestigious properties like TFUs. [22]

Unfortunately, it is empirically challenging to identify who the speculators are. Theory on speculation provides little guidance too. Therefore, we address the speculation issue with different approaches. To begin, we define speculative trades as housing units resold within 24 months, a definition used by Fu et al. (2016) and the Hong Kong government for policy measures. Figure 6 illustrates the percentage of housing units resold within two years ("speculative trade") and ten years ("normal trade"), revealing similar speculative trends in TFU and ordinary units. However, TFU sales percentages exhibit greater volatility due to the segment's smaller size.

[21] Among others, see Kwan et al. (2015), Leung et al. (2020b) for more details.
[22] Tang (2019) shows that even parking lots are speculated in Hong Kong.

[Figure 6 and Table 5 about here]

While the 24-month definition is common, it may need validation in Hong Kong's secondary market.[23] Hence, we investigate the connection between holding periods and annualized returns for TFU and ordinary units over various sub-periods. The appendix contains several scatter plots for reference. Table 5a presents the correlations between holding periods and real annualized returns for TFU and ordinary units. Notably, while none of the annualized returns for TFU surpasses 80% in our dataset, the returns for ordinary units can exceed several hundred percent. This significant difference suggests that if the extraordinary returns are due to speculation, ordinary units may be more prone to speculative trading.

Both ordinary units and TFU display negative correlations between holding periods and returns. Intuitively, with the potential entry of speculators, shorter holding periods would be associated with higher annualized returns in equilibrium (Leung and Tse, 2017). In addition, ordinary units display more negative correlations between the holding period and annualized return during the first and second subperiod. Thus, if relatively short holding periods and more significant annualized returns are "signs" of “speculative trades,” then ordinary units may be more susceptible to speculative trades than TFU. The idea is simple. Some speculators could have liquidity concerns. Since ordinary units are, on average cheaper, the market for ordinary units is more liquid and hence preferred. However, the situation is reversed in the third subperiod (2008Q3 – 2017Q2). The correlation in the TFU segment is -0.57, while the counterpart in ordinary units is only -0.41.

Since we observe trades that carry several hundred percentage points in annualized returns, one may worry that a small number of outliers drives the results above. To mitigate the possible impact of extreme values, Table 5a also reports the results for the “winsorized sample”: we remove the top 1% and the bottom 1% of the return distribution for both ordinary units and TFU, re-calculate the correlations, and find that the qualitative results

[23] Fu et al. (2016) focuses on the pre-sale market in Singapore, where housing units are not completed. It is arguably different from the secondary housing market, which is the focus of this paper.

are preserved. Also, the correlations for TFU usually change little, while the correlations for ordinary units become *more negative*. In other words, *there may be fewer extreme transactions in the market segment of TFU than in ordinary units*. Perhaps more important, the gap in the holding period-return correlations for TFU and ordinary units in the first two subperiods maintain substantial.[24]

The current empirical findings are consistent with the idea that *speculator involvement is endogenous and subject to fluctuations over time* (Leung and Tse, 2017). Recognizing this endogeneity, our study will delve into the interconnected dynamics of prices and trading volumes across various housing markets. This approach holds at least two significant advantages. First, since the housing turnover seems to depend on some infrequent events, such as the Asian Financial Crisis, we adopt the Markov Switching model (RSM) to capture their regime *shifts in both mean and variance.*[25] Second, we do not restrict *when* the regime switch should occur. Our econometric procedures allow the trading pattern for various units (TFU or ordinary units) and holding periods (not more than two years or ten years) to be completely different. Here we report the results from a simple RSM, while the results from a more elaborated RSM are presented in the appendix. The following equation formalizes that we consider may have different means and variances under different regimes.

$$X_t = \begin{Bmatrix} \mu_1 + u_1, u_1 \sim N(0, (\sigma_1)^2) & regime\ 1 \\ \mu_2 + u_2, u_2 \sim N(0, (\sigma_2)^2) & regime\ 2 \end{Bmatrix}$$

In the current context, our variable of interest X_t is the percentage of resale given the purchase date $t,$ as a measure of the housing market liquidity. As a rule, regime 1 is the period with a higher mean ("more liquid"), and regime 2 is the period with a lower mean ("less liquid"). Table 5b summarizes the results, and in the appendix, we provide a visualization. Whether the holding period is no more than two years or ten years, and whether it is TFU or ordinary units, the means are always significantly different from zero

[24] The gap in the third subperiod (2008Q3 – 2017Q2) is much smaller in the winsorized sample (-0.60 versus -0.54). Figure 7b~7g provides the holding period's scatter plots and annualized returns for TFU and ordinary units in different subperiods. Again, a few outliers do not drive the negative correlations between holding periods and annualized returns.

[25] Among others, see Chang et al. (2011), Hamilton (1994).

and different from each other. In other words, depending on the purchase date, the proportion of resale differs. Except for the TFU with less than ten years of holding, even the volatility would vary. The "random" factor in resale also differs under some regimes.

Table 5c also reports the estimated smoothed probabilities under different regimes for different housing units. A few observations are immediate. First, for a given category of housing unit holding, p_{11} is always larger than p_{22}, meaning that the more liquid regime is more persistent than the less liquid one. Second, for the speculation category (i.e., holding period no more than 24 months), the persistence of TFU and ordinary units are similar in both regimes (0.97 versus 0.98 in p_{11}). The periods identified as regime 1 for TFU and ordinary units are almost identical. In other words, if 24 months is a good proxy for the holding period of speculators, then the liquidity of the TFU and ordinary segments are similar from the speculators' perspective.

On the other hand, when the holding period is extended to no more than ten years, we find that the probability of staying in the more liquid regime, p_{11}, is significantly lower for TFU (about 0.91). But the same probability for ordinary units with not more than a ten-year holding period is 0.98, almost identical to the case with not more than a 2-year holding period. Similarly, for no more than a 10-year holding period, the probability of staying in the less liquid regime, p_{22}, is 0.85 for TFU, which is lower than ordinary units (about 0.90). It means that for a more extended holding period, the liquidity of the TFU market is significantly less "stable" than the ordinary market, effectively incurring more risk on investors. In sum, while both TFU and ordinary units exhibit speculative tendencies, TFU market liquidity appears less stable over longer holding periods, potentially increasing investor risk.

5. Robustness check

The section addresses some key concerns regarding the dataset: the inclusion of primary market transactions and distressed sales. Primary market transactions, dominated by real estate developers, may involve price-setting power (Leung et al., 2020a, b), while distressed sales during financial crises could distort market prices (Campbell et al., 2011; Guren and McQuade, 2020).

To assess these concerns, we calculate the fractions of primary market transactions and distressed sales, finding them to be small in both TFU and ordinary units (Table 6). We then conduct robustness checks by excluding all primary market transactions and distressed sales from the dataset. Appendix B reports the results without primary market transactions, while Appendix C presents the findings without distressed sales. Despite these exclusions, our statistical analyses, spanning from 1996 onwards, consistently validate our empirical results. [26]

[Table 6 about here]

Furthermore, we have attempted to construct *alternative* TFPs based on the housing units on the top 10%, top 20% floors of the building. Their behaviors are significantly different from the TFP based on TFUs. This serves as suggestive evidence that TFUs are indeed distinct from other units, even if they are only a few floors below the TFUs. Further details can be found in Appendix D.

6. Concluding remarks

Geographically, Hong Kong's low seismic risk and high population density necessitate high-rise buildings as the primary housing option.[27] With this context in mind, this paper contends that top-floor units (TFU), referring to units situated on the highest floor of high-rise residential buildings, do not provide superior investment advantages.[28]

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[26] The only exception for the first robustness check is that the smoothed probabilities for selling non-TFU within ten years are different. In particular, Figure B13 shows a different regime 2, from 2003Q4 to 2005Q4. The "Application List System" adoption in 2004 is an institutional change. Under this system, the Hong Kong government will put some vacant land on a "list." A developer interested in those sites may apply to the government with a pre-committed price. That piece of land will go for auction. If the price from the auction is below the pre-committed price, the developer will purchase the land from the government at the pre-committed price. However, the land would go to the highest bidder if the auction price exceeds the pre-committed price. This new mechanism requires the developer to bear more risk. Our regime-switching model confirms our conjecture that the SARS epidemic 2003 imposed a regime change in the home-buying behavior of non-TFU. Details will be available upon request.
For the second robustness check, the period of regime 2 for "longer-term holding" in ordinary units (resale within ten years) is changed slightly to 1997Q4-2000Q2. Figure C12 suggests a more frequent shift in regimes.

[27] Hong Kong hosts seven million population, comparable to the whole state of Massachusetts, with a size of less than 10% of New York City. The boundary is fixed by historical document.

[28] As mentioned previously, there may be unobservable "structural differences" between TFUs and ordinary units, such as higher ceilings or larger windows. However, our findings indicate that the investment

Empirical findings reveal several key points. First, while the top floor premium (TFP) remains positive throughout the sampling period, its variation over time and distinct co-movements with macroeconomic variables suggest additional value for consumption and investment in TFU. Second, TFU are minimally impacted by the general housing market but exert influence on general house price growth. However, once its liquidity is taken into considerations, TFU should be excluded from optimal portfolios as they do not yield higher returns or lower risk compared to ordinary units. Third, while both TFU and ordinary units exhibit negative correlations between holding periods and returns, the significance is numerically higher in the ordinary unit segment, suggesting greater speculation activity. Fourthly, regime-switching in resale percentages indicates TFU segment liquidity instability, potentially attracting more speculators to the ordinary unit segment. In sum, top floor units as status goods are traded with a premium over the ordinary units because of the additional conspicuous consumption value and not any investment benefits.

Future research can be extended in several ways. First, Hong Kong is one of many geographically constrained cities (Saiz, 2010); understanding how the natural constraint and the rise of high-rise buildings would impact business planning and policy design. Therefore, future research should compare TFU across cities with varying regulations and geographies, examining household self-selection into TFU markets, and analyzing the impact of global shocks like COVID-19 on TFU interactions and optimal portfolios. These endeavors can deepen understanding of TFU dynamics and inform urban planning and policy design.[29]

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performance of TFUs is not significantly better than that of ordinary units, suggesting that any potential structural differences do not enhance investment performance.

[29] The city planning literature has discussed "vertical city" extensively (Harris, 2015). Apparently, that literature did not make any attempt to estimate of the top floor premium, and its relationship with other economic variables.

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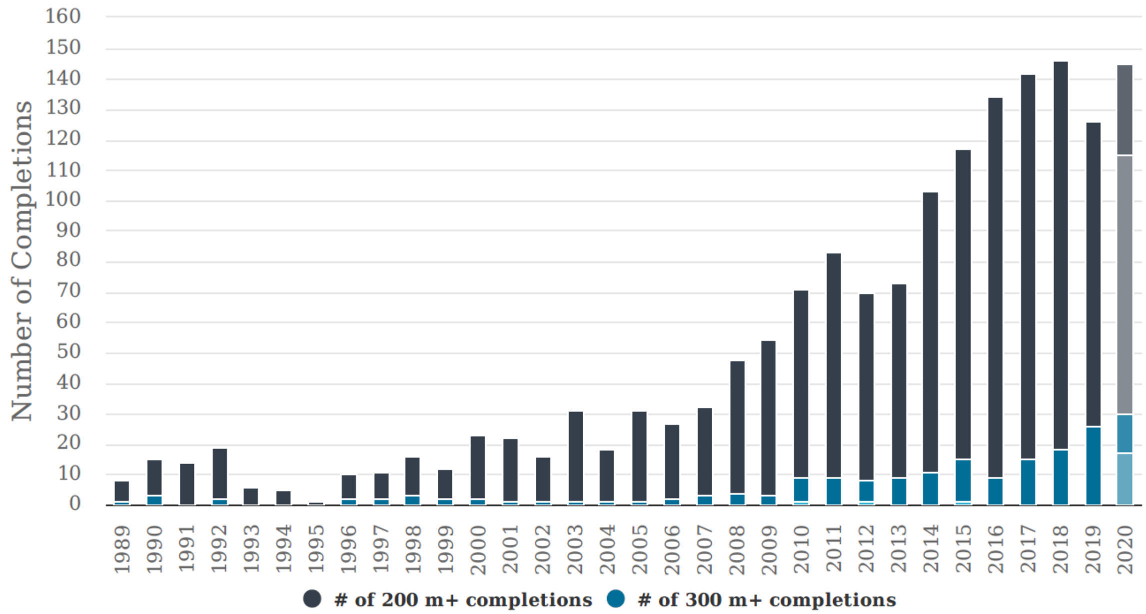
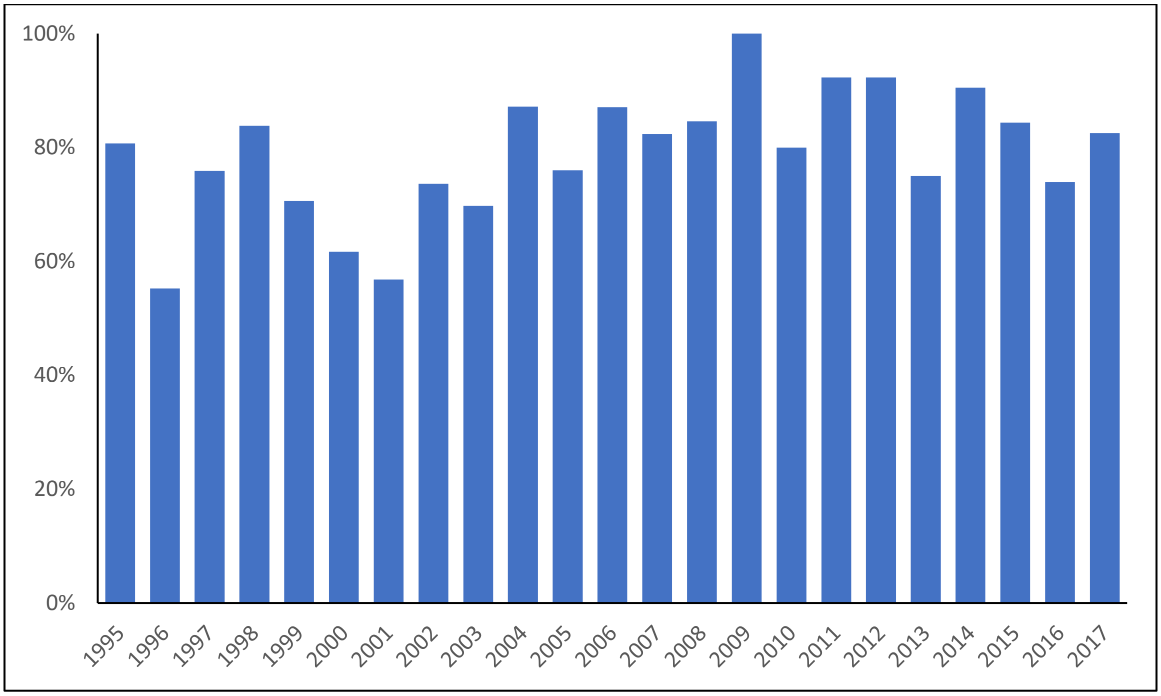
Figures and Tables

Figure 1. Completions of high-rise buildings (200 meters or more, 300 meters or more)



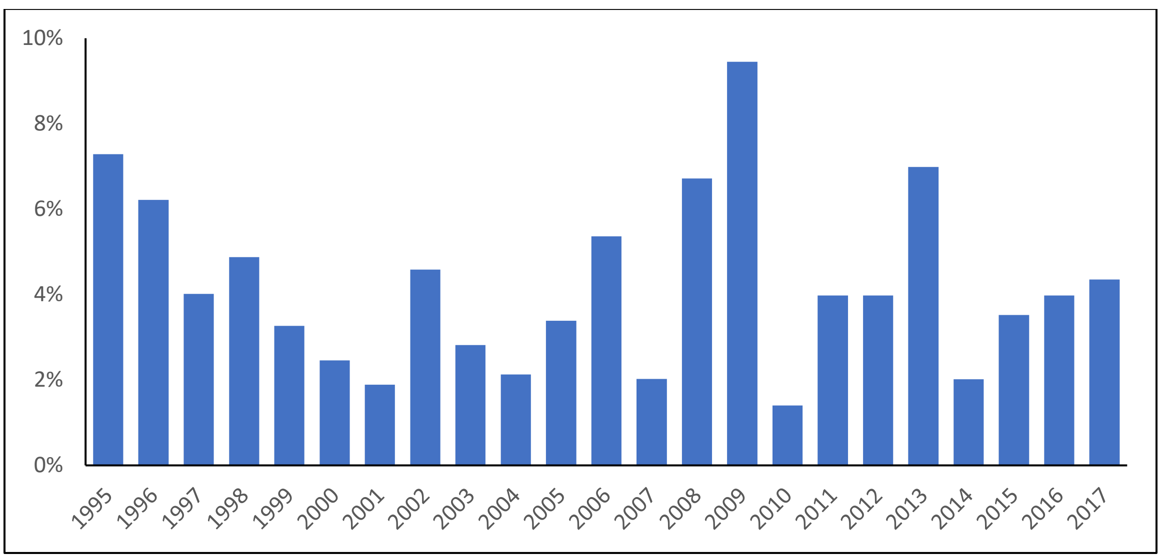
Source: Council on Tall Buildings and Urban Habitat (CTBUH). Permission to reproduced here.

Figure 2a. Percentage of completed estates having top-floor units



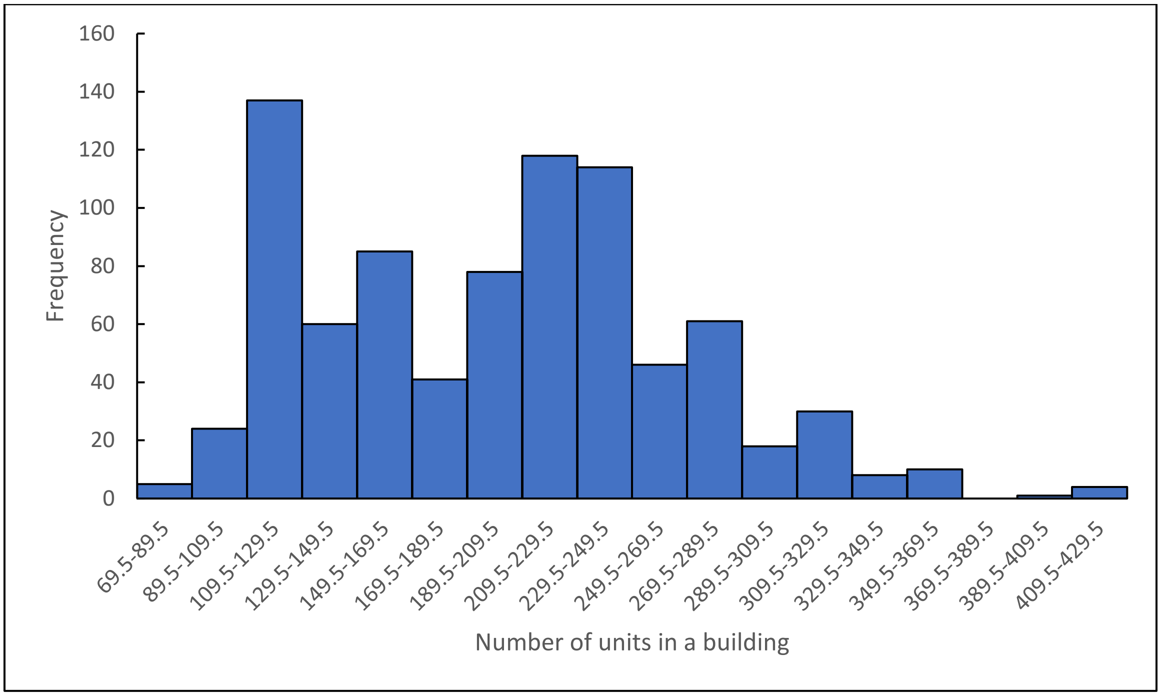
Source: Authors' calculations

Figure 2b. Ratio of completed top-floor units to the total completed housing units



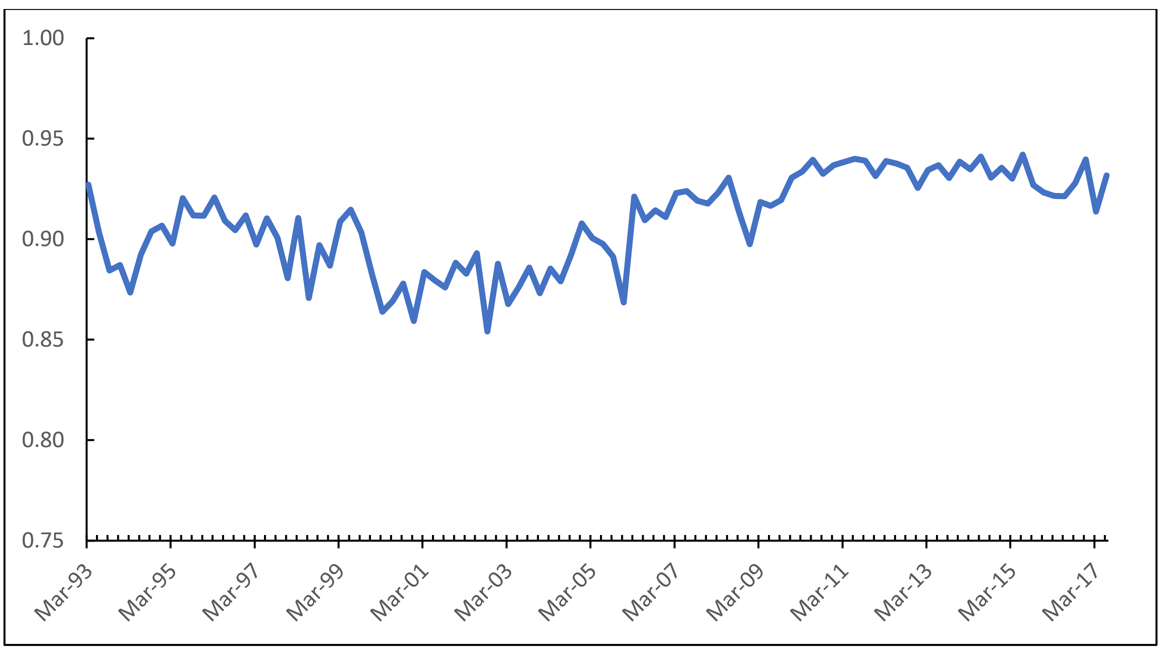
Source: Authors' calculations

Figure 3a. Distributions of housing units in each residential building



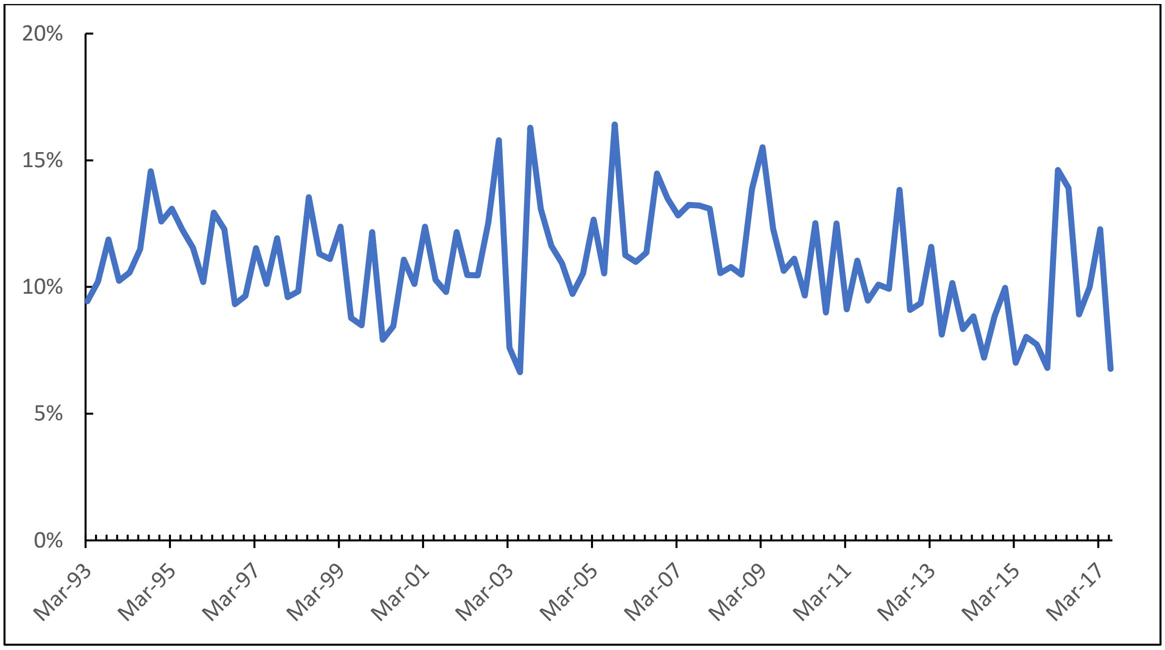
Source: Authors' calculations

Figure 3b. Adjusted R-square of hedonic regression



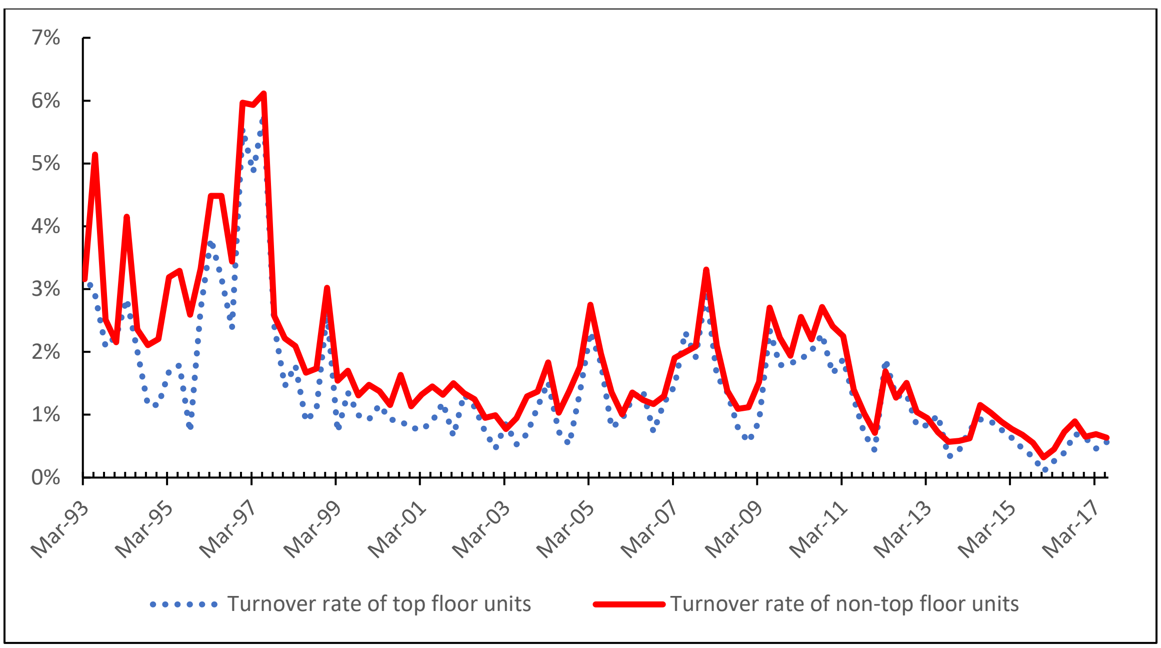
Source: Authors' calculations

Figure 3c. Top Floor Premium



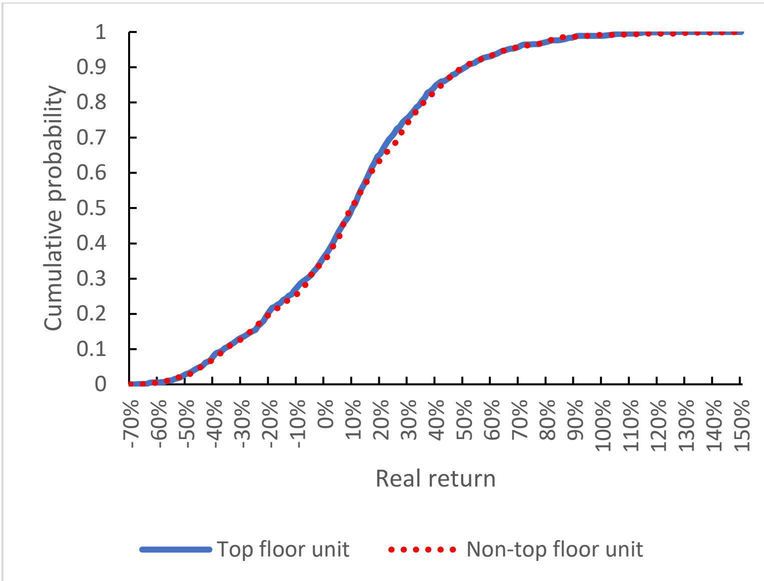
Source: Authors' calculations

Figure 4. Turnover rate of top floor units and non-top floor units



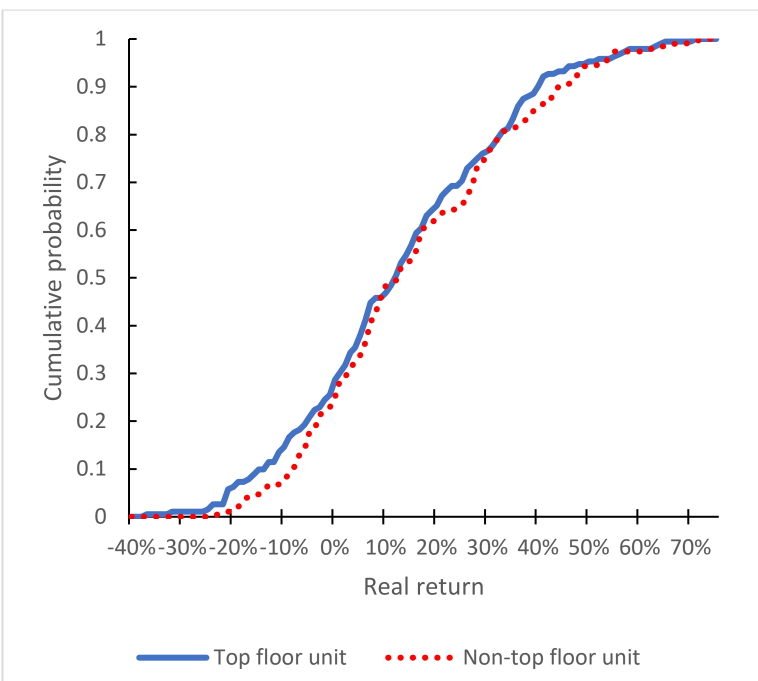
Source: Authors' calculations

Figure 5a. Cumulative Distribution of Real Returns for TPU and Ordinary Housing Units (Full Sample, 1993Q1 – 2017Q2)



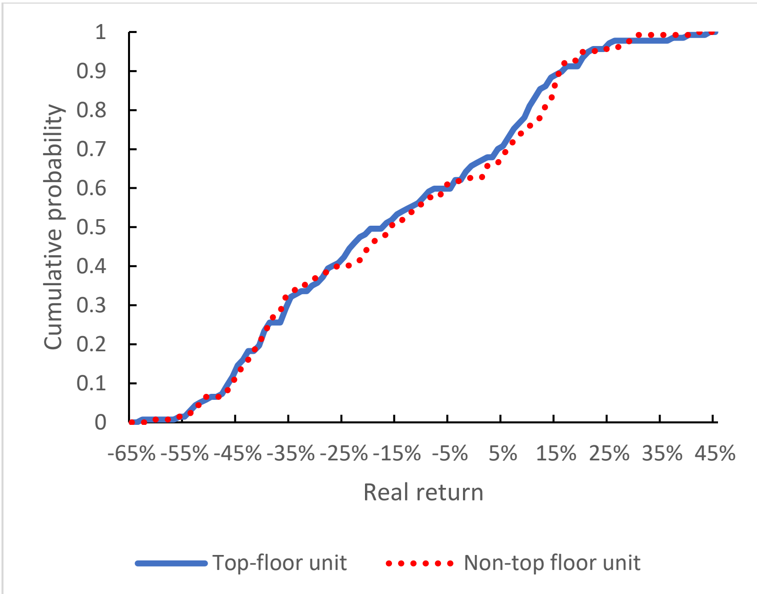
Source: Authors' calculations

Figure 5b. Cumulative Distribution of Real Returns for TPU and Ordinary Housing Units (First Sub-sample, 1993Q1 – 1997Q4)



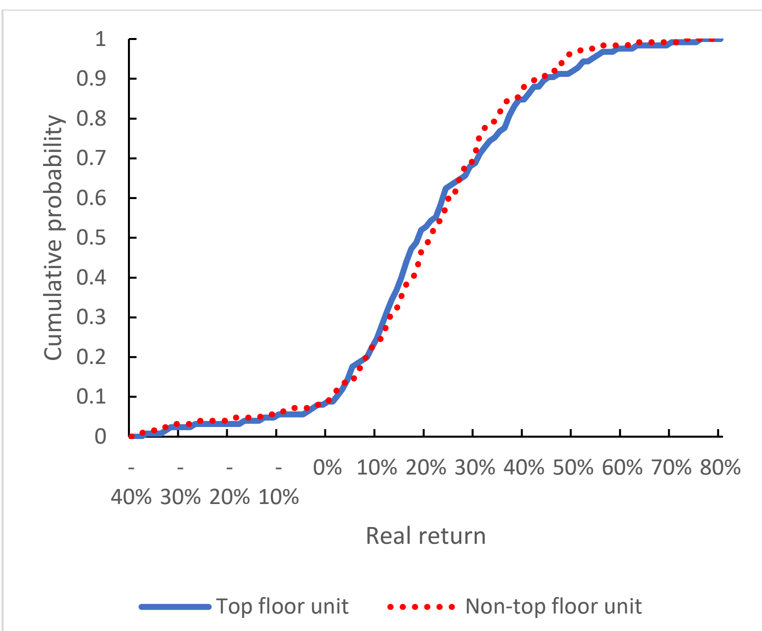
Source: Authors' calculations

Figure 5c. Cumulative Distribution of Real Returns for TPU and Ordinary Housing Units (Second Sub-sample, 1998Q1 – 2008Q2)



Source: Authors' calculations

Figure 5d. Cumulative Distribution of Real Returns for TPU and Ordinary Housing Units (Third Sub-sample, 2008Q3 – 2017Q2)



Source: Authors' calculations

Figure 6. Percentage of housing units that are resold within 2 years and 10 years

Source: Authors' calculations

Table 1a. Summary statistics of variables in hedonic pricing model

Variable	Definition	Mean	Std.Dev.	Min	Max
ln(price)	Natural logarithm of transacted housing price	14.72	0.55	12.30	17.53
floor	Floor level of housing unit	15.25	9.19	1.00	45.00
grossarea	Gross area of housing unit (square feet)	662.23	174.92	311.00	1773.00
swp	Equals 1 if the estate has a swimming pool, 0 otherwise.	0.77	0.42	0.00	1.00
scale	Number of housing units in the estate	8,122.81	4,616.25	1,120.00	15,880.00
hk	Equals 1 if the estate locates at Hong Kong Island, 0 otherwise.	0.25	0.43	0.00	1.00
kln	Equals 1 if the estate locates at Kowloon, 0 otherwise.	0.27	0.44	0.00	1.00
cbd	Distance to central business district (kilometers)	18.24	11.03	5.80	39.30
mtr	Distance to the nearest subway station (kilometers)	1.00	0.86	0.08	4.90
market	Distance to mass transit station (kilometers)	1.32	0.73	0.17	2.80
hospital	Distance to public district general hospital (kilometers)	3.56	2.30	0.50	10.20
library	Distance to the public library (kilometers)	1.12	0.48	0.17	2.20
shk	Equals 1 if the estate is developed by Sun Hung Kai, 0 otherwise.	0.18	0.38	0.00	1.00
hen	Equals 1 if the estate is developed by Henderson Land, 0 otherwise.	0.11	0.31	0.00	1.00
ck	Equals 1 if the estate is developed by Cheung Kong, 0 otherwise.	0.38	0.49	0.00	1.00
nwd	Equals 1 if the estate is developed by New World Development, 0 otherwise.	0.23	0.42	0.00	1.00
sino	Equals 1 if the estate is developed by Sino, 0 otherwise.	0.04	0.21	0.00	1.00

Table 1b. The explanatory variables are essential, verified by LASSO

		Proportion of times selected by LASSO	Proportion of times selected by square-root LASSO
Structural attributes	floor	100.00%	100.00%
	grossarea	100.00%	100.00%
	swp	100.00%	100.00%
	scale	100.00%	100.00%
Locational attributes	hk	100.00%	100.00%
	kln	100.00%	100.00%
	cbd	100.00%	100.00%
	mtr	100.00%	100.00%
	market	94.90%	95.92%
	hospital	100.00%	100.00%
	library	93.88%	93.88%
Developer dummies	shk	94.90%	96.94%
	hen	93.88%	93.88%
	ck	97.96%	97.96%
	nwd	100.00%	100.00%
	sino	100.00%	100.00%

Table 2a. List of variables in time series analysis

Sampling period: 1993Q1 – 2017Q2

Variable	Definition	Source
TFP	Top floor premium	Author's calculation
RHP	Real housing price (constant quality[30])	Author's calculation
RGDP	Real gross domestic product	Census and Statistics Department
RHS	Real Hang Seng Index	Hong Kong Exchanges and Clearing Limited
RTRADE	Real trade volume	Census and Statistics Department
TERM	10 year – 3 month Treasury yield spread	U.S. Federal Reserve
TED	3 month LIBOR – 3 month Treasury yield spread	U.S. Federal Reserve

Table 2b. Unit root test

	Level	First difference
TFP	–3.91 ***	–7.71 ***
RHP	–0.14	–5.63 ***
RGDP	–0.12	–4.50 ***
RHS	–2.44	–9.51 ***
RTRADE	–0.88	–3.45 **
TERM	–3.41 **	–7.79 ***
TED	–2.61	–10.19 ***

Note: The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters. *** and ** denotes 1% and 5% statistical significance respectively.

[30] See Appendix A for details.

Table 2c. Variance decomposition for TFP

Quarters ahead	Explained by innovations in													
	TERM		ΔTED		ΔRTRADE		ΔRGDP		ΔRHS		ΔRHP		TFP	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	4.00	0.00	0.22	0.00	0.91	0.00	0.02	0.00	0.49	0.00	0.07	0.00	94.28	100.00
2	4.92	1.70	4.67	3.30	0.84	0.00	0.15	1.61	0.45	0.02	0.11	0.15	88.86	93.21
3	4.97	1.81	4.42	3.17	1.22	0.01	1.50	1.59	2.02	2.56	2.07	3.08	83.79	87.77
4	4.76	1.67	4.65	3.98	1.12	0.04	1.78	1.49	2.81	3.57	2.88	3.77	82.00	85.47
5	4.59	1.66	4.72	3.96	1.31	0.08	1.80	1.76	2.91	3.69	2.97	3.76	81.71	85.09
6	4.51	1.71	5.17	4.26	1.38	0.11	2.63	2.33	3.00	4.06	2.93	3.82	80.39	83.70
7	4.47	1.86	5.09	4.20	1.38	0.31	2.85	2.34	2.95	4.00	2.93	3.84	80.33	83.45
8	4.49	1.93	5.14	4.29	1.39	0.32	3.06	2.37	2.97	4.05	3.14	4.13	79.82	82.91

Notes: Order I: TERM, ΔTED, ΔRTRADE, ΔRGDP, ΔRHS, ΔRHP, TFP;

Order II: TFP, ΔRHP, ΔRHS, ΔRGDP, ΔRTRADE, ΔTED, TERM

Table 2d. Granger causality

		TFP	ΔRHP	ΔRHS	ΔRGDP	ΔRTRADE	ΔTED	TERM
TFP								
ΔRHP		**		***		***		
ΔRHS			***					
ΔRGDP	Granger causes		***			***		
ΔRTRADE			***	***			**	
ΔTED		**				***		
TERM								

Notes: The lag is chosen to be one. *** and ** denote 1% and 5% statistical significance respectively.

Table 3. Augmented VAR results

	TFP_t	TO_TOP_t	$\frac{RHP_t}{RHP_{t-1}} - 1$	$TO\_NON\_TOP_t$
TFP_{t-1}	0.15	0.04	0.62 **	0.04
TO_TOP_{t-1}	0.76	0.23	4.19 **	0.23
$\frac{RHP_{t-1}}{RHP_{t-2}} - 1$	–0.08 *	$–2.78*10^{-3}$	0.23 **	–0.02
$TO\_NON\_TOP_{t-1}$	–0.26	0.36	–2.36	0.40 *
$\frac{RGDP_{t-1}}{RGDP_{t-2}} - 1$	–0.01	0.03	–0.18	0.02
$\frac{RTRADE_{t-1}}{RTRADE_{t-2}} - 1$	0.03	–0.03 **	$–5.56*10^{-5}$	–0.02
$TERM_{t-1}$	$2.30*10^{-4}$	$–2.50*10^{-4}$	$6.98*10^{-3}$	$–1.57*10^{-4}$
ΔTED_{t-1}	$6.65*10^{-3}$	$–8.56*10^{-4}$	$–4.67*10^{-3}$	$–7.68*10^{-4}$
Dummy (1993Q1 – 1997Q4)	$3.27*10^{-3}$	$3.44*10^{-3}$	–0.02	$8.82*10^{-3}$ ***
Dummy (1998Q1 – 2008Q2)	$7.22*10^{-3}$	$8.83*10^{-5}$	–0.02	$7.30*10^{-4}$
Constant	0.08 ***	$1.48*10^{-4}$	–0.08 **	$2.02*10^{-3}$
Adjusted R-square	0.07	0.55	0.25	0.65

Note: ***, ** and * denote 1%, 5% and 10% statistical significance respectively.

Table 4a. Overview of profitability analysis

Period	Top-floor transactions	Matched non-top floor transactions	Quadrant				Ratio	$r_A < \mu_A$	$r_A > \mu_A$	Ratio
			I	II	III	IV				
1993Q1 – 1997Q4	219	6,318	144	22	42	11	1 : 0.15 : 0.29 : 0.08	139	80	1.74 : 1
1998Q1 – 2008Q2	469	4,147	153	25	260	31	1 : 0.16 : 1.70 : 0.20	228	241	0.95 : 1
2008Q3 – 2017Q2	423	3,674	370	24	38	11	1 : 0.06 : 0.10 : 0.04	242	181	1.34 : 1

Table 4b. Summary of Stochastic Dominance Tests (First and Second Order)

Full sample (1993Q1 – 2017Q2)	Inconclusive – we cannot differentiate between the distribution of the real returns of non-top floor unit and top floor units, based on whether first order or second order stochastic dominance.
First subsample (1993Q1 – 1997Q4)	Real return of non-top floor unit is second order stochastic dominant over the real return of top floor unit.
Second subsample (1998Q1 – 2008Q2)	Inconclusive – we cannot differentiate between the distribution of the real returns of non-top floor unit and top floor units, based on whether first order or second order stochastic dominance.
Third subsample (2008Q3 – 2017Q2)	Inconclusive – we cannot differentiate between the distribution of the real returns of non-top floor unit and top floor units, based on whether first order or second order stochastic dominance.

Table 5a. Correlations between holding periods and real annualized returns for TFU and Ordinary Units

	Full Sample		Winsorized Sample	
	TFU	Ordinary Units (Non-TFU)	TFU	Ordinary Units (Non-TFU)
1993Q1 – 1997Q4	–0.40 ***	–0.48 ***	–0.47 ***	–0.55 ***
1998Q1 – 2008Q2	–0.21 ***	–0.29 ***	–0.21 ***	–0.34 ***
2008Q3 – 2017Q2	–0.57 ***	–0.41 ***	–0.60 ***	–0.54 ***

*** denotes 1% significance level. In the "winsorized sample," we first sort the transactions according to the annualized real return, and then remove the top 1% and the bottom 1%.

Table 5b. Switching regression results

Holding period	Type	Regime 1		Regime 2		Hypothesis (at 5% level)			
		μ_1	σ_1	μ_2	σ_2	$\mu_1 = 0$	$\mu_2 = 0$	$\mu_1 = \mu_2$	$\sigma_1 = \sigma_2$
2 years	Top floor units	0.14	0.08	0.04	0.04	Rejected	Rejected	Rejected	Rejected
	Non-top floor units	0.19	0.06	0.07	0.02	Rejected	Rejected	Rejected	Rejected
10 years	Top floor units	0.53	0.09	0.42	0.07	Rejected	Rejected	Rejected	Accepted
	Non-top floor units	0.56	0.06	0.42	0.03	Rejected	Rejected	Rejected	Rejected

Table 5c. Transition probability results

Holding period	Type	Regime 1		Regime 2		Period identified as Regime 1
		p_{11}	$1 - p_{11}$	p_{22}	$1 - p_{22}$	
2 years	Top floor units	0.97	0.03	0.93	0.07	1993Q1 – 1997Q2; 2003Q1 – 2007Q3
	Non-top floor units	0.98	0.02	0.94	0.06	1993Q1 – 1997Q2; 2002Q4 – 2007Q3
10 years	Top floor units	0.91	0.09	0.85	0.15	1993Q1 – 1996Q3; 1999Q3 – 2002Q4; 2003Q4 – 2007Q3
	Non-top floor units	0.98	0.02	0.90	0.10	1993Q1 – 1997Q2; 2000Q3 – 2007Q3

Key: p_{11} measures the probability of staying in regime 1 (the regime with a higher mean) given the previous period is already in regime 1, $(1 - p_{11})$ measures the probability of switching from regime 1 to regime 2. Similarly, p_{22} measures the probability of staying in regime 2 (the regime with a lower mean) given the previous period is already in regime 2, $(1 - p_{22})$ measures the probability of switching from regime 2 to regime 1.

Table 6. Distribution of Various types of Transactions (from 1996Q1 onwards)

	Total transactions	Primary market transactions	Distressed transactions
Top floor units	2,403	96 (4.00%)	23 (0.96%)
Non-top floor units	241,761	6,688 (2.77%)	2,402 (0.99%)

Icing on the cake: Can the Top-Floor Units serve as a status good and an investment simultaneously?

Appendix.

This version: September 2024

This appendix has several parts.

Appendix A explains how we compute the constant quality house price, the details about the hedonic regression, and provides additional results, including the efficient frontier and portfolio, scatter plots of holding periods and annualized returns, regime-switching models, etc.

Appendix B presents the results of robustness checks when the primary market transactions are removed.

Appendix C presents the results of robustness checks when the distressed transactions are removed.

Appendix D presents the results of robustness checks when the definitions $(N-1), T10, T20$, are used.

Appendix A.

Literature Review

This section provides a compact review of the relevant literature. First, there are discussions on high-rise buildings. For instance, Malpezzi (2013) argues that a higher degree of urbanization does not necessarily lead to more high-rise buildings. However, it may be the case for many major cities. Rohrmann (2018) observes that "…In 2017 there were more buildings constructed that were greater than 200 metres high than in any other previous year, with a total of 144 completions. This represented the fourth consecutive year of increased high-rise construction, almost doubling the 2013 figure of 74 buildings completed. 2017 was also the most geographically diverse year for tall buildings, with completions spanning 69 cities across 23 countries."

Council on Tall Buildings and Urban Habitat (2019) also remarks that "…The year 2019 was remarkable for the tall building industry, as it saw 26 supertall buildings (300 meters or taller) completed, the most in any year. Overall, 126 buildings of at least 200 meters were completed in 2019, compared to 146 in 2018, a 13.7 percent decline. This is the first year in which the overall completion figure declined since the 2010 to 2011 gap, which was attributed to the lag effect of project cancellations due to the 2008 recession." Recently, studies on high-rise buildings have been blooming—for instance, Ahlfeldt and McMillen (2018) study Chicago's high-rise buildings and land value. Ahlfeldt and Pietrostefani (2019) synthesize the evidence related to density in urban economics.

We also build on the literature on "status-seeking" motives. For instance, Charles et al. (2009) find that while racial minorities and Whites spend approximately the same fraction of their expenditures on visible consumption, Blacks and Hispanics spend about 25% more on visible goods, controlling for differences in permanent incomes. Bertrand and Morse (2016) find that non-rich households consume a larger share of their current income when exposed to higher income (and consumption) at the top. Bricker et al. (2020) find that relatively wealthier households in the neighborhood use more debt and spend more on high-status cars. Bursztyn et al. (2018) conduct a field experiment with an Indonesian bank. They find platinum cards are more likely to be used in social contexts. They also find that increasing self-esteem reduces the demand for status goods. Using a nationwide Dutch survey dataset, Georgarakos et al. (2014) show that households' tendency to have sizable loans increases with a social circle's perceived income. Based on Canadian data, Agarwal et al. (2020) show that with a more significant dollar value of a lottery win, the visible consumption, the value of risky asset investment, and the amount of loans of people in a small neighborhood would increase. Subsequently, the number of bankruptcies in the community also grows. All these contributions confirm the status-seeking motives.

There is related literature in macroeconomics on the "comparison utility" (Carroll et al., 1997; Kwan et al., 2015). However, they tend to focus on aggregate consumption, while this paper concentrates on micro-level housing consumption. This paper differs from consumption's "peer effect" (Maurer and Meier, 2008). First, we may choose our peers, but we may not choose our neighbors in high-rise residential buildings. We may not even know them. Second, the literature usually considers elastically supplied goods, such as automobiles. In contrast, this paper focuses on TFU, which is inelastically supplied locally.

This paper is also related to the literature on the art market. In particular, Mandel (2009, p.1654) worries that the definition of art may vary across people "…reasonable people can disagree on exactly "what is art?," which makes its supply essentially arbitrary." As explained, the TFU is located within the same high-rise buildings as the ordinary units, and there should be no ambiguity. Goetzmann et al. (2011) show that the stock market movement would affect art prices. Renneboog and Spaenjers (2013) construct a price index of paintings and work on paper. They find that the return of that index is comparable to the corporate bond but with higher risk. Korteweg et al. (2016) also find that investing in an extensive portfolio may not generate a handsome return. In this paper, we contrast the return of TFU with ordinary units. We also explore how TFU would contribute to the optimal portfolio.

This paper contributes to the growing literature on vertical gradients, along with studies such as Danton and Himbert (2018), Hwang and Ma (2023), and Liu et al. (2018), which primarily focus on rental housing. In contrast, our study specifically examines for-sale housing in Hong Kong. Hong Kong features a mix of rental and for-sale housing within the same structures (Huang et al., 2018).[31] Additionally, while for-sale housing serves both consumption and investment purposes, rental housing is solely for consumption. Therefore, this paper complements the existing literature.[32]

This paper is also related to the literature on "submarket," which can be defined as a specialized segment within a larger market. This concept can be applied to the national housing market, where each city can be considered a submarket. For example, Malpezzi (2017) identifies three distinct types of cities in the United States that exhibit significantly different housing price trends. Within a single city, there can also be various housing submarkets, as individuals with different socioeconomic backgrounds may gravitate towards certain areas and create distinct housing segments (Kain, 1962, 1968; Mills, 1967; Muth, 1969).[33]

Empirically, Goodman and Thibodeau (1998, 2003) have used school district boundaries and other administrative classifications, such as zip codes and census tracts, to divide a city market into submarkets. Alternatively, Bourassa et al. (1999, 2003) have utilized principal components and cluster analysis to identify submarkets within a city. The above studies demonstrate that the relationship between house prices and housing attributes can vary significantly across different submarkets within a city. Therefore, accurately identifying and understanding these submarkets can greatly enhance the accuracy of house price predictions. Additionally, Gong and Leung (2024) have shown that self-selection of economic agents into different housing submarkets has important implications for the effectiveness of macroprudential policies. Ignoring the impact of submarkets can lead to significantly different welfare outcomes.

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[31] In the United States, the state Florida has over 15,000 condo buildings of which many are high-rises. Some units are owner occupied; others may be let as rentals (usually short-term). We thank Kelley Pace for this insightful observation.

[32] After distributing the initial version of this paper, we discovered the studies conducted by Wong et al. (2011) and Chen et al. (2022). Wong et al. (2011) examines the vertical price gradient *within* a single real estate development in Hong Kong, based on 807 transactions. Chen et al. (2022) focuses on the ground floor premium in Taipei, as some buildings in their sample do not have elevators. Their sample includes approximately 76,000 transactions. In contrast, our research highlights the *top floor premium* across a wider range of over 30 real estate developments, all have elevators, and a longer sampling period, with our sample encompassing approximately 170,000 transactions.

[33] See also Leung (2024) for more discussion.

This paper builds upon the existing submarket literature and explores the dynamic aspects of submarkets. While previous studies have primarily focused on the static nature of submarkets, this paper delves into the relationship between submarkets and. In particular, our research shows that the “TFU submarket” exhibits significantly different patterns in relation to macroeconomic and financial variables compared to ordinary units. Additionally, we present suggestive evidence that speculative behaviors are less prevalent in TFUs than in ordinary units.

Constant-quality housing price

This section outlines how the "constant quality house price" is constructed..

Step 1: Perform hedonic price regression

For each period *t*, *t* =1, 2, …, *I* = 1, 2, …, the hedonic price regression is run:

$$lnp_t = a_{0t} + \sum_{i=1} a_{it}x_{it} + u_t$$

It then collects the "intercept" ($\hat{a}_{0t}$) and "implicit prices of housing attributes" ($\hat{a}_{it}$).

Step 2: Calculate the initial housing bundle

It calculates the average attributes at the initial period, $\overline{x}_{i1}$, *i*= 1 ,2, …

Step 3: Construct constant-quality price

Given the fixed initial housing bundle, it calculates the "constant quality house price index":

$ln\widehat{p_t} = \hat{a}_{0t} + \sum_{i=1} \hat{a}_{it}\overline{x}_{i1}$.

Therefore, $\widehat{p_t} = \exp\left(\hat{a}_{0t} + \sum_{i=1} \hat{a}_{it}\overline{x}_{i1}\right)$.

A2. More details about the Hedonic Regression

Recall that our hedonic equation is as follows (time subscripts are suppressed).

$$\begin{aligned}\text{Ln}(price) = \beta_0 &+ \beta_1\, floor + \beta_2 grossarea + \beta_3\, swp + \beta_4\, scale + \beta_5\, hk + \beta_6 kln + \beta_7\, cbd \\ &+ \beta_8\, mtr + \beta_9\, market + \beta_{10}\, hospital + \beta_{11}\, library + \beta_{12}\, shk + \beta_{13}\, hen \\ &+ \beta_{14}\, ck + \beta_{15} nwd + \beta_{16}\, sino + u\end{aligned}$$

	Minimum	Maximum	Mean	Standard Deviation	Skewness
β_0	12.9096	14.9644	13.8378	0.5203	0.5265
β_1	0.0011	0.0034	0.0023	0.0004	-0.1317
β_2	0.0013	0.0020	0.0017	0.0002	-0.1949
β_3	0.0127	0.1644	0.0702	0.0244	0.6070
β_4	$6.43*10^{-7}$	$1.69*10^{-5}$	$1.01*10^{-5}$	$4.18*10^{-6}$	-0.3364
β_5	0.1872	0.4407	0.3197	0.0530	-0.2775
β_6	-0.0372	0.2485	0.1255	0.0452	-0.3154
β_7	-0.0250	-0.0113	-0.0175	0.0040	-0.1604
β_8	-0.1051	-0.0114	-0.0563	0.0189	0.0634
β_9	-0.0298	0.0671	0.0186	0.0232	-0.0627
β_{10}	-0.0504	-0.0030	-0.0256	0.0111	-0.0664
β_{11}	-0.0683	0.0484	-0.0161	0.0316	0.1445
β_{12}	0.0030	0.1809	0.0643	0.0309	0.3160
β_{13}	-0.1333	0.1451	0.0233	0.0692	-0.0547
β_{14}	-0.1126	0.1087	-0.0097	0.0540	0.1791
β_{15}	-0.1348	-0.0428	-0.0868	0.0187	0.0303
β_{16}	0.0903	0.3084	0.1815	0.0404	0.4124

Then we can do the formal statistical test:

$$Null\ Hypothesis: \beta(t) = \beta, \forall t.$$

In other words, we ask

$$\beta_i(t) = \beta_i, \forall i, t.$$

To reject the null hypothesis, we need to find some i such that $\beta_i(t) \neq \beta_i(t')$, for some $t \neq t'$.

We test a stronger version of that: if we show that $\{\beta_i(t)\}$ as a stochastic process has a unit root, meaning that $\{\beta_i(t)\}$ is, in fact, non-stationary, it follows that $\beta_i(t) \neq \beta_i(t')$, $t \neq t'$. The null hypothesis is that $\{\beta_i(t)\}$ contains a unit root, and "***" means that it is 1% statistically significant.

Even if that $\{\beta_i(t)\}$ does not contain unit root, it may still vary over time. Thus, we also test another version of non-constant $\{\beta_i(t)\}$, which is that $\{\beta_i(t)\}$ follows a regime-switching model,

$$\beta_i(t) = \begin{Bmatrix} \mu_1 + u_1, u_1 \sim N(0, \sigma_1) & prob = q_1 \\ \mu_2 + u_2, u_2 \sim N(0, \sigma_2) & prob = 1 - q_1 \end{Bmatrix}$$

If $\beta_i(t)$ is indeed a constant, and we estimate the regime-switching model above, we should find that $\mu_1 = \mu_2$. Hence, it will be our focus of the test.

Unit root test

	Level	1st difference
β_1	-6.34 ***	-6.82 ***
β_2	-0.67	-11.57 ***
β_3	-4.30 ***	-7.93 ***
β_4	-1.88	-14.52 ***
β_5	-2.88	-7.93 ***
β_6	-1.67	-7.64 ***
β_7	-1.46	-12.43 ***
β_8	-0.94	-11.53 ***
β_9	-1.42	-9.29 ***
β_{10}	-1.45	-6.76 ***
β_{11}	-1.99	-14.87 ***
β_{12}	-3.43 **	-10.12 ***
β_{13}	-1.37	-5.80 ***
β_{14}	-1.20	-7.40 ***
β_{15}	-4.73 ***	-8.75 ***
β_{16}	-5.10 ***	-9.05 ***

*** and ** denote 1% and 5% statistical significance respectively.

Switching model

	Regime 1		Regime 2		Hypothesis (at 5% level)			
	μ_1	σ_1	μ_2	σ_2	$\mu_1 = 0$	$\mu_2 = 0$	$\mu_1 = \mu_2$	$\sigma_1 = \sigma_2$
β_1	0.00290	0.00019	0.00219	0.00036	Rejected	Rejected	Rejected	Rejected
β_2	0.00173	0.00011	0.00144	0.00008	Rejected	Rejected	Rejected	Accepted
β_3	0.10580	0.01982	0.06417	0.01927	Rejected	Rejected	Rejected	Accepted
β_4	0.00001	$2.07*10^{-6}$	$6.04*10^{-6}$	$2.39*10^{-6}$	Rejected	Rejected	Rejected	Accepted
β_5	0.35471	0.03138	0.27091	0.03459	Rejected	Rejected	Rejected	Accepted
β_6	0.14763	0.03237	0.07986	0.03050	Rejected	Rejected	Rejected	Accepted
β_7	-0.01363	0.00142	-0.02053	0.00233	Rejected	Rejected	Rejected	Accepted
β_8	-0.03879	0.00961	-0.07079	0.01015	Rejected	Rejected	Rejected	Accepted
β_9	0.03301	0.01423	-0.00678	0.01012	Rejected	Rejected	Rejected	Rejected
β_{10}	-0.01372	0.00393	-0.03316	0.00644	Rejected	Rejected	Rejected	Rejected
β_{11}	0.01614	0.01389	-0.03878	0.01746	Rejected	Rejected	Rejected	Accepted
β_{12}	0.07821	0.02549	0.03738	0.02058	Rejected	Rejected	Rejected	Accepted
β_{13}	0.09614	0.02426	-0.02614	0.03900	Rejected	Rejected	Rejected	Rejected
β_{14}	0.03628	0.02928	-0.05933	0.01794	Rejected	Rejected	Rejected	Rejected
β_{15}	-0.07897	0.01507	-0.10416	0.01308	Rejected	Rejected	Rejected	Accepted
β_{16}	0.21399	0.03098	0.15472	0.02374	Rejected	Rejected	Rejected	Accepted

Thus, the unit root test and regime-switching model estimation show that $\{\beta_i(t)\}$ are not constant over time; hence, using the time-varying coefficient model may be appropriate.

In addition, recall that we assume $U(t) \sim N(0, \sigma(t)^2 \Omega(\mathrm{t}))$

Thus, the formal test is stated as follows.

$$Null\ Hypothesis: \sigma(t) = \sigma, \Omega(\mathrm{t}) = \Omega, \forall t.$$

We use the data in 1998Q1 (Asian Financial Crisis) and 2008Q3 (Global Financial Crisis) for testing.

Here is the computer printout.

```
. mvtest covariances floor grossarea hk kln swp estate_scale shk hen ckh nwd sino hospital mtr library market cbd, by(tran_year)

Test of equality of covariance matrices across 2 samples

      Modified LR chi2 =  807.5926
 Box F(136,45062548.2) =      5.92      Prob > F =  0.0000
         Box chi2(136) =    804.73   Prob > chi2 =  0.0000
```

Thus, we have shown that both $\{\beta_i(t)\}$ and $\{\sigma(t)\}$ vary over time.

If we assume equation (2), i.e., both β and σ are constant over time, the implied portfolio would be very different.

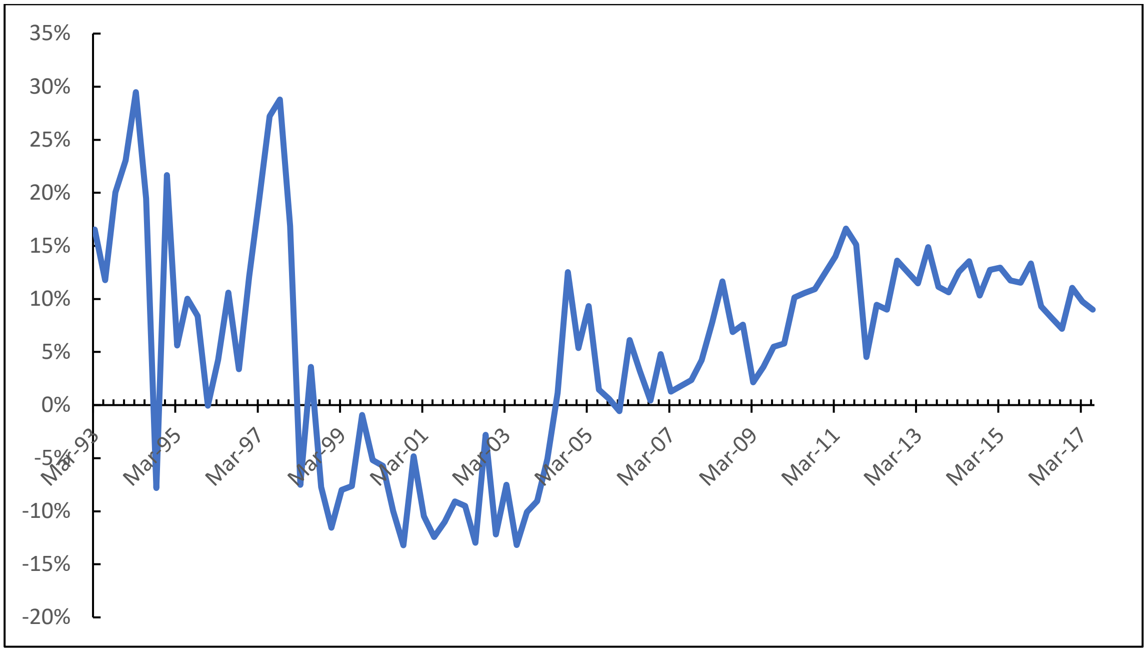
Efficient Frontier

The main text has shown that the price premium and trading activities of TFUs differ from those of the general housing market, particularly in their relationship with macroeconomic variables. This section explores the potential of TFUs as an asset class to improve portfolio performance. There are several motives for this analysis. Firstly, housing is considered both a consumption and investment good, and the demand for TFUs may be influenced by both consumption and investment considerations. It is therefore natural to examine the performance of TFUs as an investment. Additionally, we have noted the similarities between TFUs and art, as both are often associated with consumption and investment demands. Furthermore, real estate agents have suggested to us privately that TFUs can be a lucrative investment opportunity. This section aims to formally investigate the investment potential of TFUs.

Our investigation proceeds in several steps. First, we examine TFU return using a repeated-sales approach, in order to control the unobserved attributes (Bailey et al., 1963; Case and Shiller, 1987). From our sample, we identify 1,111 TFU that have been transacted twice. Hence, for each record, we can apply the formula for computing the annualized return, $\left(\frac{P_t}{P_{t-m}}\right)^{\frac{12}{m}} - 1$, where m is the number of months between trades.

We take a simple average to obtain the annualized return of the TFU market (AR_{TFU}) each quarter. Figure A1 confirms that market timing is crucial (Bolton et al., 2012). Typically, AR_{TFU} is positive before the Asian Financial Crisis but exhibits a sudden drop after the incident. It remains negative for about six years. Afterward, the Individual Travel Scheme brings in many Mainland China tourists, hence, reignites the Hong Kong economy and TFU investment. AR_{TFU} stays positive since 2006.

Figure A1. Annualized return of TFU market (Based on Repeated Sales Method)



Source: Authors' calculations

Next, we construct an efficient frontier, incorporating TFU alongside other assets like the mass housing market, stock indices, gold, and currencies (Cheung et al., 2017; Yiu et al., 2013).[34] We compute risk premia by subtracting the risk-free rate from annualized return. Table A1 provides the summary statistics of the risk premiums for 1993Q1 – 2017Q2, and more results of the efficient frontier analysis.

Table A1. Summary statistics of variables in efficient frontier analysis

Risk premium of:	Mean	Std.Dev.	Min	Max
Top-floor housing market	0.03	0.11	–0.19	0.25
Mass housing market	0.04	0.18	–0.43	0.42
Hang Seng Index	0.07	0.27	–0.52	1.12
S&P 500	0.06	0.16	–0.43	0.52
Gold	0.04	0.16	–0.27	0.39
British Pound	–0.04	0.09	–0.30	0.14
Japanese Yen	–0.02	0.11	–0.28	0.22

[34] DeMiguel et al. (2014) demonstrate that VAR portfolios, which exploit the serial correlations of stock returns, are profitable only for minimal transaction costs relative to the traditional unconditional portfolio. Hence, this section uses the traditional efficient frontier for portfolio analysis.

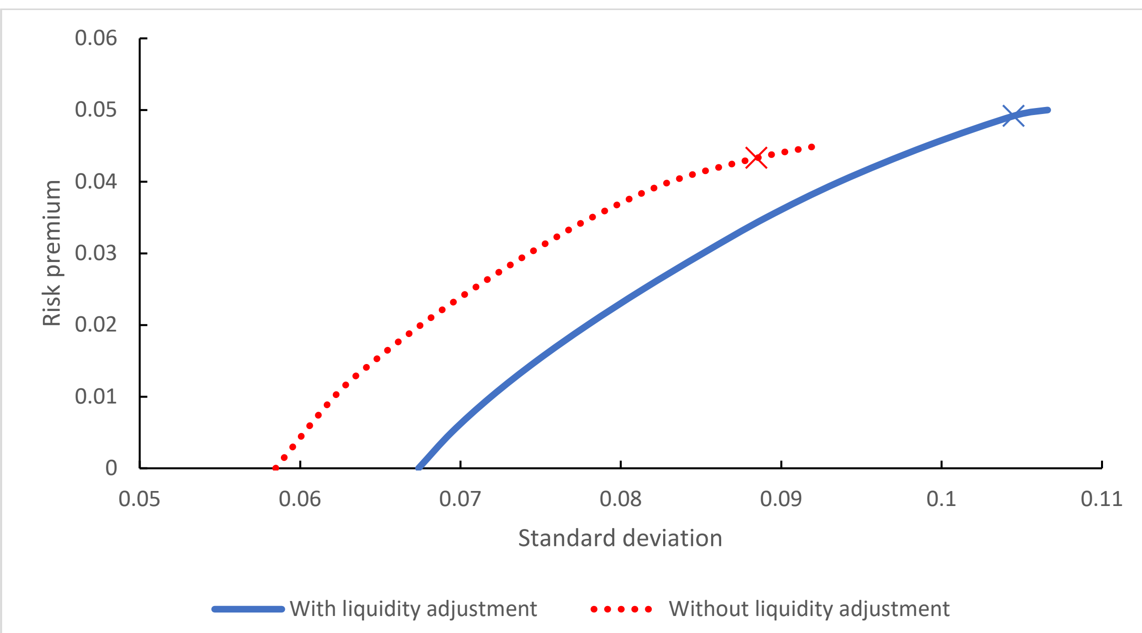
Table A2. Composition of minimum variance portfolio and optimal portfolio

	Minimum variance portfolio		Optimal tangency portfolio	
	Without liquidity adjustment	With liquidity adjustment	Without liquidity adjustment	With liquidity adjustment
Top-floor housing market	25.76%	1.73%	23.54%	0.00%
Mass housing market	0.00%	0.00%	0.00%	0.00%
Hang Seng Index	0.00%	0.00%	0.00%	0.00%
S&P 500	3.98%	10.41%	41.47%	55.95%
Gold	0.00%	0.00%	34.99%	44.05%
British Pound	43.61%	36.21%	0.00%	0.00%
Japanese Yen	26.65%	51.64%	0.00%	0.00%

Table A3. A Comparison of Hedging Effectiveness

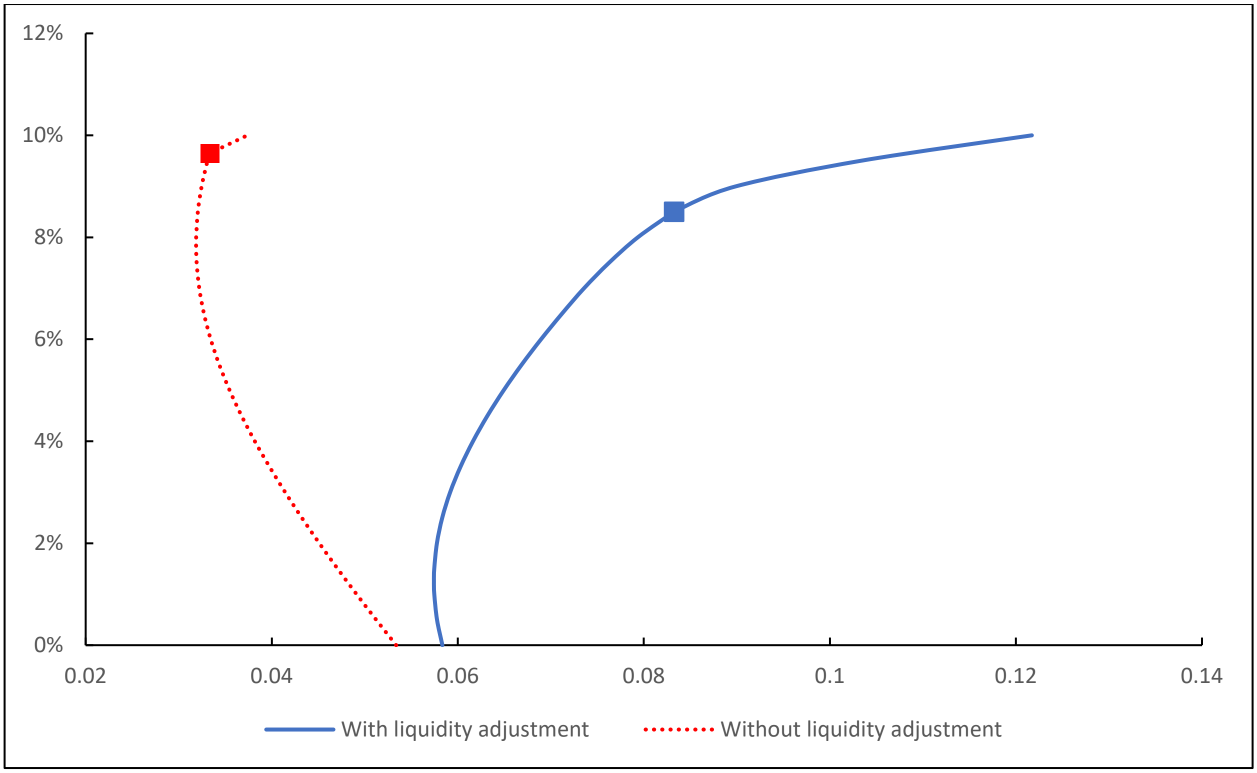
Commodity	Hedging effectiveness		
	Top Floor Units	Ordinary Housing Units	HK Stock Market (Hang Seng Index)
Cement	75.64%	6.70%	5.61%
Copper	3.47%	5.38%	70.94%
Steel	28.27%	8.67%	1.27%
Wood	27.53%	9.92%	0.84%

Figure A2. Efficient frontier



Note: ■= Optimal tangency portfolio

Figure A3. Efficient frontier with liquidity adjustment



A few remarks are in order. Although real estate's role under efficient frontier analysis has been studied extensively in previous literature, this paper may be the first to consider TFU in an optimal portfolio.[35] Unlike financial assets, the transactions of real estate often take time. Here we follow Janabi's (2011) approach to liquidity adjustment in the portfolio calculation.[36] We set the number of transaction days for TFU and the mass housing market to be 30 days, and that of the financial assets is normalized as one day.[37] Table A2 shows that the optimal portfolio weight is very *sensitive* to whether the *liquidity adjustment* is made. Once the difference in transaction time between real estate and financial assets is considered, the optimal portfolio weight on housing becomes zero,

[35] For example, Sa-Aadu et al. (2010) find that real estate investment trust (REIT) as an asset class can improve portfolio performance.
[36] Janabi (2011) shows that, under some assumptions, the adjusted standard deviation of the return of an asset is $\sigma_{adj} = f\left(\sqrt{(2t+1)(t+1)/6t}\right)$, where t = the number of days it takes to trade an asset.
[37] It may be a conservative estimate. Based on the data between 1993 to 1999, Leung et al. (2002) find that the TOM (time on the market) is 81 days in Hong Kong. However, their sample includes the Asian Financial Crisis (AFC) period, which tends to inflate the TOM. On the other hand, the continuing progress of information technology would shorten the TOM and transaction days.

indicating its role primarily as a durable consumption good. See also Figure A2, A3 for a visualization.

Moving forward, we explore hedging effectiveness, measuring commodities' ability to hedge TFU risk. Employing a VAR(1) model, we calculate hedged portfolio returns (HPO) by short-selling commodities against TFU holdings, with the optimal hedge ratio determined by the model (Arouri et al., 2012; Chang et al., 2010; Chang et al., 2011).

To formally assess the hedging effectiveness, we require a multivariate GARCH model. Therefore, we must introduce some notations. Let $R_{TOP,t}$ represent the real top floor premium at time *t*, and $R_{COM,t}$ represent the real commodity return at time t.[38] The estimation proceeds in two steps. First, we estimate the following VAR(1) model:

$$\begin{bmatrix} R_{TOP,t} \\ R_{COM,t} \end{bmatrix} = \begin{bmatrix} \alpha_{TOP,0} \\ \alpha_{COM,0} \end{bmatrix} + \begin{bmatrix} \alpha_{TOP,1} & \alpha_{TOP,2} \\ \alpha_{COM,1} & \alpha_{COM,2} \end{bmatrix} \begin{bmatrix} R_{TOP,t-1} \\ R_{COM,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{TOP,t} \\ \varepsilon_{COM,t} \end{bmatrix}$$

where $\varepsilon_{TOP,t}$ and $\varepsilon_{COM,t}$ are distributed as $N(0, H_t)$. The conditional variance in matrix form $H_t = \begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix}$ is modelled as a diagonal BEKK model,[39]

$$\begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} = C'C + \begin{bmatrix} a_{11} & 0 \\ 0 & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon_{TOP,t} \\ \varepsilon_{COM,t} \end{bmatrix} \begin{bmatrix} \varepsilon_{TOP,t} \\ \varepsilon_{COM,t} \end{bmatrix}' \begin{bmatrix} a_{11} & 0 \\ 0 & a_{22} \end{bmatrix} +$$
$$\begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} \begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix}.$$

Under these assumptions, it has been shown that the hedged portfolio (*HPO*), holding the top floor units and short-selling the commodity, can be computed by the formula,

$R_{HPO,t} = R_{TOP,t} - \beta_t R_{COM,t}$. At the same time, the optimal hedge ratio is obtained by $\beta_t = \frac{h_{12,t}}{h_{22,t}}$. At last, we calculate the hedging effectiveness (*HE*), simply the reduction of variance in percentage terms, $HE = \frac{Variance_{unhedged} - Variance_{hedged}}{Variance_{unhedged}}$.

[38] We follow the standard approach in calculating the real premium and return, subtracting the inflation rate from the corresponding nominal premium and return.
[39] For a discussion of BEKK model, see Caporin and McAleer (2012).

Here we consider four essential commodities in housing construction (cement, copper, steel, and wood) and calculate their hedging effectiveness. Table A3 shows that all commodities can produce positive hedging effectiveness. The first column shows that short-selling cement can reduce the risk of holding TFU by 75.64%, suggesting that the price of TFU indeed moves with its cost. Short-selling, either wood or steel, can also mitigate the risk of holding TFU by about 28%. These results highlight the comovement between commodity prices and the TFU market (Leung et al., 2013).

The second column compares the situation of holding *ordinary* housing units and short-selling commodities. If the results for ordinary units are similar to the TFU, it is possible that there is a common trend guiding both ordinary units and TFU. Interestingly, none of the commodities can reduce the risk by more than 10%! These results suggest that the ordinary housing units are moved by other forces, a possibility that has been further explored in the main text.

The third column compares the case of having a long position in the Hang Seng Index (the stock market index in Hong Kong) and short-selling the commodities.[40] Even a short sale of copper can reduce the risk of holding the Hong Kong stock market index. Our interpretation is straightforward. Hong Kong is a small open economy. Copper is a globally traded commodity, and research has confirmed the dynamic interaction between commodity prices and global economic activities (Alquist et al., 2020; Matsumoto et al., 2023). Thus, Table A3 is consistent with the research.

[40] Notice that Hong Kong has maintained a fixed exchange rate with the U.S. dollar. Thus, although the commodities are priced in U.S. dollars and the Hang Seng Index in Hong Kong dollars, the exchange rate risk is minimal.

Table A4. Composition of minimum variance portfolio and optimal portfolio

(3rd model)

	Minimum variance portfolio		Optimal tangency portfolio	
	Without liquidity adjustment	With liquidity adjustment	Without liquidity adjustment	With liquidity adjustment
Top-floor housing market	77.27%	22.16%	91.06%	65.51%
Mass housing market	1.44%	0%	0.78%	0%
Hang Seng Index	0%	0%	0%	0%
S&P 500	7.60%	14.06%	8.15%	31.94%
Gold	0%	0%	0%	2.55%
British Pound	5.23%	26.14%	0%	0%
Japanese Yen	8.46%	37.64%	0%	0%

Notice that the equation (2) under-estimate the risk in the housing market, and hence suggests a very high portfolio weight for the TPU (top floor units).

Here we provide the scatter plots of the holding periods and the annualized returns.

Figure A4. Scatter Plots of Holding period Annualized Real Return of TFU (1993Q1 – 1997Q4)

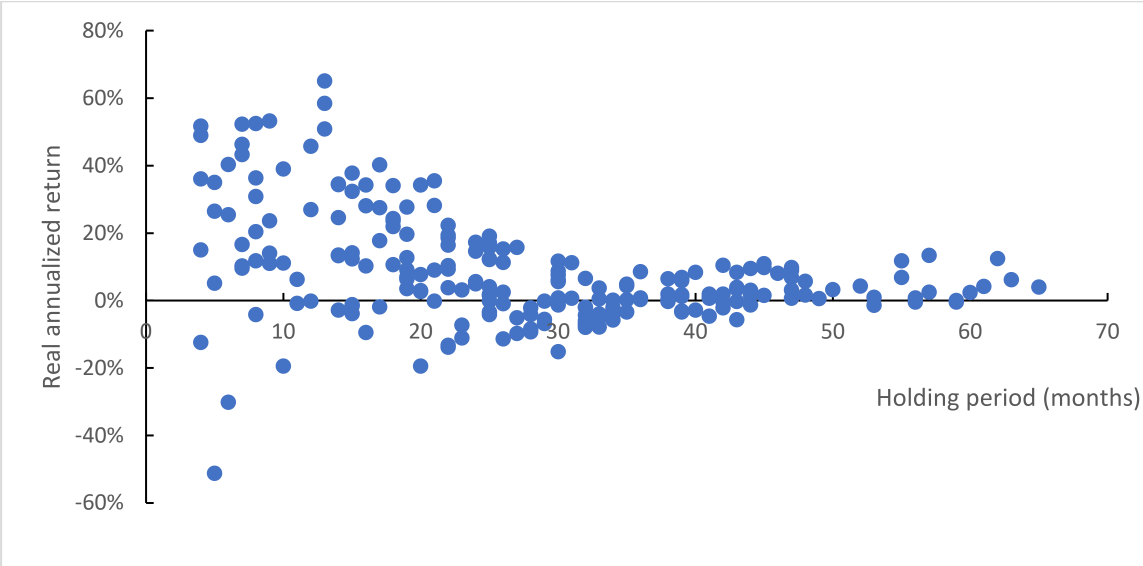


Figure A5. Scatter Plots of Holding period Annualized Real Return of Ordinary Units (1993Q1 – 1997Q4)

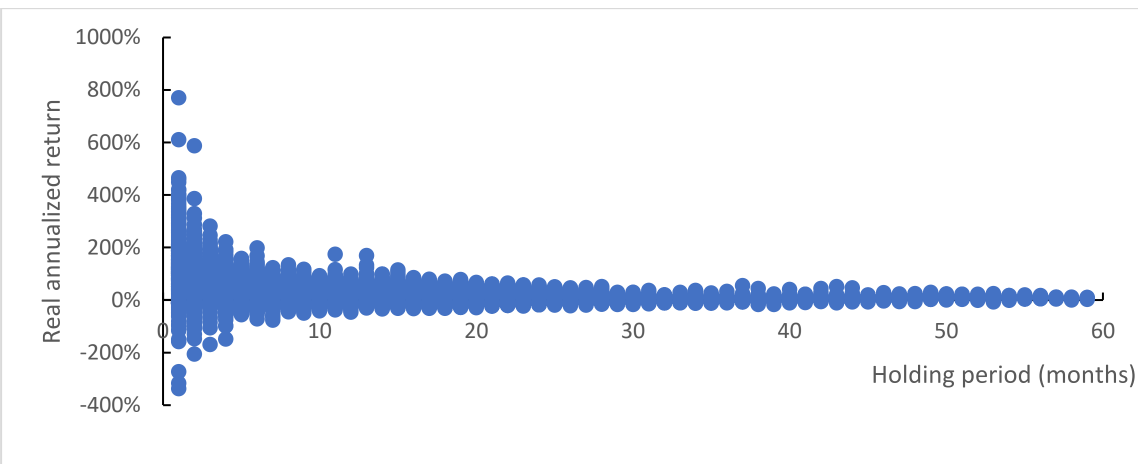


Figure A6. Scatter Plots of Holding period Annualized Real Return of TFU (1998Q1 – 2008Q2)

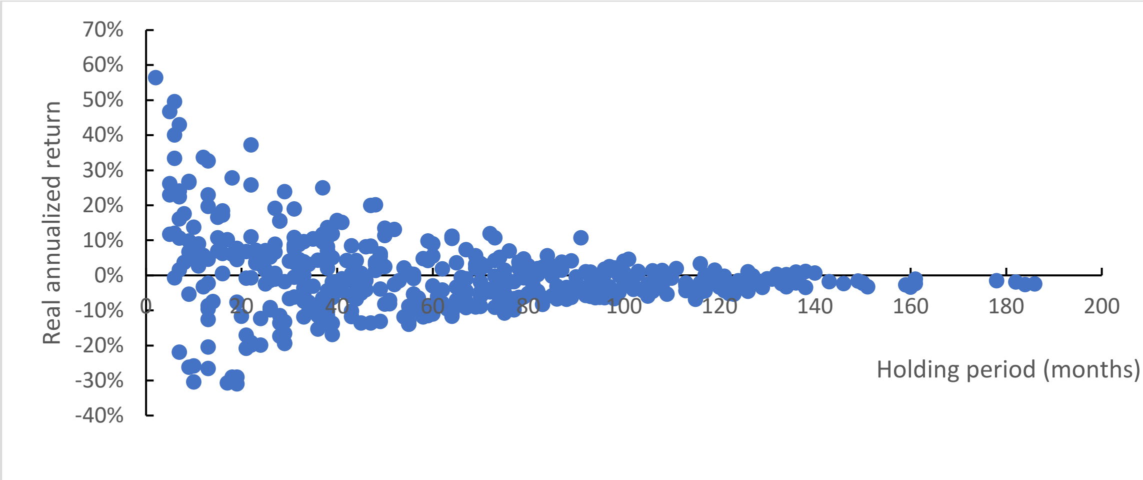


Figure A7. Scatter Plots of Holding period Annualized Real Return of Ordinary Units (1998Q1 – 2008Q2)

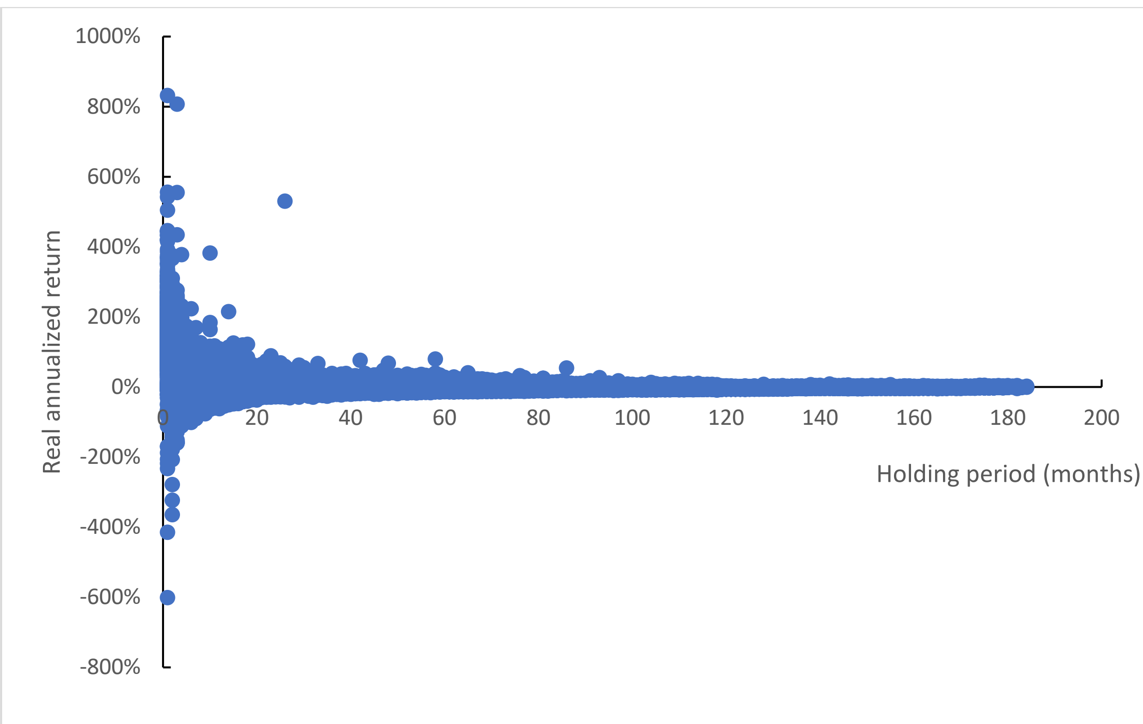


Figure A8. Scatter Plots of Holding period Annualized Real Return of TFU (2008Q3 – 2017Q2)

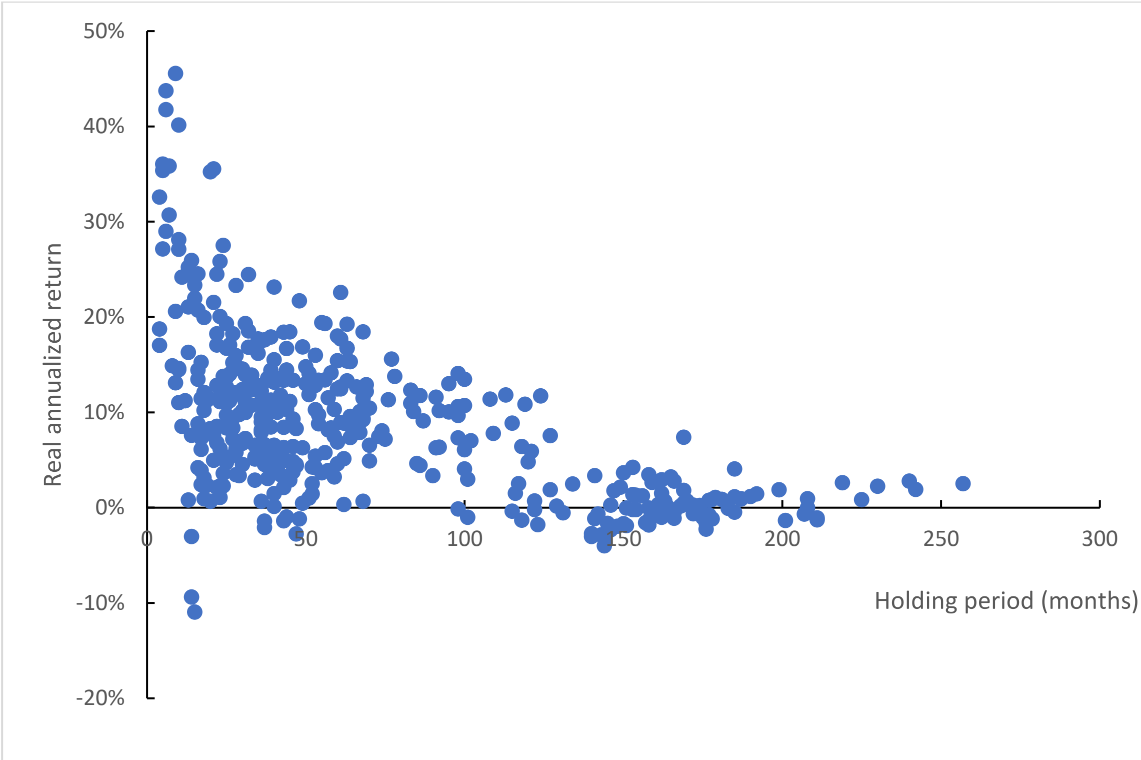
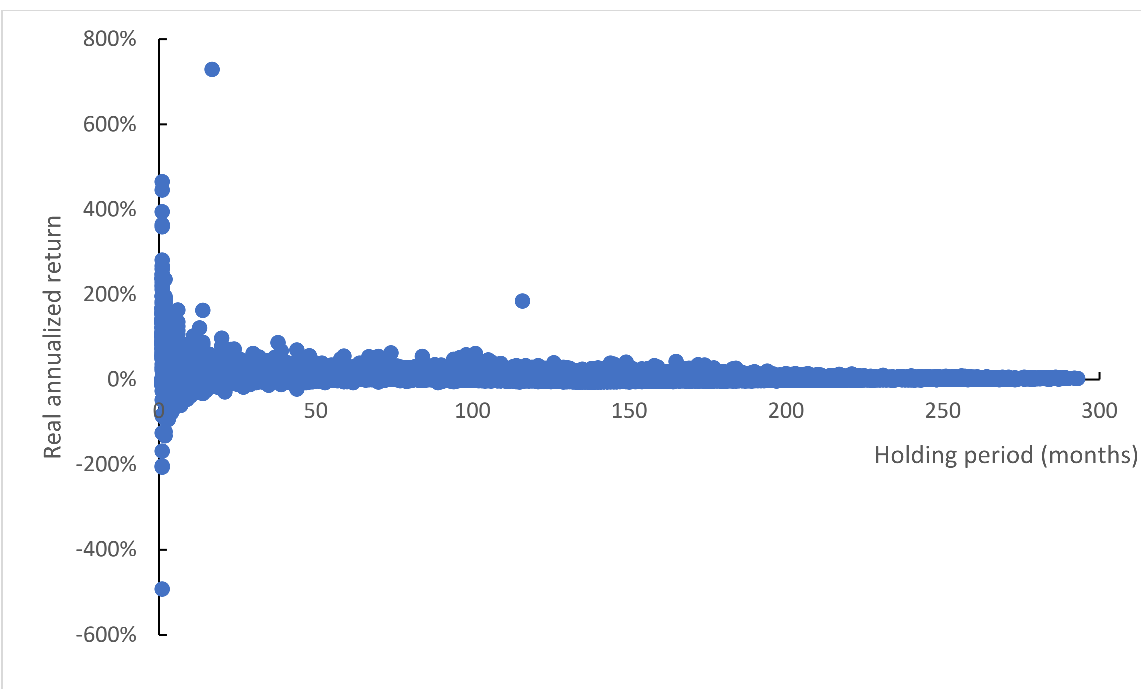


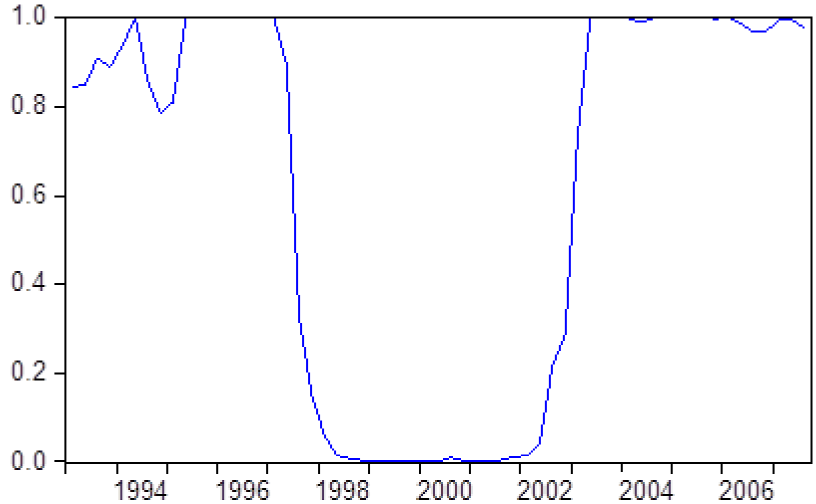
Figure A9. Scatter Plots of Holding period Annualized Real Return of Ordinary Units (2008Q3 – 2017Q2)



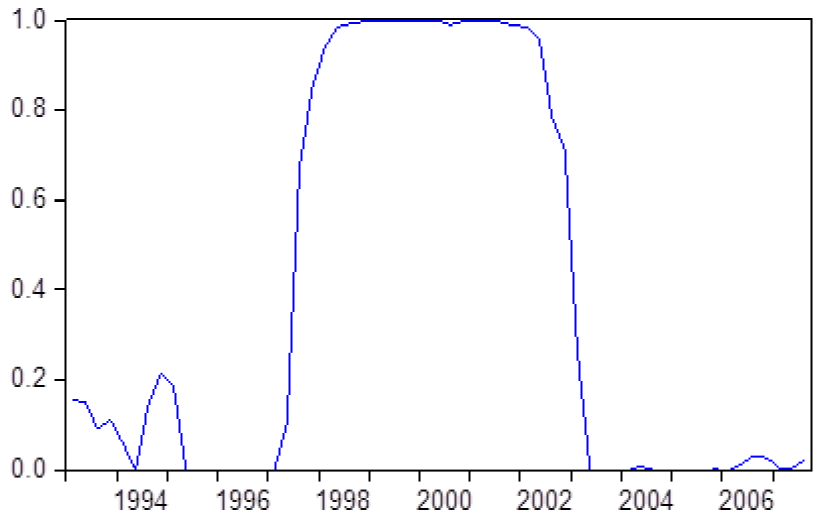
Here we present the figures related to the regime-switching models.

Figure A10. Smoothed probabilities for percentage of reselling top floor units within 2 years

Regime 1

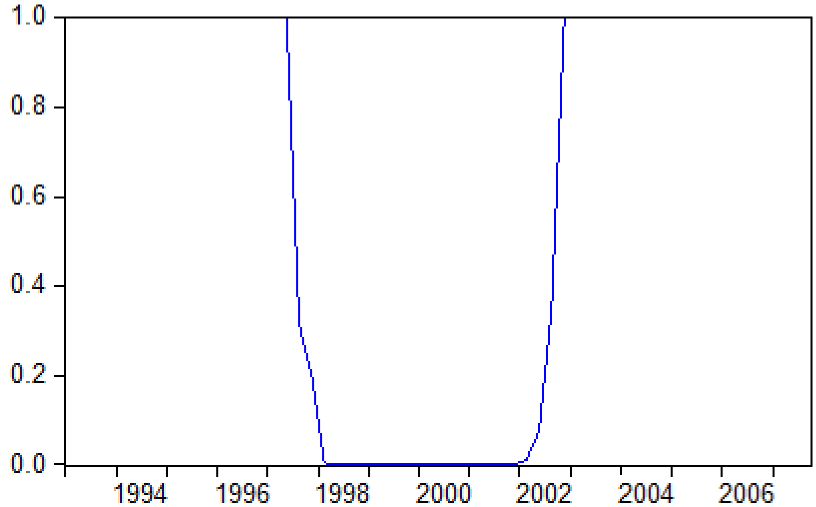
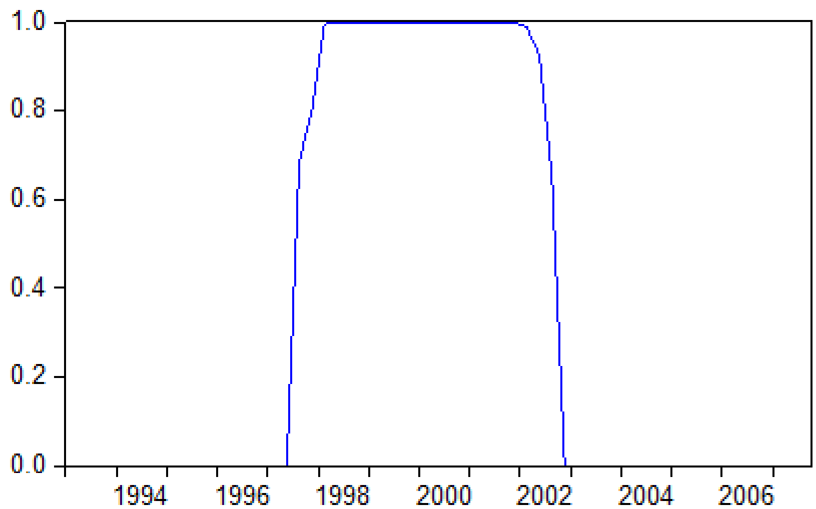


Regime 2



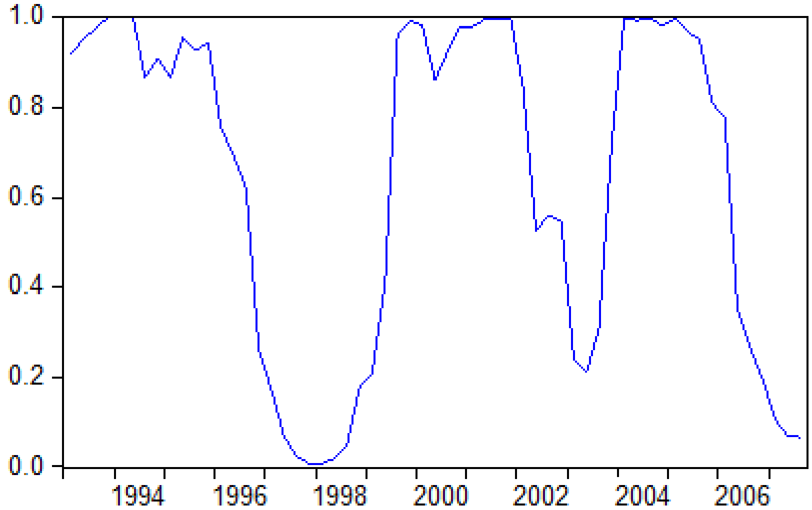
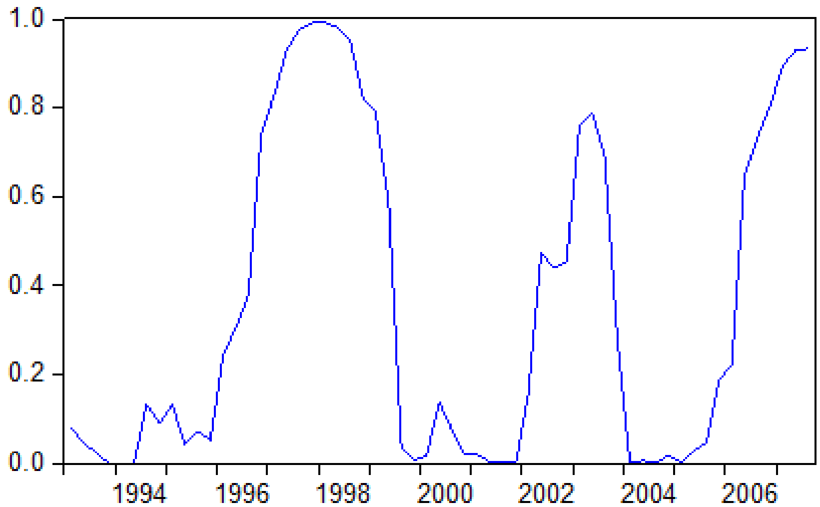
Source: Authors' calculations

Figure A11. Smoothed probabilities for percentage of reselling non-top floor units within 2 years

Regime 1	
Regime 2	

Source: Authors' calculations

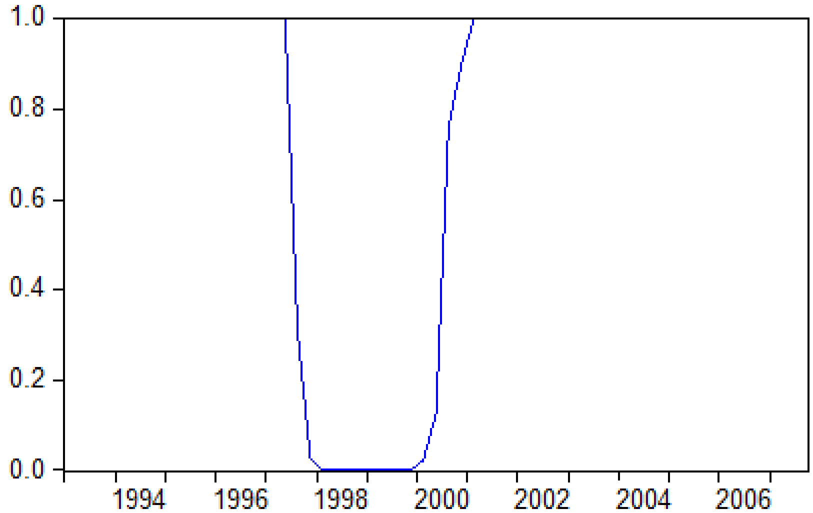
Figure A12. Smoothed probabilities for percentage of reselling top floor units within 10 years

Regime 1	
Regime 2	

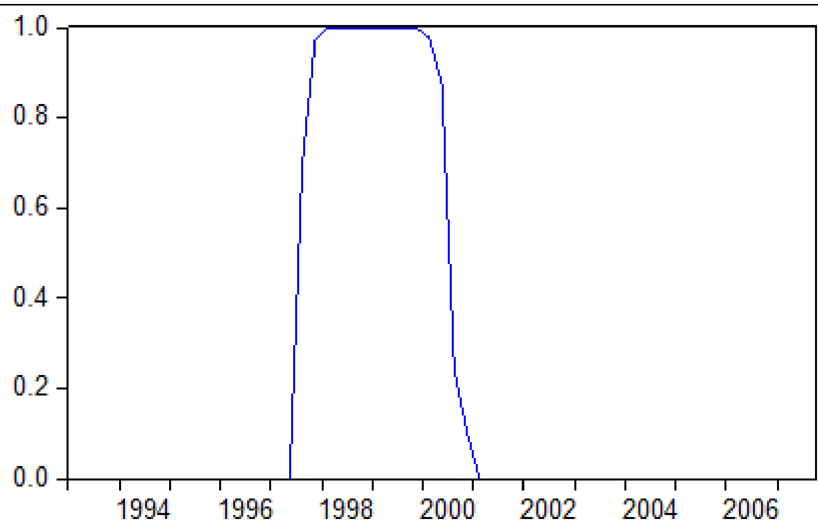
Source: Authors' calculations

Figure A13. Smoothed probabilities for percentage of reselling non-top floor units within 10 years

Regime 1



Regime 2



Source: Authors' calculations

Details of the Lasso tests.

(Lasso)

	floor	grossarea	swp	scale	hk	kln	cbd	mtr	market	hospital	library	shk	hen	ck	nwd	sino
93Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
93Q2	*	*	*	*	*	*	*	*	*	*				*	*	*
93Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
93Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
94Q1	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
94Q2	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
94Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
94Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
96Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
96Q2	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
96Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
96Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
97Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
97Q2	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
97Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
97Q4	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
98Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
98Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
98Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
98Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q4	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
02Q1	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
02Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
02Q3	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
02Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
03Q1	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*

03Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	floor	grossarea	swp	scale	hk	kln	cbd	mtr	market	hospital	library	shk	hen	ck	nwd	sino
03Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
03Q4	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*
04Q1	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
04Q2	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
04Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
04Q4	*	*	*	*	*	*	*	*	*	*		*			*	*
05Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
05Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
05Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
05Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
06Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
06Q2	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
06Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
06Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
09Q1	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
09Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
09Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
09Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10Q3	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
10Q4	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
11Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11Q4	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
12Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
14Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

14Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	floor	grossarea	swp	scale	hk	kln	cbd	mtr	market	hospital	library	shk	hen	ck	nwd	sino
14Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
14Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q4	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
16Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
17Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
17Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

(Square-root lasso)

	floor	grossarea	swp	scale	hk	kln	cbd	mtr	market	hospital	library	shk	hen	ck	nwd	sino
93Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
93Q2	*	*	*	*	*	*	*	*	*	*		*			*	*
93Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
93Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
94Q1	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
94Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
94Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
94Q4	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
95Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
95Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
96Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
96Q2	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
96Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
96Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
97Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
97Q2	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
97Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
97Q4	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*
98Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
98Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
98Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
98Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
99Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
00Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
01Q4	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
02Q1	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
02Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
02Q3	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
02Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
03Q1	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
03Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

	floor	grossarea	swp	scale	hk	kln	cbd	mtr	market	hospital	library	shk	hen	ck	nwd	sino
03Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
03Q4	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*
04Q1	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
04Q2	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
04Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
04Q4	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*
05Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
05Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
05Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
05Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
06Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
06Q2	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*
06Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
06Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
07Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
08Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
09Q1	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
09Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
09Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
09Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
10Q3	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
10Q4	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
11Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11Q4	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*
12Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
13Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
14Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
14Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

	floor	grossarea	swp	scale	hk	kln	cbd	mtr	market	hospital	library	shk	hen	ck	nwd	sino
14Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
14Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
15Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
16Q4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
17Q1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
17Q2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

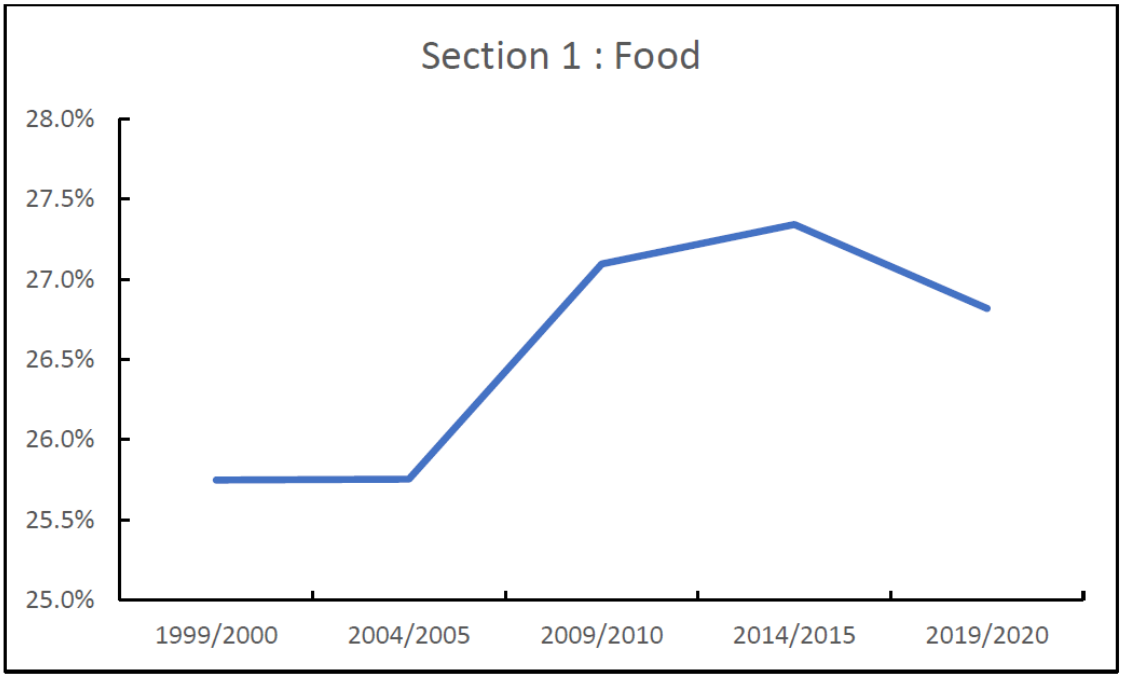
Thus, whether we use the standard LASSO or square-root LASSO, we find that our variables are essential in most, if not all, periods of time.

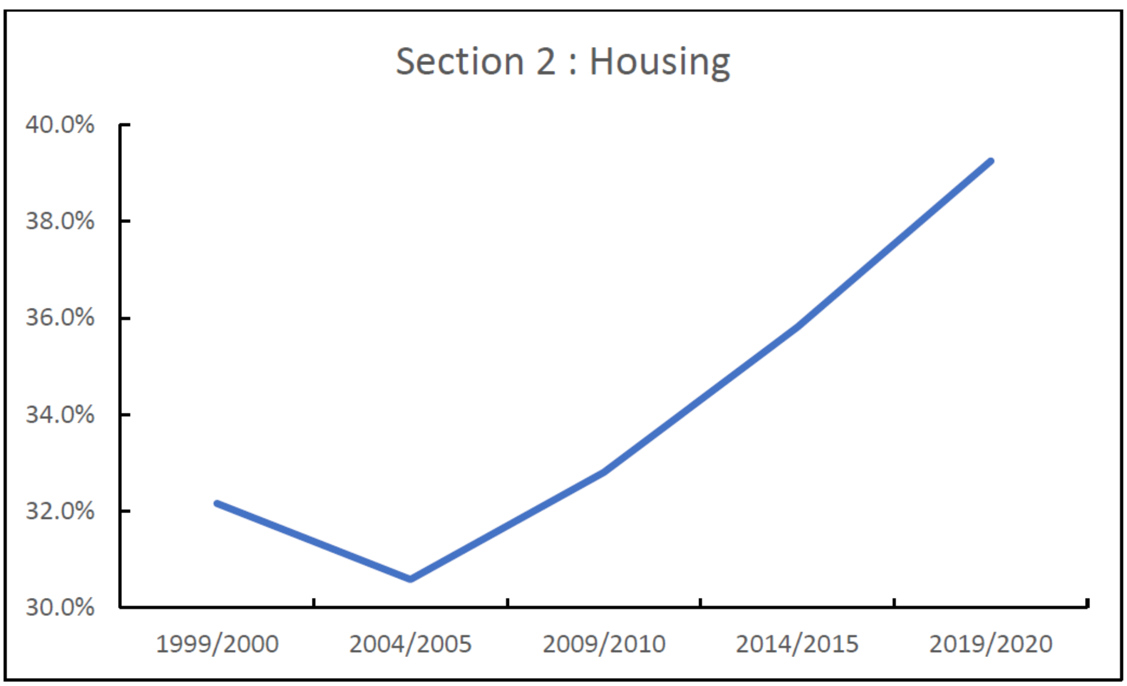
Additional Results

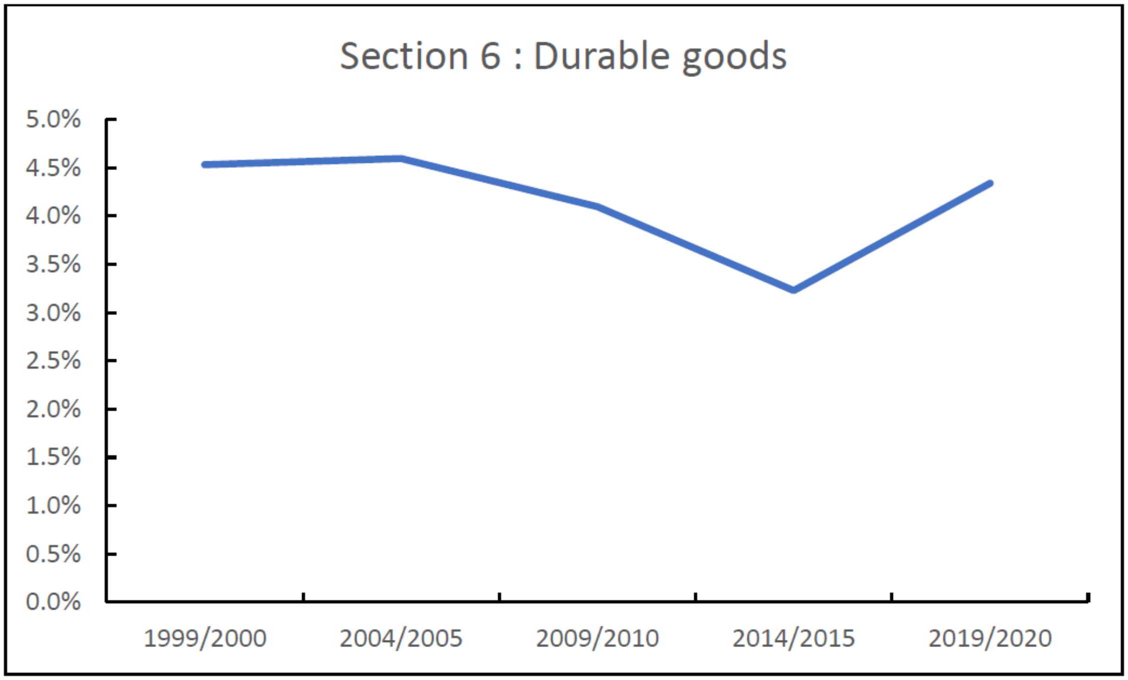
The Hong Kong government only provides consumption expenditure data every five years. And the earliest data we can access is from 1999/2000, after the Asian Financial Crisis. We plot the following graphs based on the information provided by the Hong Kong government website https://www.censtatd.gov.hk/en/.

(We provide the graphs for major items only. An item such as "alcoholic drinks" accounts for less than 2%, and the item "electricity, gas and water" accounts for something like 3%).

(X-axis is time, and Y-axis is the expenditure share)


Section 1 : Food
28.0%
27.5%
27.0%
26.5%
26.0%
25.5%
25.0%
1999/2000
2004/2005
2009/2010
2014/2015
2019/2020

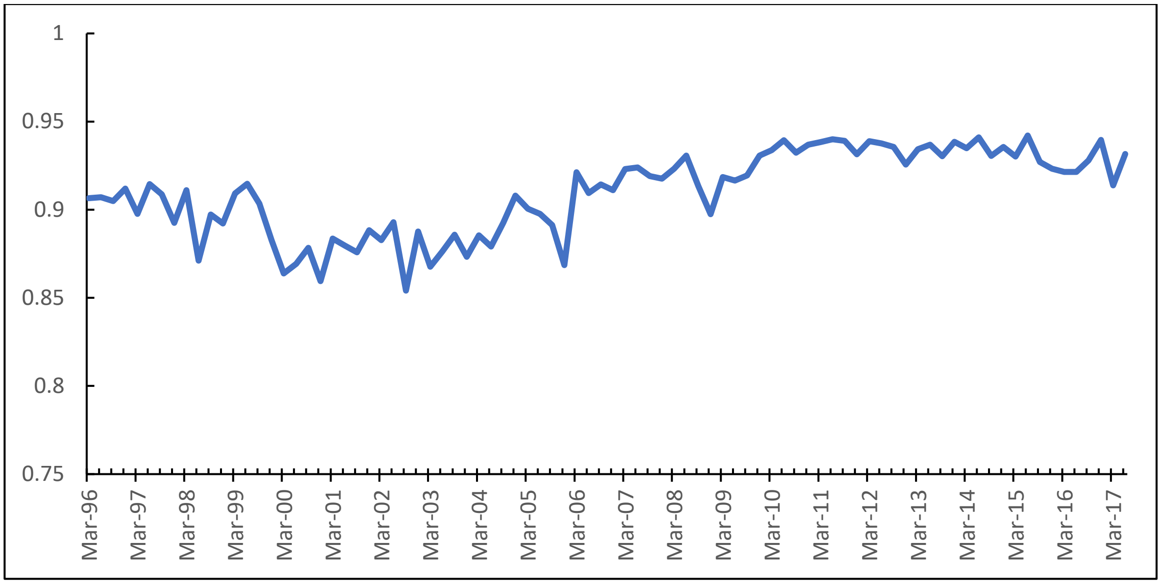

Section 2 : Housing
40.0%
38.0%
36.0%
34.0%
32.0%
30.0%
1999/2000
2004/2005
2009/2010
2014/2015
2019/2020



It is clear that the share of housing has dropped after the Asian Financial Crisis, and hits a low point in 2004/2005. It then rebounds. Since we only have a few data points for each category, we would not make any speculation about the long term trend.

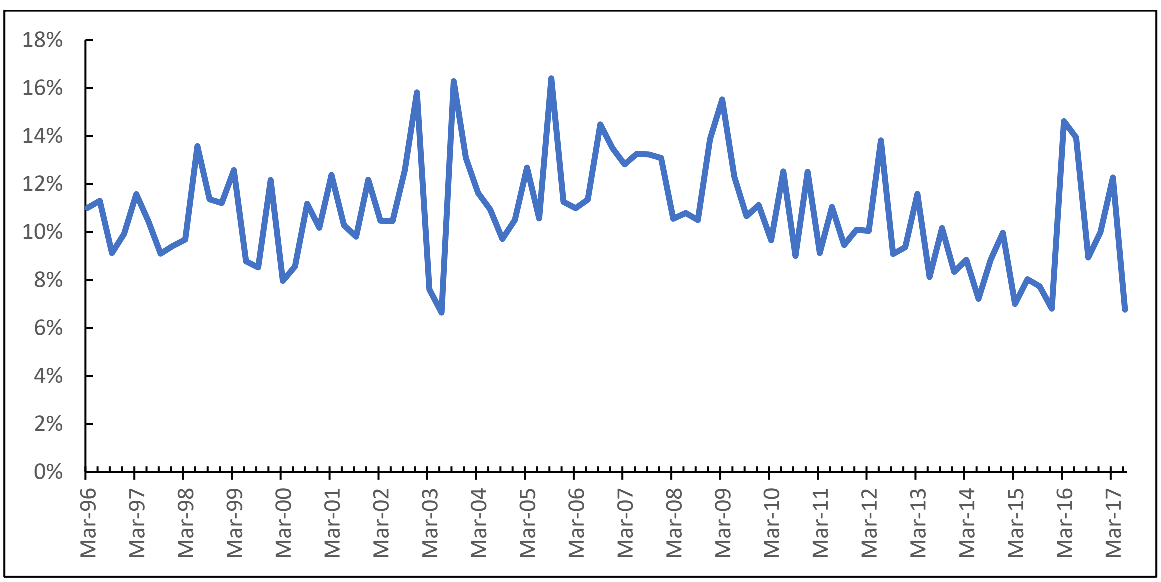
Appendix B. Robustness check – removing primary market transactions

Figure B1. Adjusted R-square of hedonic regression



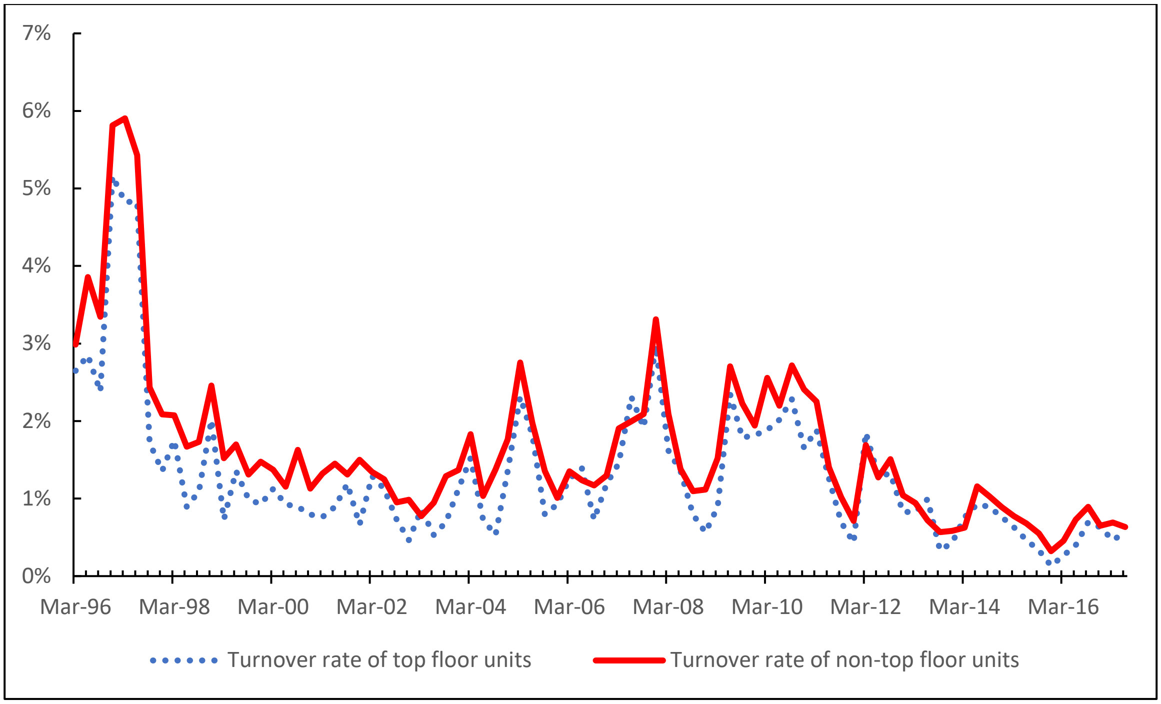
Source: Authors' calculations

Figure B2. Top Floor Premium



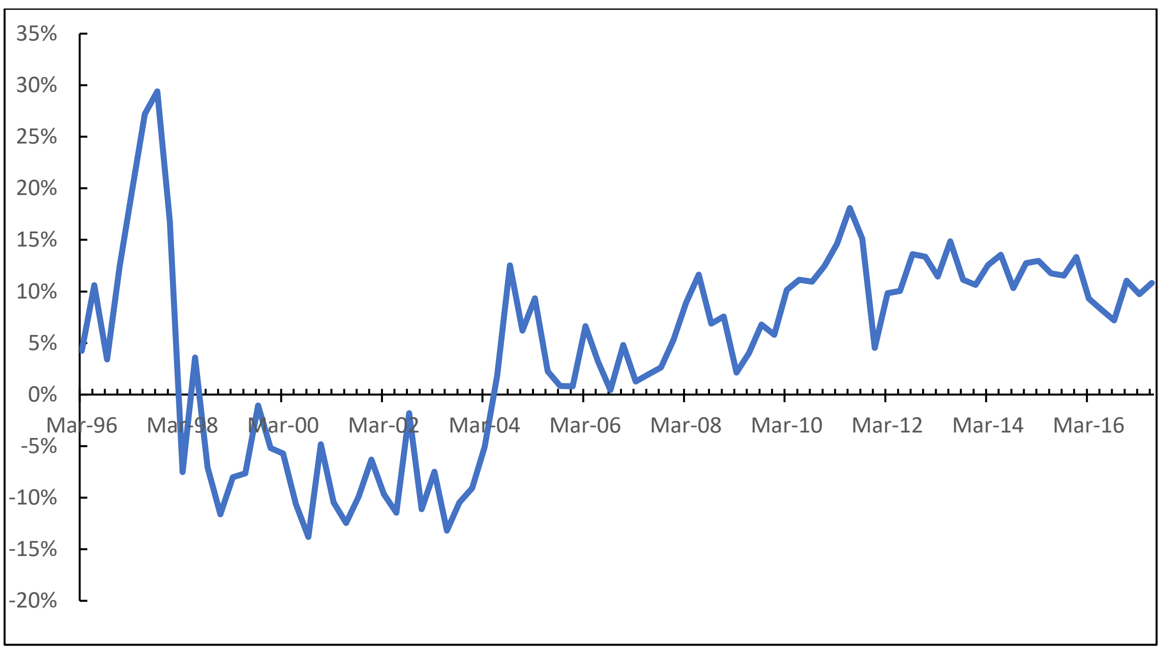
Source: Authors' calculations

Figure B3. Turnover rate of top floor units and non-top floor units



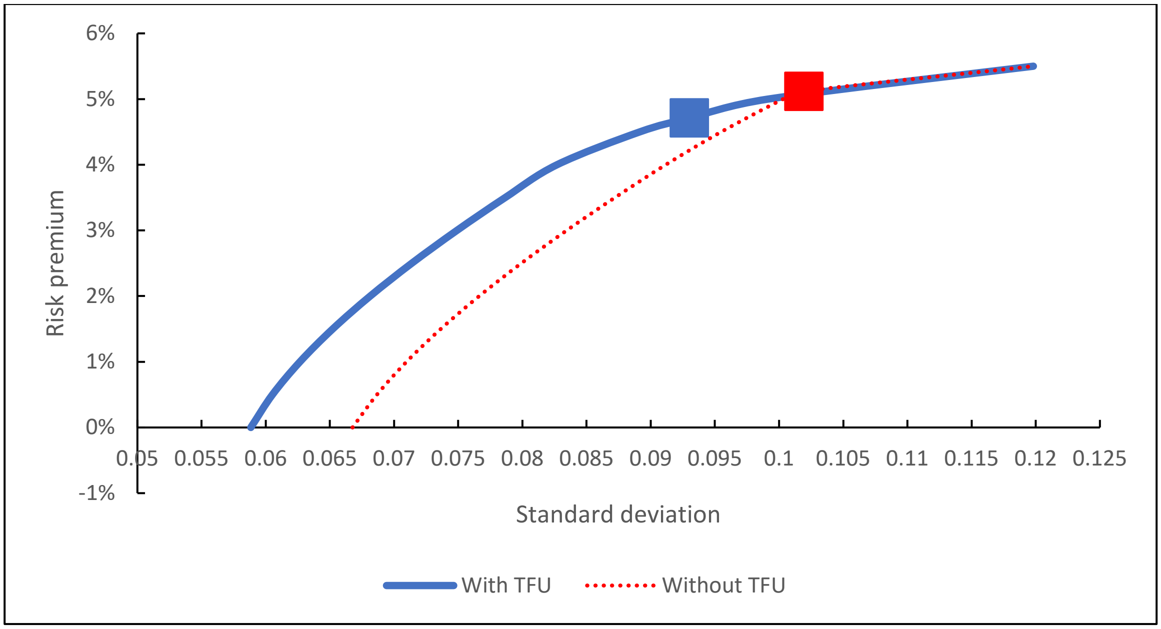
Source: Authors' calculations

Figure B4. Annualized return of TFU market



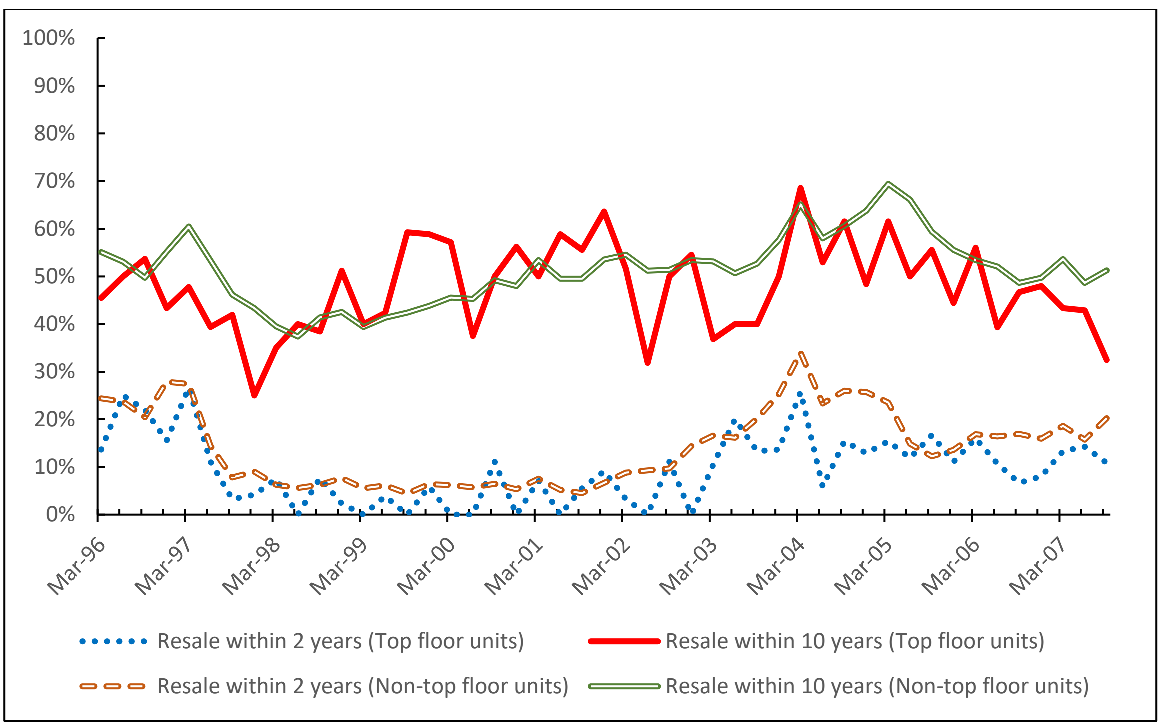
Source: Authors' calculations

Figure B5. Efficient frontier



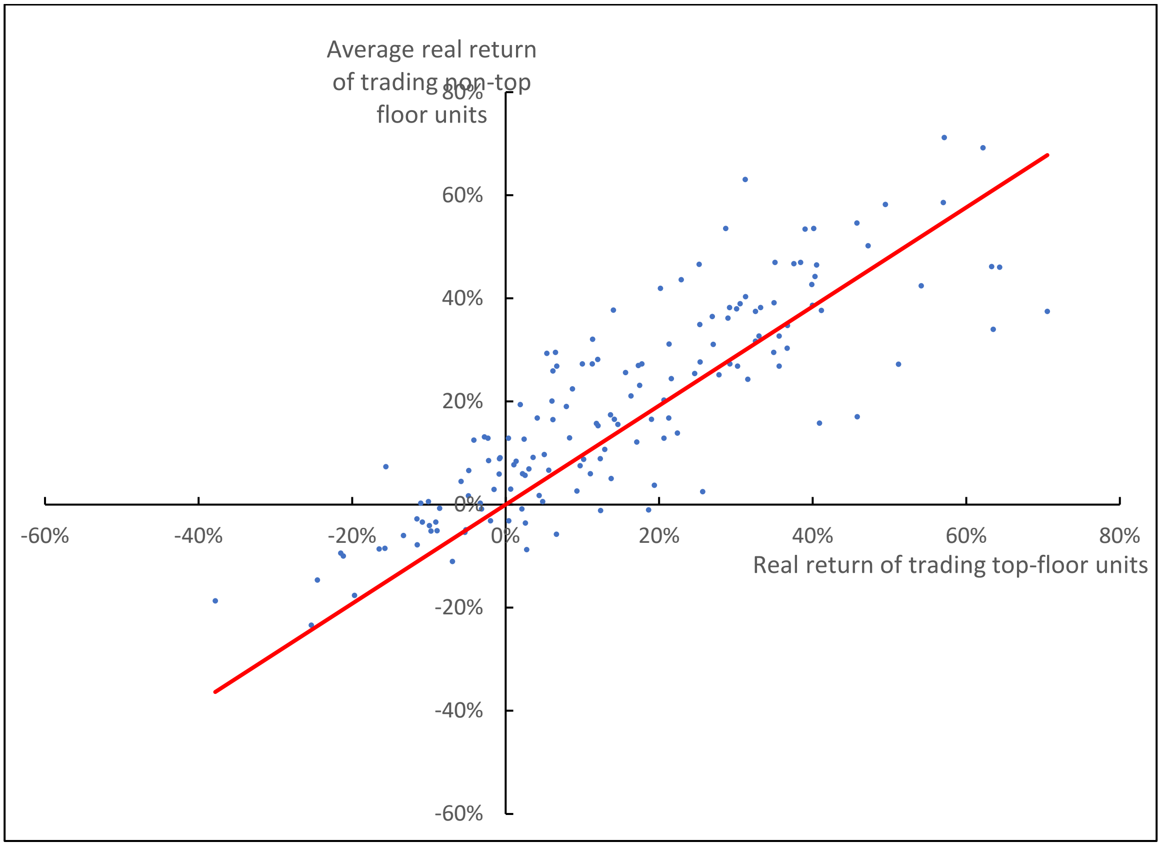
Note: ■ = Optimal tangency portfolio
Source: Authors' calculations

Figure B6. Percentage of housing units that are resold within 2 years and 10 years



Source: Authors' calculations

Figure B7. Scatter plot of r_A and μ_A during 1996Q1 – 1997Q4

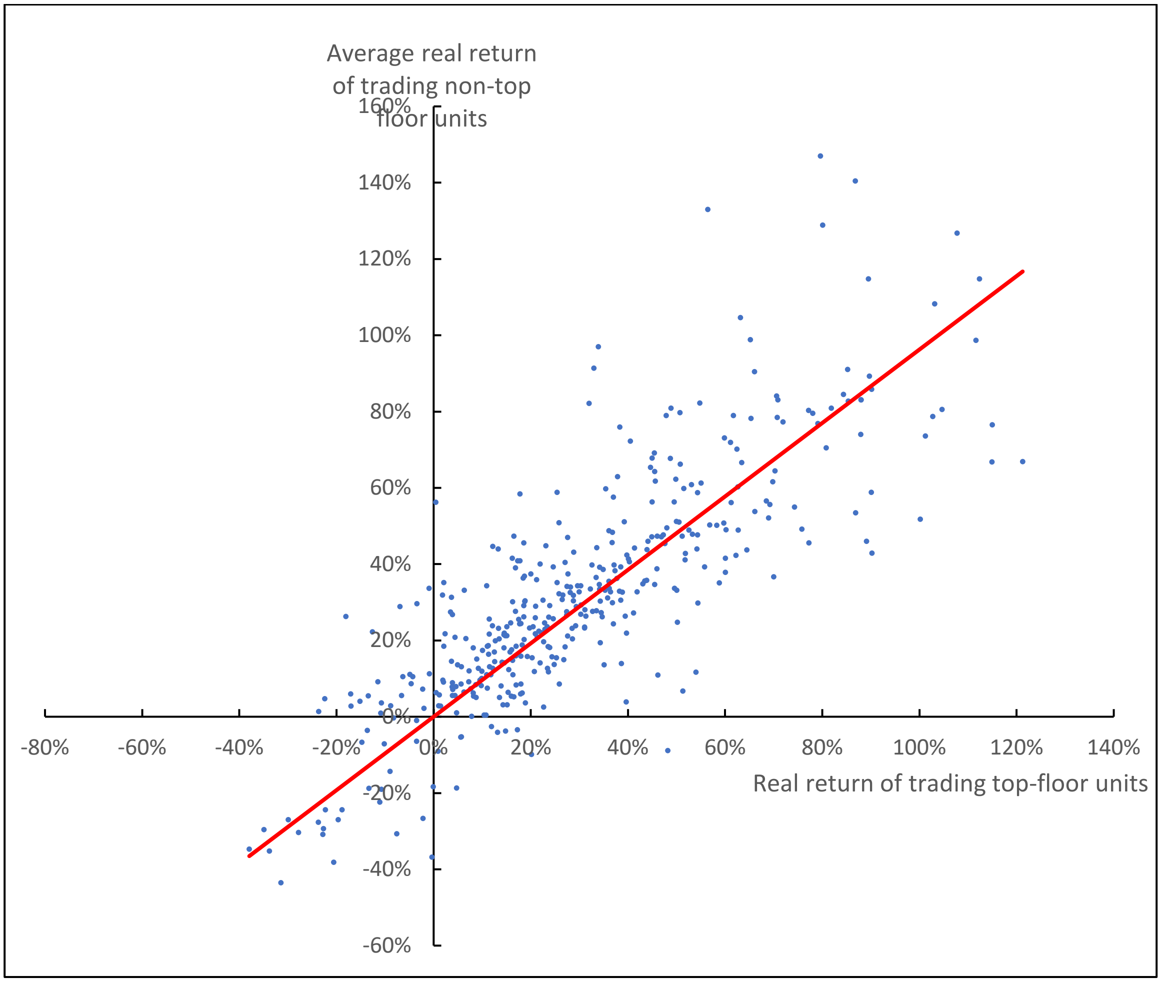


Source: Authors' calculations

Figure B8. Scatter plot of r_A and μ_A during 1998Q1 – 2008Q2

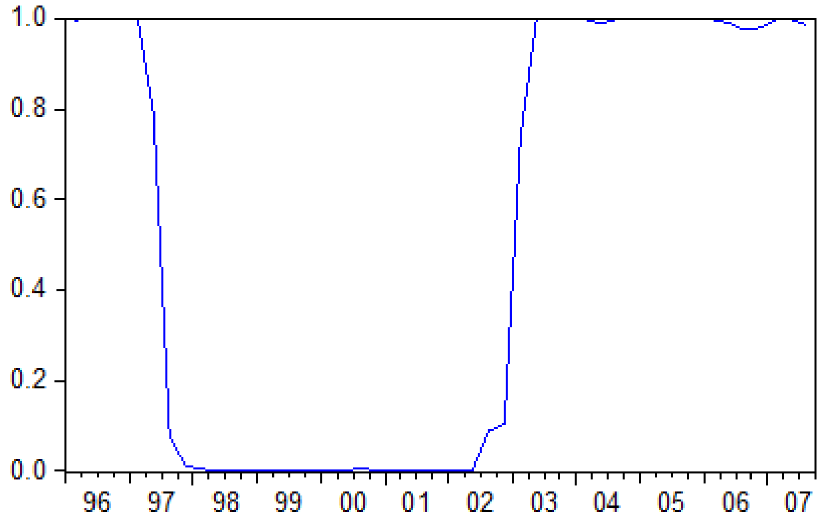
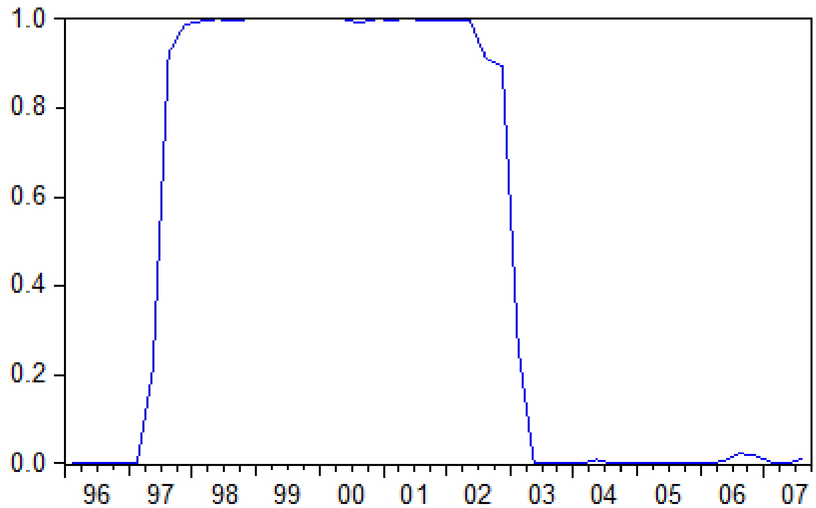
Source: Authors' calculations

Figure B9. Scatter plot of r_A and μ_A during 2008Q3 – 2017Q2



Source: Authors' calculations

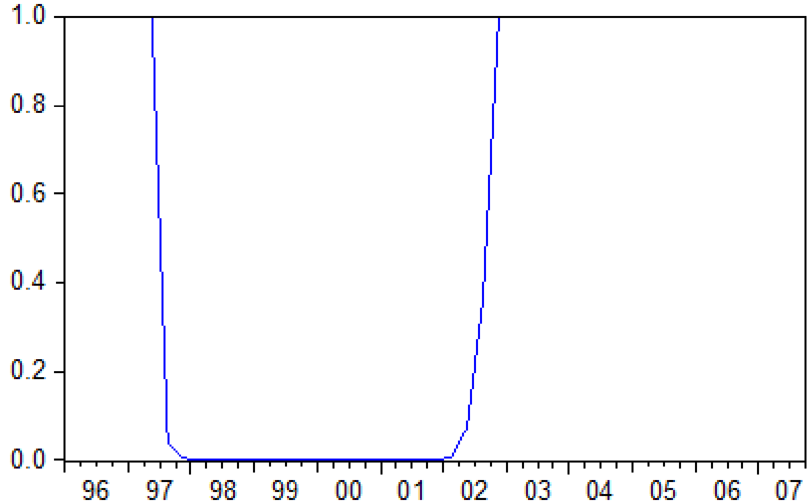
Figure B10. Smoothed probabilities for percentage of reselling top floor units within 2 years

Regime 1	
Regime 2	

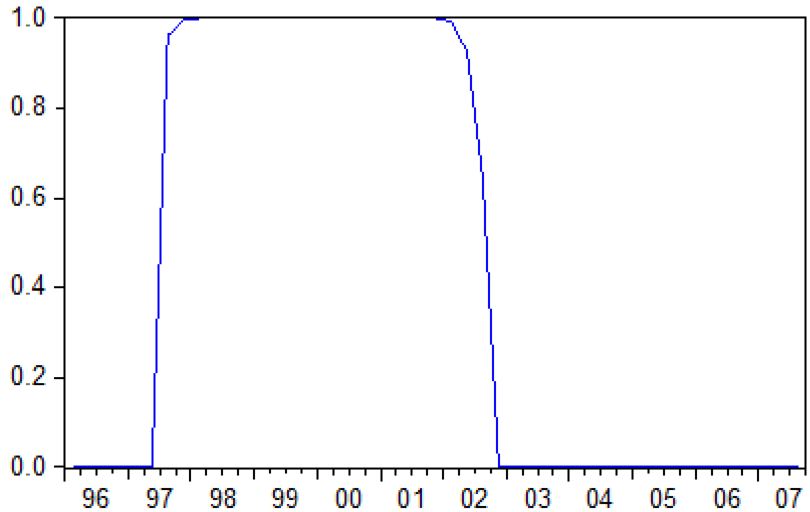
Source: Authors' calculations

Figure B11. Smoothed probabilities for percentage of reselling non-top floor units within 2 years

Regime 1



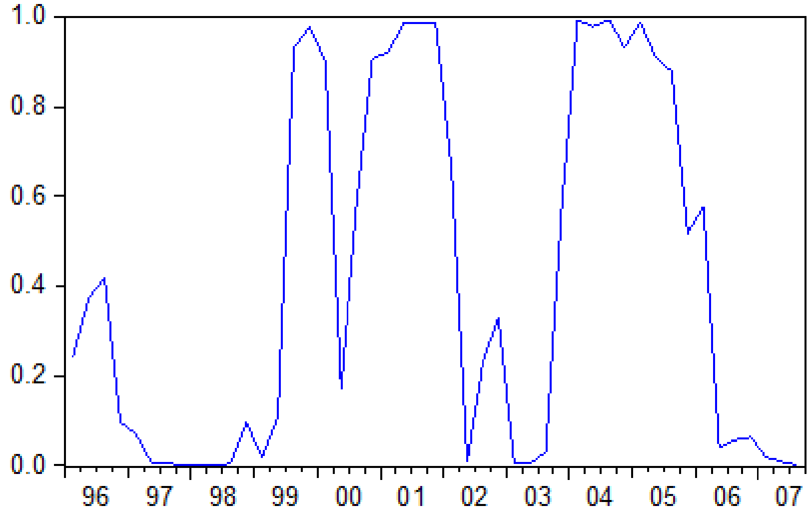
Regime 2



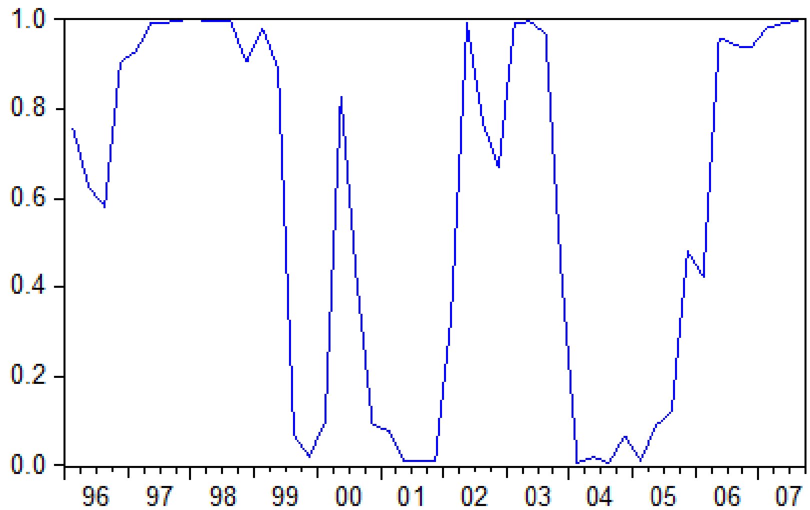
Source: Authors' calculations

Figure B12. Smoothed probabilities for percentage of reselling top floor units within 10 years

Regime 1



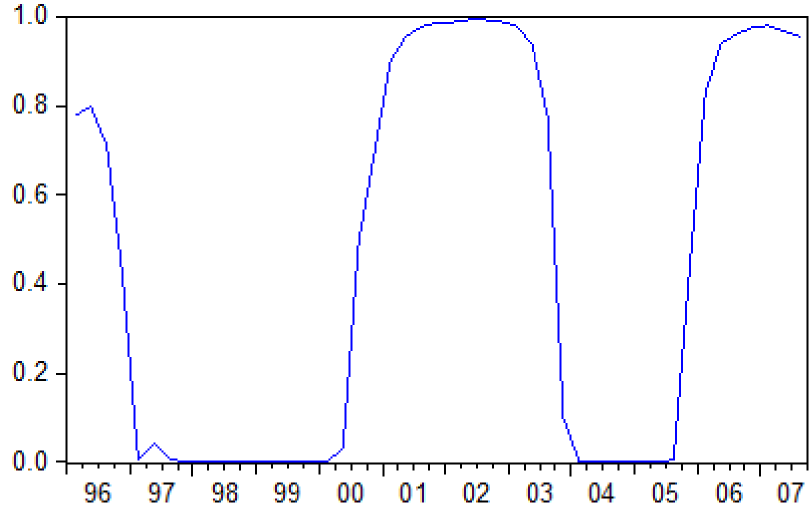
Regime 2



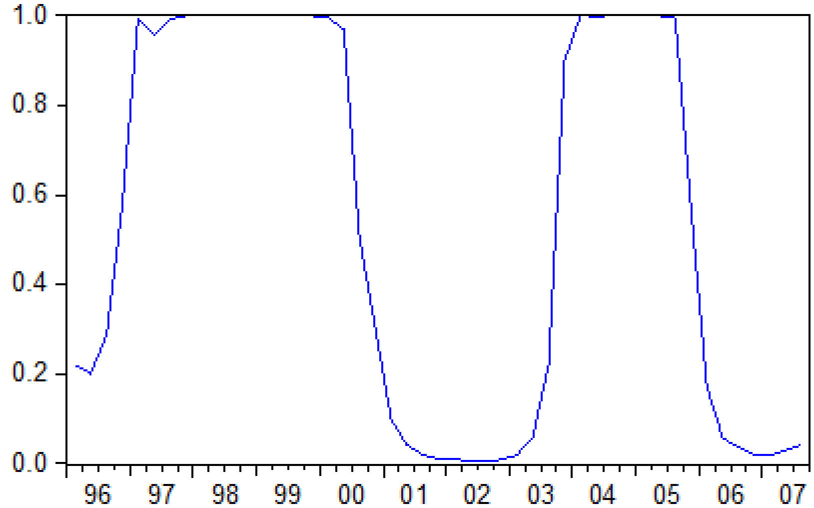
Source: Authors' calculations

Figure B13. Smoothed probabilities for percentage of reselling non-top floor units within 10 years

Regime 1



Regime 2



Source: Authors' calculations

Table B1. Summary statistics of variables in hedonic pricing model

Variable	Definition	Mean	Std.Dev.	Min	Max
ln(price)	Natural logarithm of transacted housing price	14.74	0.58	12.30	17.53
floor	Floor level of housing unit	15.12	9.15	1	45
grossarea	Gross area of housing unit (square feet)	656.03	176.33	311	1773
swp	Equals 1 if the estate has a swimming pool, 0 otherwise.	0.75	0.43	0	1
scale	Number of housing units in the estate	7929.16	4553.13	1120	15880
hk	Equals 1 if the estate locates at Hong Kong Island, 0 otherwise.	0.25	0.43	0	1
kln	Equals 1 if the estate locates at Kowloon, 0 otherwise.	0.28	0.45	0	1
cbd	Distance to central business district (kilometers)	17.80	10.68	5.8	39.3
mtr	Distance to the nearest subway station (kilometers)	0.99	0.86	0.08	4.9
market	Distance to mass transit station (kilometers)	1.29	0.72	0.17	2.8
hospital	Distance to public district general hospital (kilometers)	3.51	2.22	0.5	10.2
library	Distance to the public library (kilometers)	1.11	0.49	0.17	2.2
shk	Equals 1 if the estate is developed by Sun Hung Kai, 0 otherwise.	0.19	0.39	0	1
hen	Equals 1 if the estate is developed by Henderson Land, 0 otherwise.	0.12	0.32	0	1
ck	Equals 1 if the estate is developed by Cheung Kong, 0 otherwise.	0.35	0.48	0	1
nwd	Equals 1 if the estate is developed by New World Development, 0 otherwise.	0.24	0.43	0	1
sino	Equals 1 if the estate is developed by Sino, 0 otherwise.	0.05	0.21	0	1

Table B2. Unit root test

	Level	First difference
TFP	-3.7426 ***	-7.3390 ***
RHP	0.1886	-5.3912 ***
RGDP	-0.2088	-4.2455 ***
RHS	-2.2648	-8.4530 ***
RTRADE	-1.0518	-3.2409 **
TERM	-3.1208 **	-7.4799 ***
TED	-2.4599	-9.4967 ***

Note: The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters. *** and ** denotes 1% and 5% statistical significance respectively.

Table B3. Variance decomposition for TFP

Quarters ahead	Explained by innovations in													
	TERM		ΔTED		ΔRTRADE		ΔRGDP		ΔRHS		ΔRHP		TFP	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	3.2	0.0	0.7	0.0	1.6	0.0	0.3	0.0	0.0	0.0	0.9	0.0	93.2	100.0
2	4.9	2.5	5.1	2.8	1.5	0.1	0.4	0.7	0.2	0.0	1.6	2.0	86.3	91.9
3	6.5	3.7	4.6	2.7	2.1	0.1	1.6	0.9	1.7	2.3	4.7	6.8	78.8	83.4
4	5.9	3.4	5.8	4.5	2.0	0.2	2.2	0.9	4.7	5.4	4.6	6.7	74.9	78.9
5	5.7	3.3	5.6	4.4	2.3	0.3	2.2	1.2	4.7	5.5	4.8	6.7	74.7	78.6
6	5.7	3.6	5.8	4.5	2.6	0.3	2.8	1.8	4.7	6.0	4.7	6.6	73.5	77.3
7	5.8	4.0	5.7	4.4	2.5	0.5	3.2	1.9	4.6	5.9	4.6	6.5	73.5	77.0
8	6.0	4.3	5.7	4.4	2.5	0.5	3.3	1.9	4.6	5.9	4.8	6.6	73.0	76.4

Notes:

Order I: TERM, ΔTED, ΔRTRADE, ΔRGDP, ΔRHS, ΔRHP, TFP

Order II: TFP, ΔRHP, ΔRHS, ΔRGDP, ΔRTRADE, ΔTED, TERM

Table B4. Granger causality

		TFP	ΔRHP	ΔRHS	ΔRGDP	ΔRTRADE	ΔTED	TERM
TFP			**					
ΔRHP		**			***	***		
ΔRHS			**					
ΔRGDP	Granger		***			***		
ΔRTRADE	causes		***		***		**	
ΔTED						***		
TERM								

Notes: The lag is chosen to be one. *** and ** denote 1% and 5% statistical significance respectively.

Table B5a. Regression results

$Dependent\ variable: \frac{RHP_t}{RHP_{t-1}} - 1$	
$\frac{RHP_{t-1}}{RHP_{t-2}} - 1$	0.2462 **
TO_TOP_t	6.7983 **
$TO\_NON\_TOP_t$	-3.5716
$\frac{RGDP_t}{RGDP_{t-1}} - 1$	0.1308
$\frac{RTRADE_t}{RTRADE_{t-1}} - 1$	0.1093
$TERM_t$	0.0096
ΔTED_t	-0.0649 ***
Constant	-0.0410 **
Adjusted R-square	0.39

Note: *** and ** denote 1% and 5% statistical significance respectively.

Table B5b. Augmented VAR results

	TFP_t	TO_TOP_t	$\frac{RHP_t}{RHP_{t-1}} - 1$	$TO\_NON\_TOP_t$
TFP_{t-1}	0.1258	0.0500	0.8557 ***	0.0331
TO_TOP_{t-1}	1.4794	-0.1965	5.7133 **	-0.1517
$\frac{RHP_{t-1}}{RHP_{t-2}} - 1$	-0.0948 *	-0.0016	0.2579 **	-0.0171
$TO\_NON\_TOP_{t-1}$	-0.6032	0.7455 **	-4.0428	0.8348 ***
$\frac{RGDP_{t-1}}{RGDP_{t-2}} - 1$	0.0246	0.0032	-0.2183	0.0066
$\frac{RTRADE_{t-1}}{RTRADE_{t-2}} - 1$	0.0176	-0.0105	0.0205	-0.0052
$TERM_{t-1}$	-0.0006	$-5.29*10^{-5}$	0.0072	0.0002
ΔTED_{t-1}	0.0043	-0.0009	-0.0037	-0.0008
Dummy (1996Q1 – 1997Q4)	-0.0197	0.0052	0.0130	0.0075 *
Dummy (1998Q1 – 2008Q2)	0.0067	-0.0005	-0.0169	0.0003
Constant	0.0849 ***	-0.0023	-0.0965 ***	-0.0001
Adjusted R-square	0.09	0.59	0.31	0.68

Note: ***, ** and * denote 1%, 5% and 10% statistical significance respectively.

Table B6. Summary statistics of variables in efficient frontier analysis

Risk premium of:	Mean	Std.Dev.	Min	Max
Top-floor housing market	0.0202	0.1048	-0.1988	0.2393
Mass housing market	0.0416	0.1851	-0.4323	0.4155
Hang Seng Index	0.0518	0.2527	-0.5203	0.6282
S&P 500	0.0595	0.1715	-0.4308	0.5175
Gold	0.0429	0.1649	-0.2747	0.3948
British Pound	-0.0307	0.0858	-0.2986	0.1402
Japanese Yen	-0.0259	0.1150	-0.2798	0.2182

Table B7. Composition of minimum variance portfolio and optimal portfolio

	Minimum variance portfolio		Optimal tangency portfolio	
	With TFU	Without TFU	With TFU	Without TFU
Top-floor housing market	25.76%		14.36%	
Mass housing market	0%	4.47%	0%	5.78%
Hang Seng Index	0%	0%	0%	0%
S&P 500	3.98%	10.29%	45.07%	50.49%
Gold	0%	0%	40.56%	43.73%
British Pound	43.61%	49.14%	0%	0%
Japanese Yen	26.65%	36.11%	0%	0%

Table B8. Summary of profitability analysis

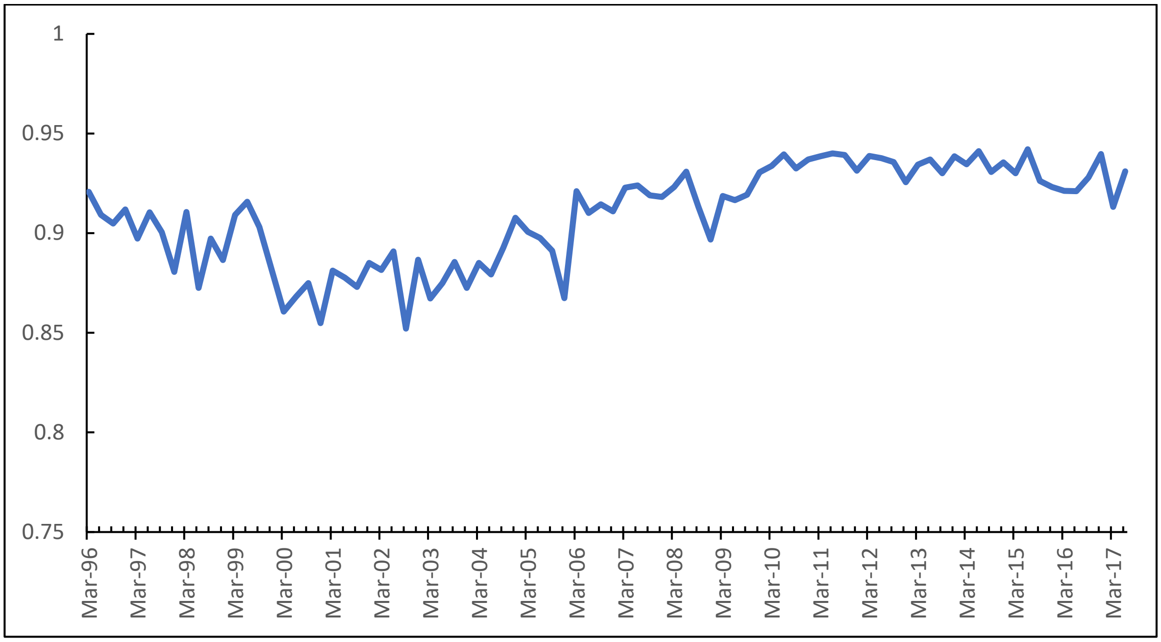
Period	Top-floor transactions	Matched non-top floor transactions	Quadrant				Ratio	$r_A < \mu_A$	$r_A > \mu_A$	Ratio
			I	II	III	IV				
1996Q1 – 1997Q4	153	4;548	109	15	22	7	1: 0.14 : 0.20 : 0.07	105	48	2.19 : 1
1998Q1 – 2008Q2	434	3,773	152	23	229	30	1 : 0.15 : 1.51 : 0.20	203	231	0.88 : 1
2008Q3 – 2017Q2	411	3,593	351	23	27	10	1 : 0.07 : 0.08 : 0.03	233	178	1.31 : 1

Table B9. Switching regression results

Holding period	Type	Regime 1		Regime 2		Hypothesis (at 5% level)			
		μ_1	σ_1	μ_2	σ_2	$\mu_1 = 0$	$\mu_2 = 0$	$\mu_1 = \mu_2$	$\sigma_1 = \sigma_2$
2 years	Top floor units	0.1462	0.0555	0.0387	0.0387	Rejected	Rejected	Rejected	Accepted
	Non-top floor units	0.1999	0.0550	0.0663	0.0145	Rejected	Rejected	Rejected	Rejected
10 years	Top floor units	0.5524	0.0618	0.4249	0.0704	Rejected	Rejected	Rejected	Accepted
	Non-top floor units	0.5177	0.0217	0.5117	0.0950	Rejected	Rejected	Accepted	Rejected

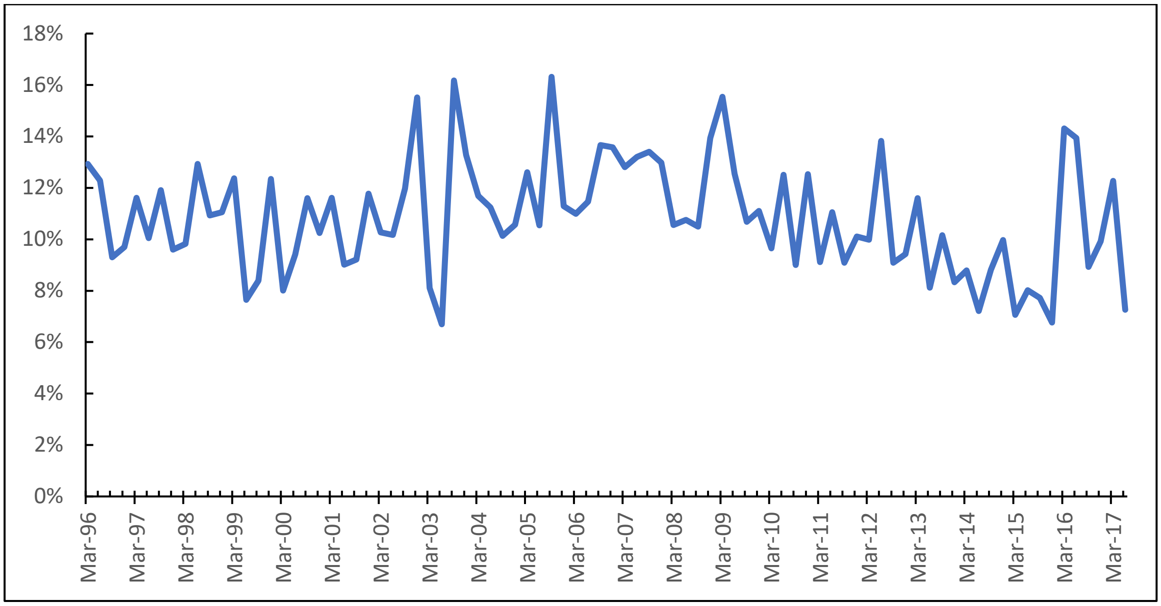
Appendix C. Robustness check – removing distressed transactions

Figure C1. Adjusted R-square of hedonic regression



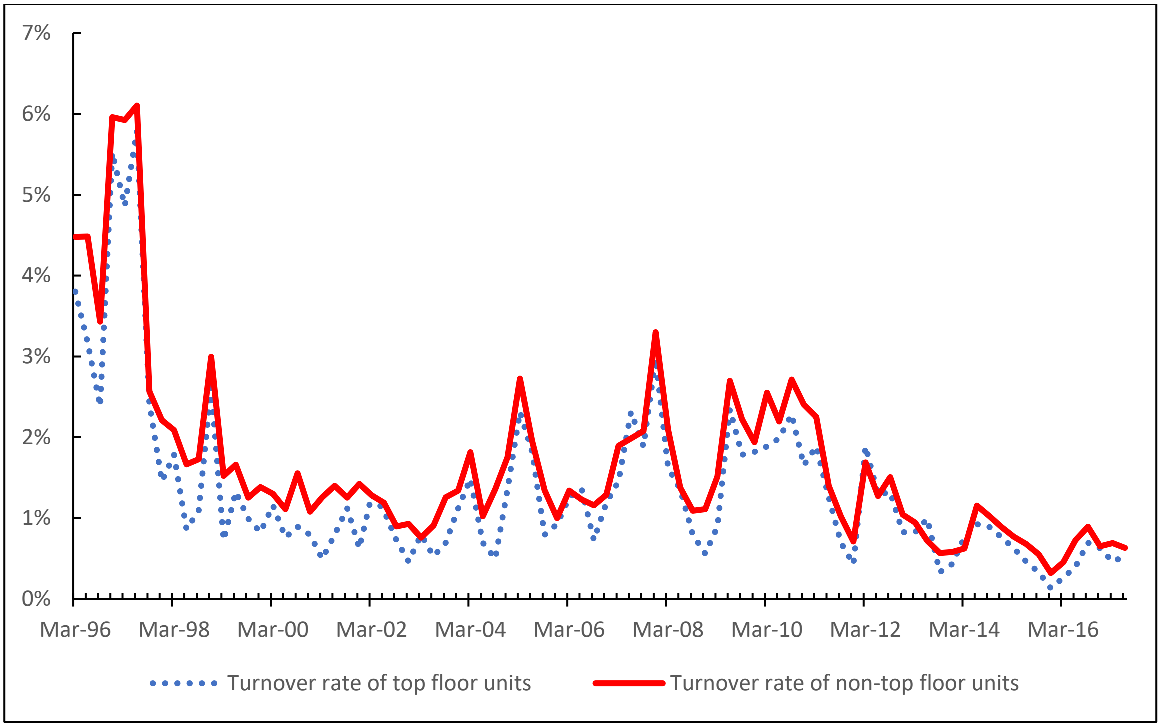
Source: Authors' calculations

Figure C2. Top Floor Premium



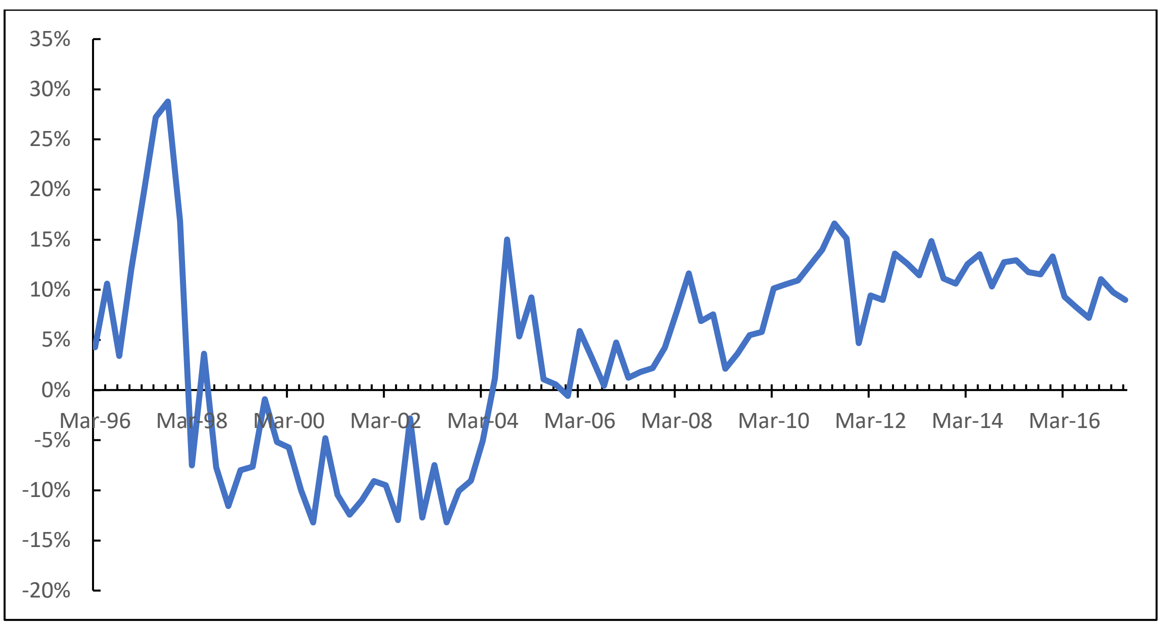
Source: Authors' calculations

Figure C3. Turnover rate of top floor units and non-top floor units



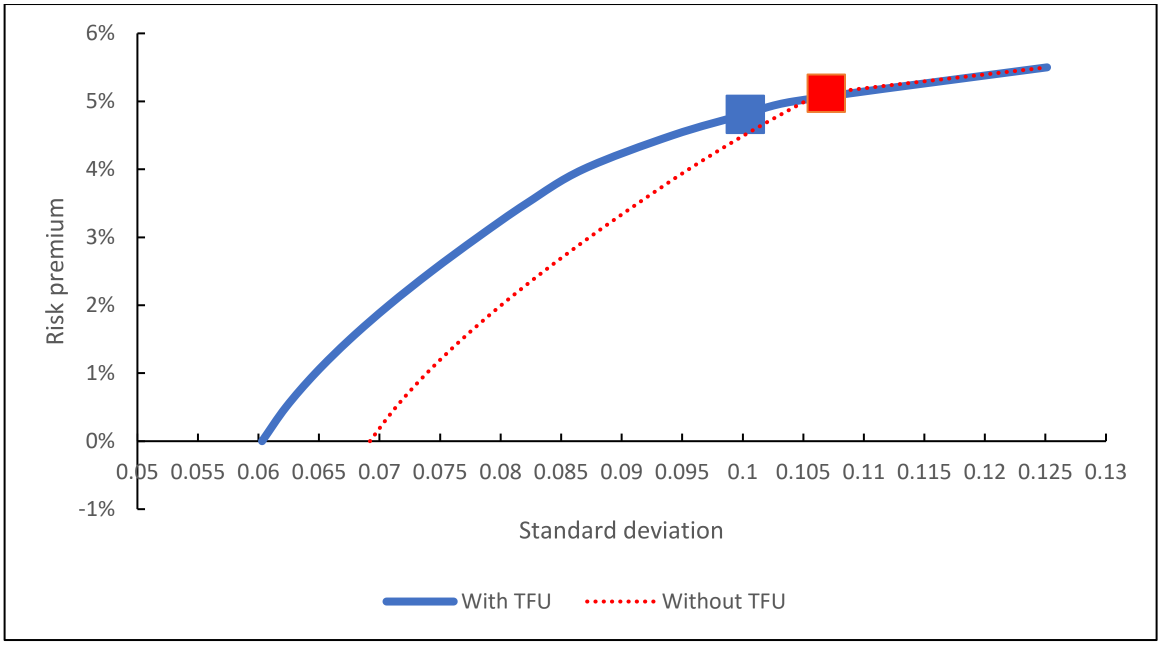
Source: Authors' calculations

Figure C4. Annualized return of TFU market



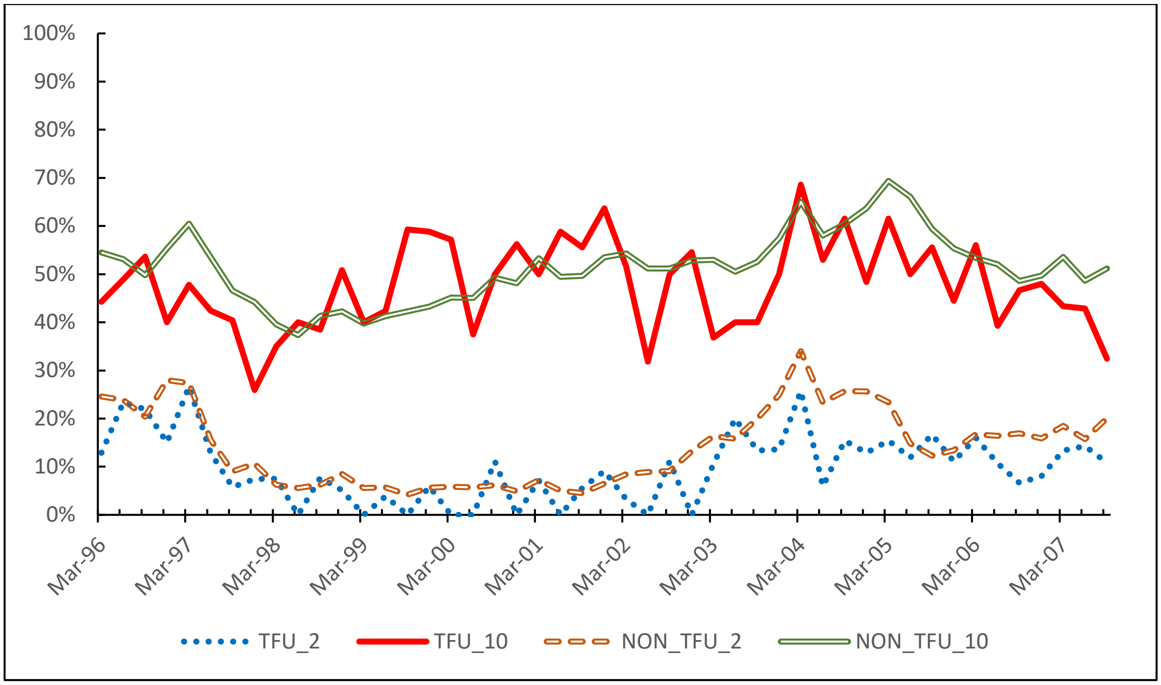
Source: Authors' calculations

Figure C5. Efficient frontier



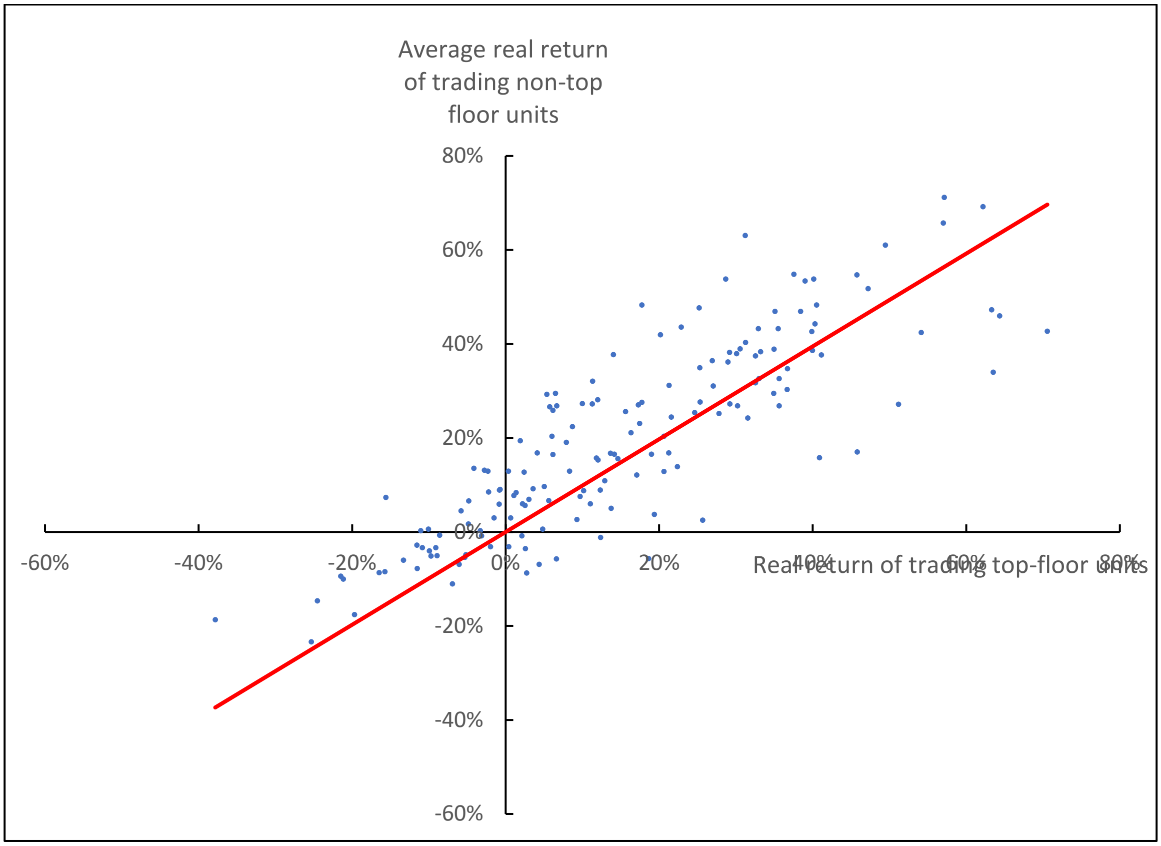
Note: ■ = Optimal tangency portfolio
Source: Authors' calculations

Figure C6. Percentage of housing units that are resold within 2 years and 10 years



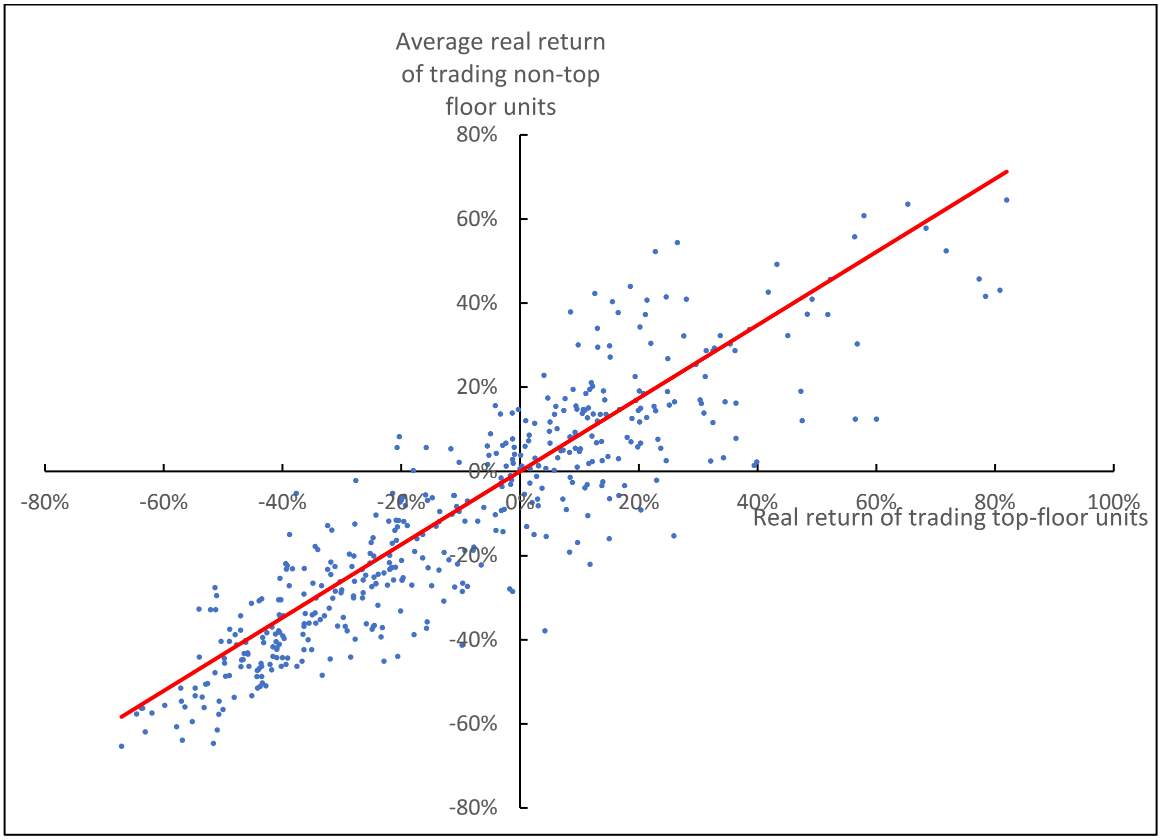
Source: Authors' calculations

Figure C7. Scatter plot of r_A and μ_A during 1996Q1 – 1997Q4



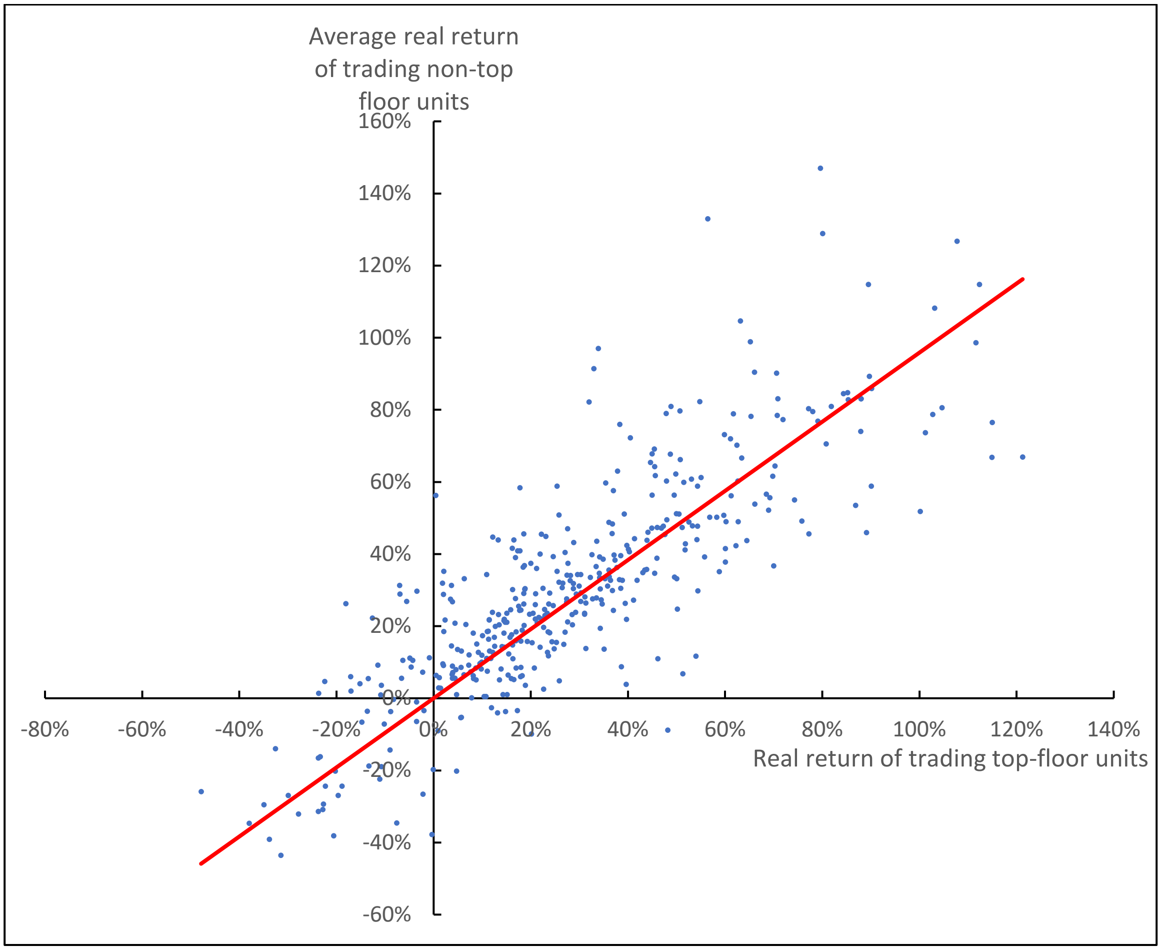
Source: Authors' calculations

Figure C8. Scatter plot of r_A and μ_A during 1998Q1 – 2008Q2



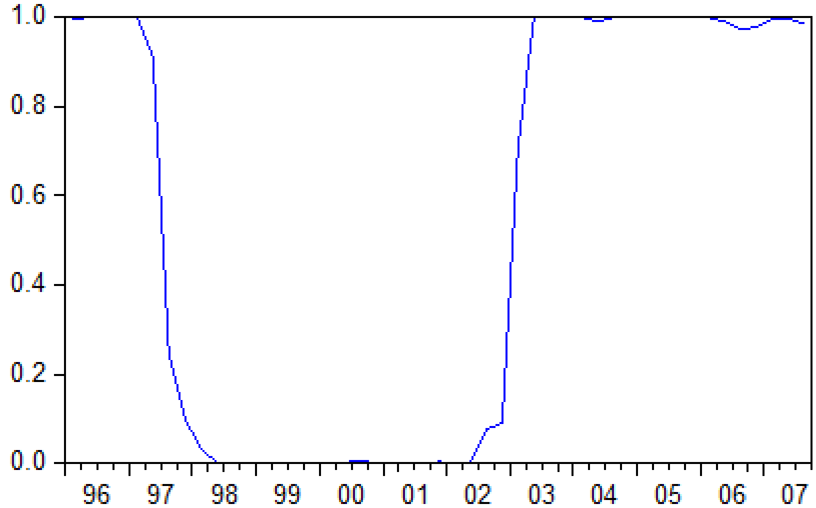
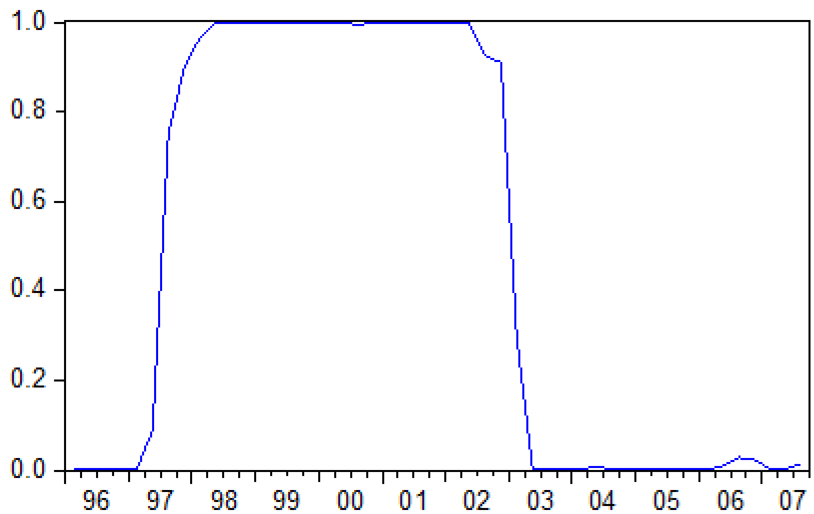
Source: Authors' calculations

Figure C9. Scatter plot of r_A and μ_A during 2008Q3 – 2017Q2



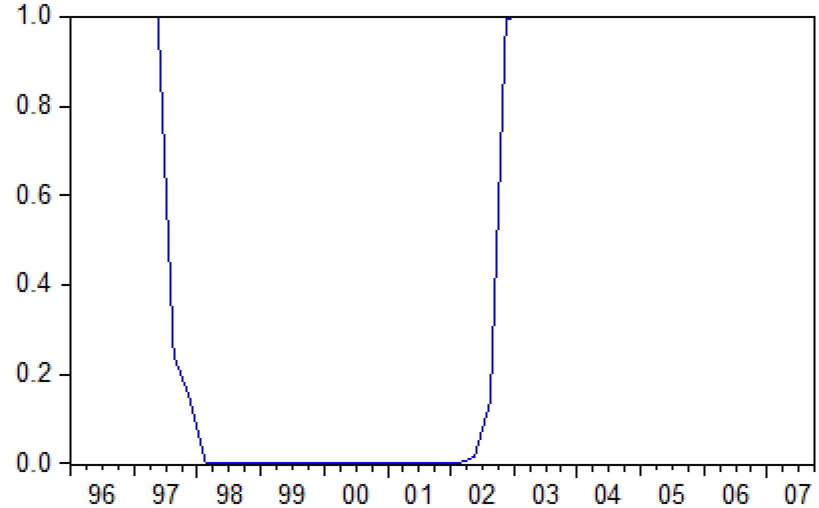
Source: Authors' calculations

Figure C10. Smoothed probabilities for percentage of reselling top floor units within 2 years

Regime 1	
Regime 2	

Source: Authors' calculations

Figure C11. Smoothed probabilities for percentage of reselling non-top floor units within 2 years

<table>
<tr><td>Regime 1</td><td>
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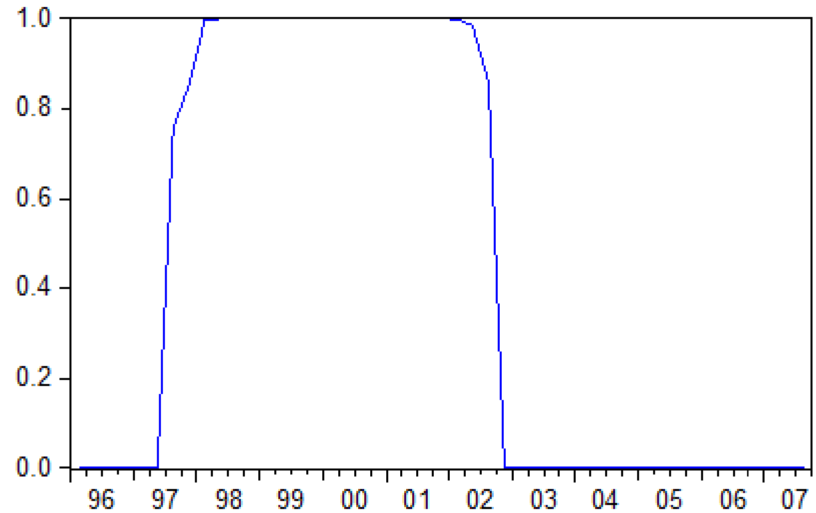
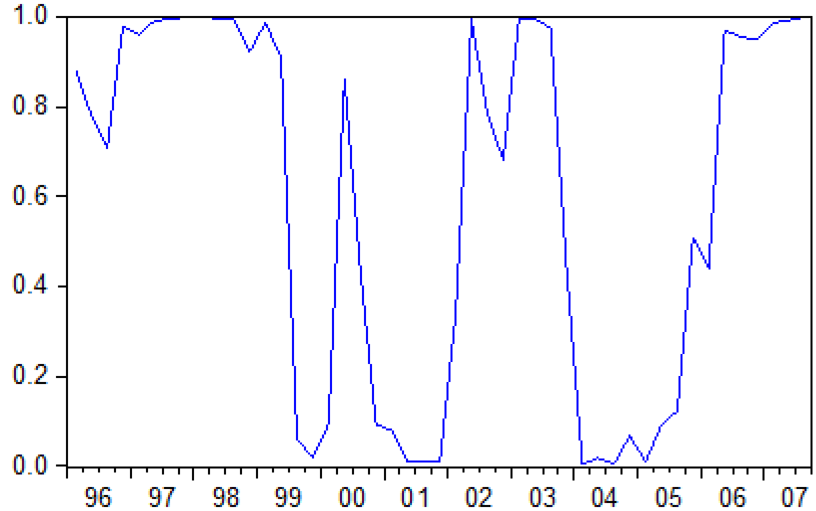
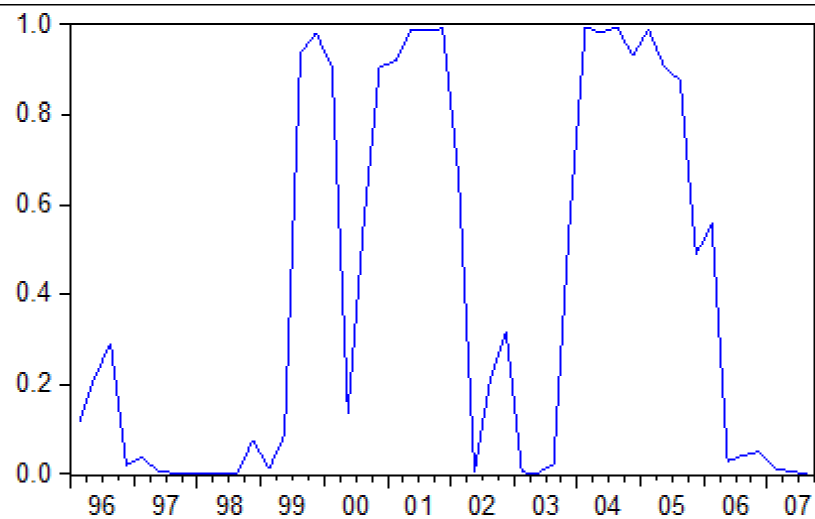
<tr><td>Regime 2</td><td>
</td></tr>
</table>

Source: Authors' calculations

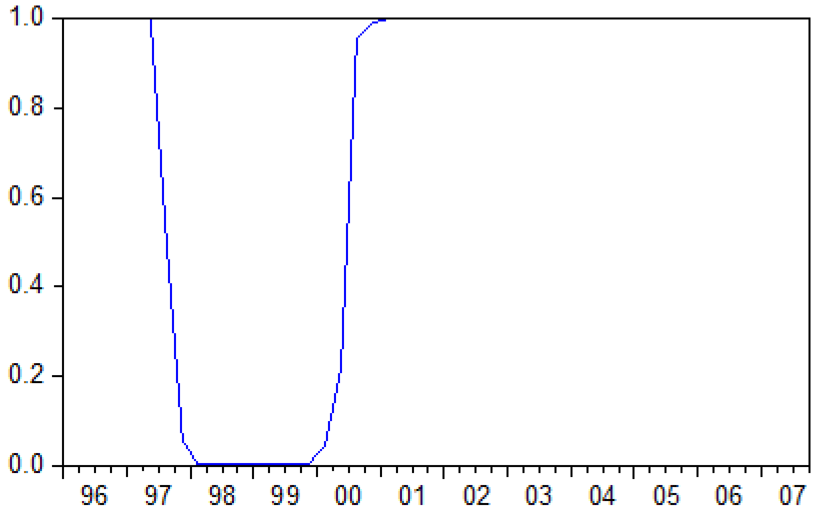
Figure C12. Smoothed probabilities for percentage of reselling top floor units within 10 years

<table>
<tr><td>Regime 1</td><td>
</td></tr>
<tr><td>Regime 2</td><td>
</td></tr>
</table>

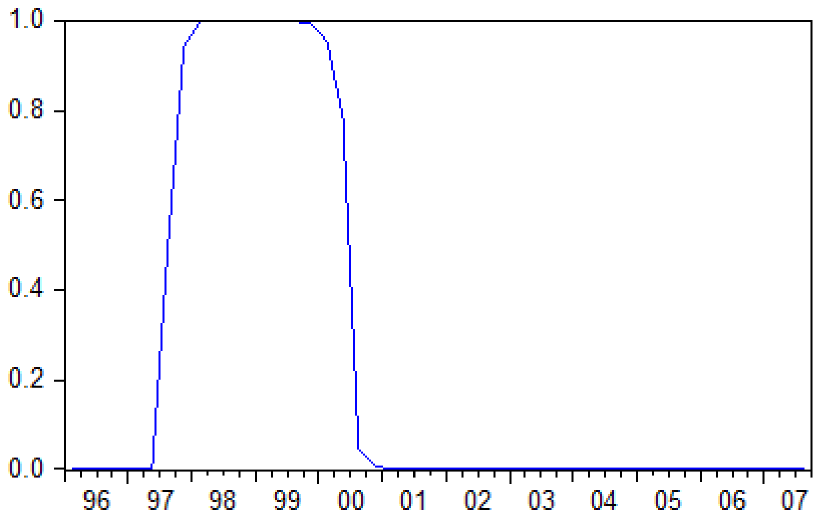
Source: Authors' calculations

Figure C13. Smoothed probabilities for percentage of reselling non-top floor units within 10 years

Regime 1



Regime 2



Source: Authors' calculations

Table C1. Summary statistics of variables in hedonic pricing model

Variable	Definition	Mean	Std.Dev.	Min	Max
ln(price)	Natural logarithm of transacted housing price	14.74	0.57	12.30	17.53
floor	Floor level of housing unit	15.18	9.18	1	45
grossarea	Gross area of housing unit (square feet)	656.90	174.70	311	1773
swp	Equals 1 if the estate has a swimming pool, 0 otherwise.	0.76	0.43	0	1
scale	Number of housing units in the estate	8078.61	4640.27	1120	15880
hk	Equals 1 if the estate locates at Hong Kong Island, 0 otherwise.	0.24	0.43	0	1
kln	Equals 1 if the estate locates at Kowloon, 0 otherwise.	0.27	0.45	0	1
cbd	Distance to central business district (kilometers)	18.29	11.01	5.8	39.3
mtr	Distance to the nearest subway station (kilometers)	1.01	0.85	0.08	4.9
market	Distance to mass transit station (kilometers)	1.31	0.73	0.17	2.8
hospital	Distance to public district general hospital (kilometers)	3.48	2.19	0.5	10.2
library	Distance to the public library (kilometers)	1.11	0.48	0.17	2.2
shk	Equals 1 if the estate is developed by Sun Hung Kai, 0 otherwise.	0.18	0.39	0	1
hen	Equals 1 if the estate is developed by Henderson Land, 0 otherwise.	0.11	0.32	0	1
ck	Equals 1 if the estate is developed by Cheung Kong, 0 otherwise.	0.37	0.48	0	1
nwd	Equals 1 if the estate is developed by New World Development, 0 otherwise.	0.24	0.43	0	1
sino	Equals 1 if the estate is developed by Sino, 0 otherwise.	0.05	0.21	0	1

Table C2. Unit root test

	Level	First difference
TFP	-3.6472 ***	-7.4668 ***
RHP	0.1405	-5.5696 ***
RGDP	-0.2088	-4.2455 ***
RHS	-2.2648	-8.4530 ***
RTRADE	-1.0518	-3.2409 **
TERM	-3.1208 **	-7.4799 ***
TED	-2.4599	-9.4967 ***

Note: The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters. *** and ** denotes 1% and 5% statistical significance respectively.

Table C3. Variance decomposition for TFP

Quarters ahead	Explained by innovations in													
	TERM		ΔTED		ΔRTRADE		ΔRGDP		ΔRHS		ΔRHP		TFP	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	1.8	0.0	0.5	0.0	2.6	0.0	0.1	0.0	1.0	0.0	1.3	0.0	92.7	100.0
2	4.4	3.8	6.5	3.7	2.3	0.0	0.2	1.8	1.5	0.4	1.8	1.3	83.3	89.0
3	5.6	4.6	6.2	3.4	2.7	0.0	1.0	2.0	2.6	2.5	3.6	4.5	78.3	83.0
4	5.2	4.3	6.5	4.4	2.6	0.1	1.4	1.9	4.5	4.8	3.4	4.3	76.4	80.2
5	5.0	4.2	6.4	4.3	2.9	0.1	1.5	2.3	4.7	5.2	3.6	4.4	75.8	79.5
6	4.9	4.2	6.6	4.4	3.2	0.1	2.3	2.9	4.8	5.6	3.5	4.4	74.6	78.4
7	4.8	4.4	6.5	4.3	3.2	0.3	2.5	2.9	4.7	5.5	3.5	4.3	74.8	78.4
8	5.0	4.6	6.5	4.4	3.2	0.3	2.7	2.9	4.8	5.6	3.6	4.4	74.3	77.9

Notes:

Order I: TERM, ΔTED, ΔRTRADE, ΔRGDP, ΔRHS, ΔRHP, TFP

Order II: TFP, ΔRHP, ΔRHS, ΔRGDP, ΔRTRADE, ΔTED, TERM

Table C4. Granger causality

		TFP	ΔRHP	ΔRHS	ΔRGDP	ΔRTRADE	ΔTED	TERM
TFP								
ΔRHP		**			***	***		
ΔRHS			**					
ΔRGDP	Granger		***			***		
ΔRTRADE	causes		***		***		**	
ΔTED						***		
TERM								

Notes: The lag is chosen to be one. *** and ** denote 1% and 5% statistical significance respectively.

Table C5a. Regression results

$Dependent\ variable: \frac{RHP_t}{RHP_{t-1}} - 1$	
$\frac{RHP_{t-1}}{RHP_{t-2}} - 1$	0.2486 **
TO_TOP_t	4.7662
$TO\_NON\_TOP_t$	-1.9561
$\frac{RGDP_t}{RGDP_{t-1}} - 1$	0.0733
$\frac{RTRADE_t}{RTRADE_{t-1}} - 1$	0.1431
$TERM_t$	0.0103
ΔTED_t	-0.0618 ***
Constant	-0.0432 **
Adjusted R-square	0.38

Note: *** and ** denote 1% and 5% statistical significance respectively.

Table C5b. Augmented VAR results

	TFP_t	TO_TOP_t	$\frac{RHP_t}{RHP_{t-1}} - 1$	$TO\_NON\_TOP_t$
TFP_{t-1}	0.1466	0.0441	0.8264 ***	0.0321
TO_TOP_{t-1}	1.8026 *	-0.4891 *	3.7844	-0.5086 *
$\frac{RHP_{t-1}}{RHP_{t-2}} - 1$	-0.0923 *	0.0042	0.2895 **	-0.0087
$TO\_NON\_TOP_{t-1}$	-0.8736	0.9748 ***	-2.3791	1.0872 ***
$\frac{RGDP_{t-1}}{RGDP_{t-2}} - 1$	0.0309	-0.0032	-0.2490 *	-0.0009
$\frac{RTRADE_{t-1}}{RTRADE_{t-2}} - 1$	0.0183	-0.0081	0.0317	-0.0032
$TERM_{t-1}$	$-2.28*10^{-5}$	-0.0001	0.0066	$2.89*10^{-7}$
ΔTED_{t-1}	0.0046	-0.0003	-0.0004	-0.0002
Dummy (1996Q1 – 1997Q4)	-0.0204	0.0076	-0.0050	0.0090 *
Dummy (1998Q1 – 2008Q2)	0.0064	-0.0007	-0.0179	$9.05*10^{-5}$
Constant	0.0814 ***	-0.0014	-0.0935 ***	0.0008
Adjusted R-square	0.11	0.61	0.29	0.67

Note: ***, ** and * denote 1%, 5% and 10% statistical significance respectively.

Table C6. Summary statistics of variables in efficient frontier analysis

Risk premium of:	Mean	Std.Dev.	Min	Max
Top-floor housing market	0.0177	0.1051	-0.1928	0.2330
Mass housing market	0.0416	0.1851	-0.4323	0.4155
Hang Seng Index	0.0518	0.2527	-0.5203	0.6282
S&P 500	0.0595	0.1715	-0.4308	0.5175
Gold	0.0429	0.1649	-0.2747	0.3948
British Pound	-0.0307	0.0858	-0.2986	0.1402
Japanese Yen	-0.0259	0.1150	-0.2798	0.2182

Table C7. Composition of minimum variance portfolio and optimal portfolio

	Minimum variance portfolio		Optimal tangency portfolio	
	With TFU	Without TFU	With TFU	Without TFU
Top-floor housing market	27.80%		10.14%	
Mass housing market	0%	4.30%	1.37%	5.96%
Hang Seng Index	0%	0%	0%	0%
S&P 500	2.55%	9.18%	46.91%	50.62%
Gold	0%	0%	41.59%	43.42%
British Pound	43.36%	50.83%	0%	0%
Japanese Yen	26.28%	35.68%	0%	0%

Table C5. Summary of profitability analysis

Period	Top-floor transactions	Matched non-top floor transactions	Quadrant				Ratio	$r_A < \mu_A$	$r_A > \mu_A$	Ratio
			I	II	III	IV				
1996Q1 – 1997Q4	158	4,929	112	15	23	8	1 : 0.13 : 0.21 : 0.07	109	49	2.22 : 1
1998Q1 – 2008Q2	457	4,027	144	24	259	30	1 : 0.17 : 1.80 : 0.21	222	235	0.94 : 1
2008Q3 – 2017Q2	419	3,655	353	22	34	10	1 : 0.06 : 0.09 : 0.03	239	180	1.33 : 1

Table C9. Switching regression results

Holding period	Type	Regime 1		Regime 2		Hypothesis (at 5% level)			
		μ_1	σ_1	μ_2	σ_2	$\mu_1 = 0$	$\mu_2 = 0$	$\mu_1 = \mu_2$	$\sigma_1 = \sigma_2$
2 years	Top floor units	0.1448	0.0542	0.0420	0.0395	Rejected	Rejected	Rejected	Accepted
	Non-top floor units	0.1989	0.0555	0.0657	0.0167	Rejected	Rejected	Rejected	Rejected
10 years	Top floor units	0.4251	0.0689	0.5553	0.0606	Rejected	Rejected	Rejected	Accepted
	Non-top floor units	0.5430	0.0536	0.4210	0.0249	Rejected	Rejected	Rejected	Rejected

Appendix D

(This section was inspired by the insightful comments of an anonymous referee, and we are extremely grateful for the valuable input.)

In the main text, we examine the difference between top floor units (TFUs) and regular units. In this appendix, we follow the approach of the RDD literature and compare TFUs with the floor directly below, i.e., (N-1), as they are more similar. We also consider other alternatives.

Unfortunately, the tables below reveal that our sample size for (N-1) transactions is limited. (Note: The high numbers in 1993Q1, 1994Q2, and 1997Q2 are due to primary-market sales.) As a result, we are unable to calculate the TFP in many cases. Even when we expand our analysis to include the top 10% (T10) and top 20% (T20), there is only a slight increase in the number of transactions. Therefore, we must use interpolation to fill in the missing data points.

Please note that in a residential building with 20 floors, the units on the 20th floor are considered TFU, the units on the 19th floor are considered (N-1), and the units on the 18th and 19th floors are classified as T-10 units. The units on the 16th, 17th, 18th, and 19th floors are classified as T-20 units.

As a preview, the following table show that the TFP based on T10 and T20 are very different from that based on TFUs.

	Full Sample 1993Q1 – 2013Q1
Correl (TFP, T10-TFP)	–0.06
Correl (TFP, T20-TFP)	0.02

Since the top floor premium for the top 10%, top 20% units (T10-TFP) (T20-TFP), respectively, cannot be obtained after 2013, we can only compute the quantity for the period 1993Q1 – 2013Q1 only. (Intrapolation is used in some quarters).

An important finding is that once T10-TFP, T20-TFP are used, the portfolio analysis suggest to skip the mass housing market and put a significant weight on the top 10% units (Table D2f, D3h), even after liquidity adjustment. This is in sharp contrast with the results of TFUs (Table 4b in the maintext). It confirms that TFU are indeed unique.

<u>Table D1a. N-1 transactions</u>

	Q1	Q2	Q3	Q4
1993	38	0	0	2
1994	2	22	0	8
1995	11	8	0	3
1996	4	4	4	11
1997	5	19	3	2
1998	0	0	0	8
1999	0	0	0	0
2000	0	0	0	0
2001	1	0	0	0
2002	1	0	0	0
2003	0	0	0	1
2004	0	1	0	0
2005	1	0	0	0
2006	1	1	0	0
2007	0	0	0	1
2008	2	0	0	0
2009	0	1	1	1
2010	1	1	0	1
2011	1	1	0	0
2012	0	1	0	0
2013	1	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	1
2017	0	0		

Table D1b. Top floor premium using N-1 transactions

	Q1	Q2	Q3	Q4
1993	8.99%	N.A.	N.A.	1.41%
1994	29.30%	8.96%	N.A.	9.63%
1995	7.27%	7.98%	N.A.	5.57%
1996	8.34%	7.27%	8.61%	10.76%
1997	9.48%	7.44%	13.79%	2.24%
1998	N.A.	N.A.	N.A.	12.09%
1999	N.A.	N.A.	N.A.	N.A.
2000	N.A.	N.A.	N.A.	N.A.
2001	4.33%	N.A.	N.A.	N.A.
2002	5.52%	N.A.	N.A.	N.A.
2003	N.A.	N.A.	N.A.	15.84%
2004	N.A.	27.15%	N.A.	N.A.
2005	11.41%	N.A.	N.A.	N.A.
2006	8.17%	8.04%	N.A.	N.A.
2007	N.A.	N.A.	N.A.	4.58%
2008	8.35%	N.A.	N.A.	N.A.
2009	N.A.	14.21%	14.25%	6.39%
2010	4.00%	3.02%	N.A.	11.09%
2011	14.66%	10.30%	N.A.	N.A.
2012	N.A.	6.19%	N.A.	N.A.
2013	33.33%	N.A.	N.A.	N.A.
2014	N.A.	N.A.	N.A.	N.A.
2015	N.A.	N.A.	N.A.	N.A.
2016	N.A.	N.A.	N.A.	0.47%
2017	N.A.	N.A.		

Table D1c. Top 10% transactions

	Q1	Q2	Q3	Q4
1993	39	9	1	3
1994	4	24	0	8
1995	11	9	0	7
1996	16	7	7	17
1997	17	30	14	2
1998	4	0	1	18
1999	0	2	1	1
2000	1	0	0	0
2001	1	1	1	0
2002	2	0	0	1
2003	0	0	0	1
2004	1	1	0	0
2005	3	2	0	0
2006	1	2	0	1
2007	0	0	1	7
2008	2	0	0	0
2009	0	3	2	5
2010	4	4	2	2
2011	2	4	0	0
2012	1	3	0	0
2013	2	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	1
2017	0	0	[redacted]	

Table D1d. Top floor premium using top 10% transactions

	Q1	Q2	Q3	Q4
1993	8.93%	6.27%	5.18%	2.92%
1994	17.84%	8.66%	N.A.	9.63%
1995	7.27%	8.22%	N.A.	11.33%
1996	11.60%	7.44%	7.45%	13.30%
1997	16.08%	9.86%	7.87%	2.24%
1998	6.07%	N.A.	30.10%	11.43%
1999	N.A.	10.99%	15.66%	8.40%
2000	17.45%	N.A.	N.A.	N.A.
2001	4.33%	16.67%	20.70%	N.A.
2002	9.23%	N.A.	N.A.	16.65%
2003	N.A.	N.A.	N.A.	15.84%
2004	9.03%	27.15%	N.A.	N.A.
2005	7.78%	12.16%	N.A.	N.A.
2006	8.17%	22.31%	N.A.	10.99%
2007	N.A.	N.A.	7.40%	12.46%
2008	8.35%	N.A.	N.A.	N.A.
2009	N.A.	15.63%	7.17%	8.70%
2010	8.99%	16.44%	7.86%	13.10%
2011	13.60%	8.38%	N.A.	N.A.
2012	20.44%	14.74%	N.A.	N.A.
2013	29.46%	N.A.	N.A.	N.A.
2014	N.A.	N.A.	N.A.	N.A.
2015	N.A.	N.A.	N.A.	N.A.
2016	N.A.	N.A.	N.A.	0.47%
2017	N.A.	N.A.	[redacted]	[redacted]

Table D2a. Unit root test (Use 1993Q1 – 2013Q1 only)

	Level	First difference
T10-TFP	-5.3072 ***	-7.0747 ***
RHP	-0.9351	-5.5040 ***
RGDP	-0.1689	-3.7404 ***
RHS	-2.2653	-8.2346 ***
RTRADE	0.2208	-3.3967 **
TERM	-3.1643 **	-7.1208 ***
TED	-2.3693	-9.2738 ***

Note: The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters. *** and ** denotes 1% and 5% statistical significance respectively.

Table D2b. Variance decomposition for T10-TFP (Use 1993Q1 – 2013Q1 only)

Quarters ahead	Explained by innovations in													
	TERM		ΔTED		ΔRTRADE		ΔRGDP		ΔRHS		ΔRHP		T10-TFP	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	0.8	0.0	3.2	0.0	1.4	0.0	0.4	0.0	0.0	0.0	0.3	0.0	93.8	100.0
2	2.0	0.3	3.7	0.0	3.1	0.9	0.4	0.8	0.3	0.1	0.6	0.3	90.0	97.5
3	1.9	0.3	4.0	0.6	2.9	3.1	4.0	1.0	1.1	2.2	0.6	0.4	85.5	92.3
4	2.1	1.3	3.7	1.2	2.8	3.5	5.3	0.9	4.0	5.4	1.0	0.7	81.1	87.1
5	2.4	1.7	3.5	1.2	2.8	3.3	5.4	0.9	3.9	5.1	3.8	3.6	78.1	84.3
6	3.2	2.2	3.4	1.1	2.7	3.3	5.6	1.0	3.9	5.0	3.8	3.7	77.4	83.7
7	4.1	2.8	3.5	1.4	2.6	3.2	5.4	1.0	4.3	5.5	3.8	3.7	76.3	82.4
8	4.1	2.9	3.5	1.4	2.7	3.3	5.5	1.0	4.2	5.5	4.0	3.8	75.9	82.1

Notes:

Order I: TERM, ΔTED, ΔRTRADE, ΔRGDP, ΔRHS, ΔRHP, T10-TFP

Order II: T10-TFP, ΔRHP, ΔRHS, ΔRGDP, ΔRTRADE, ΔTED, TERM

Table D2c. Granger causality (Use 1993Q1 – 2013Q1 only)

		T10-TFP	ΔRHP	ΔRHS	ΔRGDP	ΔRTRADE	ΔTED	TERM
T10-TFP	Granger causes			*				
ΔRHP					**	***		
ΔRHS			***					
ΔRGDP			***			***		
ΔRTRADE			***		***		***	
ΔTED						***		
TERM								

Notes: The lag is chosen to be one. *** and ** denote 1% and 5% statistical significance respectively.

Table D2d. Augmented VAR results (Use 1993Q1 – 2013Q1 only)

	$T10 - TFP_t$	TO_TOP_t	$\frac{RHP_t}{RHP_{t-1}} - 1$	$TO\_NON\_TOP_t$
$T10 - TFP_{t-1}$	0.3314 ***	0.0165	0.2605 *	0.0144
TO_TOP_{t-1}	0.6214	0.1977	3.0035	0.2234
$\frac{RHP_{t-1}}{RHP_{t-2}} - 1$	-0.0146	0.0018	0.2153	-0.0141
$TO\_NON\_TOP_{t-1}$	-1.5931	0.3114	-0.0209	0.3028
$\frac{RGDP_{t-1}}{RGDP_{t-2}} - 1$	0.0764	0.0344	-0.0340	0.0259
$\frac{RTRADE_{t-1}}{RTRADE_{t-2}} - 1$	-0.1471	-0.0377 **	-0.1659	-0.0263
$TERM_{t-1}$	0.0009	-0.0005	0.0109	-0.0005
ΔTED_{t-1}	0.0015	-0.0004	-0.0031	-0.0004
Dummy (1993Q1 – 1997Q4)	-0.0171	0.0039	-0.0239	0.0093 ***
Dummy (1998Q1 – 2008Q2)	-0.0113	-0.0015	-0.0063	-0.0015
Constant	0.1197 ***	0.0053	-0.0797 **	0.0085 **
Adjusted R-square	0.15	0.48	0.27	0.59

Note: ***, ** and * denote 1%, 5% and 10% statistical significance respectively.

Table D2e. Summary statistics of variables in efficient frontier analysis (Use 1993Q1 – 2013Q1 only)

Risk premium of:	Mean	Std.Dev.	Min	Max
T10-TFP	0.09	0.07	-0.03	0.29
Mass housing market	0.03	0.19	-0.43	0.42
Hang Seng Index	0.08	0.29	-0.52	1.12
S&P 500	0.05	0.17	-0.43	0.52
Gold	0.06	0.15	-0.27	0.39
British Pound	-0.03	0.09	-0.30	0.14
Japanese Yen	-0.01	0.11	-0.28	0.22

Table D2f. Composition of minimum variance portfolio and optimal portfolio (Use 1993Q1 – 2013Q1 only)

	Minimum variance portfolio		Optimal tangency portfolio	
	Without liquidity adjustment	With liquidity adjustment	Without liquidity adjustment	With liquidity adjustment
T10-TFP	50.47%	5.87%	92.35%	30.90%
Mass housing market	0.00%	0.00%	0.00%	0.00%
Hang Seng Index	0.00%	0.00%	3.32%	5.15%
S&P 500	3.86%	0.07%	0.07%	24.10%
Gold	0.00%	0.00%	4.26%	39.84%
British Pound	26.17%	36.48%	0.00%	0.00%
Japanese Yen	19.49%	57.57%	0.00%	0.00%

Table D3a. Top 20% transactions

	Q1	Q2	Q3	Q4
1993	42	9	5	6
1994	7	25	0	10
1995	11	10	1	9
1996	21	9	9	31
1997	22	43	16	3
1998	4	0	3	20
1999	0	3	2	2
2000	1	0	1	0
2001	1	2	1	0
2002	3	1	1	1
2003	0	0	0	1
2004	2	1	1	1
2005	9	3	1	0
2006	2	3	0	1
2007	2	2	3	13
2008	4	1	1	0
2009	0	10	4	6
2010	6	12	4	4
2011	4	7	0	0
2012	3	4	0	2
2013	2	0	0	0
2014	1	1	1	0
2015	0	0	0	0
2016	0	0	0	1
2017	0	1	[redacted]	

Table D3b. Top floor premium using top 20% transactions

	Q1	Q2	Q3	Q4
1993	8.48%	6.27%	11.61%	6.51%
1994	14.01%	8.73%	N.A.	9.19%
1995	7.27%	8.46%	0.53%	11.18%
1996	13.42%	8.24%	8.88%	13.61%
1997	14.83%	11.13%	8.13%	4.99%
1998	6.07%	N.A.	11.36%	12.17%
1999	N.A.	11.09%	9.89%	11.43%
2000	17.45%	N.A.	3.61%	N.A.
2001	4.33%	14.19%	20.70%	N.A.
2002	18.36%	15.87%	13.99%	16.65%
2003	N.A.	N.A.	N.A.	15.84%
2004	9.52%	27.15%	3.29%	12.44%
2005	10.25%	5.67%	5.76%	N.A.
2006	18.12%	17.51%	N.A.	10.99%
2007	11.82%	9.37%	10.40%	10.96%
2008	9.49%	12.82%	14.09%	N.A.
2009	N.A.	12.67%	9.07%	9.24%
2010	6.32%	12.75%	10.64%	13.15%
2011	13.54%	7.12%	N.A.	N.A.
2012	9.71%	12.26%	N.A.	10.79%
2013	29.46%	N.A	N.A	N.A
2014	22.32%	7.91%	12.34%	N.A
2015	N.A	N.A	N.A	N.A
2016	N.A	N.A	N.A	0.47%
2017	N.A.	4.95%		

Table D3c. Unit root test (Use 1993Q1 – 2013Q1 only)

	Level	First difference
T20-TFP	–5.67 ***	–12.74 ***
RHP	–0.94	–5.50 ***
RGDP	–0.17	–3.74 ***
RHS	–2.27	–8.23 ***
RTRADE	0.22	–3.40 **
TERM	–3.16 **	–7.12 ***
TED	–2.37	–9.27 ***

Note: The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters. *** and ** denotes 1% and 5% statistical significance respectively.

Table D3d. Variance decomposition for T20-TFP (Use 1993Q1 – 2013Q1 only)

Quarters ahead	Explained by innovations in													
	TERM		ΔTED		ΔRTRADE		ΔRGDP		ΔRHS		ΔRHP		T20-TFP	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	2.54	0.00	0.00	0.00	2.57	0.00	0.22	0.00	0.77	0.00	0.27	0.00	93.62	100.00
2	3.15	0.10	1.17	0.69	2.89	0.01	0.21	0.70	1.30	0.57	1.34	0.95	89.94	97.00
3	8.21	4.54	1.06	0.73	4.22	1.50	1.54	1.16	1.25	0.55	1.92	1.22	81.80	90.30
4	9.70	6.99	1.26	1.21	3.94	2.55	5.48	2.18	2.05	2.10	1.78	1.39	75.79	83.57
5	9.63	7.31	1.83	1.78	3.80	3.13	6.36	2.68	1.98	2.06	1.84	1.38	74.56	81.67
6	9.67	7.96	1.78	1.75	4.01	4.24	6.95	2.60	1.92	1.98	1.97	1.59	73.70	79.89
7	9.47	7.78	1.79	1.71	3.93	4.14	6.91	2.93	2.07	2.39	3.21	2.34	72.62	78.69
8	10.05	8.29	1.84	1.70	3.87	4.09	6.90	2.89	2.26	2.36	4.05	3.61	71.03	77.06

Notes:

Order I: TERM, ΔTED, ΔRTRADE, ΔRGDP, ΔRHS, ΔRHP, T20-TFP

Order II: T20-TFP, ΔRHP, ΔRHS, ΔRGDP, ΔRTRADE, ΔTED, TERM

Table D3e. Granger causality (Use 1993Q1 – 2013Q1 only)

		T20-TFP	ΔRHP	ΔRHS	ΔRGDP	ΔRTRADE	ΔTED	TERM
T20-TFP								
ΔRHP					**	***		
ΔRHS			***					
ΔRGDP	Granger causes		***			***		
ΔRTRADE			***		***		***	
ΔTED						***		
TERM								

Notes: The lag is chosen to be one. *** and ** denote 1% and 5% statistical significance respectively.

Table D3f. Augmented VAR results (Use 1993Q1 – 2013Q1 only)

	$T20-TFP_t$	TO_TOP_t	$\frac{RHP_t}{RHP_{t-1}}-1$	$TO\_NON\_TOP_t$
$T20-TFP_{t-1}$	0.18	0.01	0.04	0.01
TO_TOP_{t-1}	0.42	0.17	2.92	0.20
$\frac{RHP_{t-1}}{RHP_{t-2}}-1$	–0.03	7.03×10^{-4}	0.1973	–0.02
$TO\_NON\_TOP_{t-1}$	–0.79	0.33	0.06	0.32
$\frac{RGDP_{t-1}}{RGDP_{t-2}}-1$	0.20	0.03	–0.05	0.02
$\frac{RTRADE_{t-1}}{RTRADE_{t-2}}-1$	–0.21 **	–0.04 **	–0.14	–0.02
$TERM_{t-1}$	0.01	-5.95×10^{-4}	0.01	-5.26×10^{-4}
ΔTED_{t-1}	1.34×10^{-3}	-4.36×10^{-4}	-4.83×10^{-3}	-4.70×10^{-4}
Dummy (1993Q1 – 1997Q4)	–0.01	3.2×10^{-3}	–0.03	0.01 ***
Dummy (1998Q1 – 2008Q2)	0.01	-1.79×10^{-3}	-7.42×10^{-3}	-1.79×10^{-3}
Constant	0.09 ***	0.01 *	–0.05	0.01 ***
Adjusted R-square	0.08	0.47	0.24	0.59

Note: ***, ** and * denote 1%, 5% and 10% statistical significance respectively.

Table D3g. Summary statistics of variables in efficient frontier analysis (Use 1993Q1 – 2013Q1 only)

Risk premium of:	Mean	Std.Dev.	Min	Max
T20-TFP	0.08	0.06	–0.05	0.29
Mass housing market	0.03	0.19	–0.43	0.42
Hang Seng Index	0.08	0.29	–0.52	1.12
S&P 500	0.05	0.17	–0.43	0.52
Gold	0.06	0.15	–0.27	0.39
British Pound	–0.03	0.09	–0.30	0.14
Japanese Yen	–0.01	0.11	–0.28	0.22

Table D3h. Composition of minimum variance portfolio and optimal portfolio (Use 1993Q1 – 2013Q1 only)

	Minimum variance portfolio		Optimal tangency portfolio	
	Without liquidity adjustment	With liquidity adjustment	Without liquidity adjustment	With liquidity adjustment
T20-TFP	57.79%	7.40%	93.81%	32.60%
Mass housing market	0.00%	0.00%	0.00%	0.00%
Hang Seng Index	0.00%	0.00%	1.06%	2.89%
S&P 500	3.44%	8.35%	2.85%	26.83%
Gold	0.00%	0.00%	2.27%	37.69%
British Pound	23.25%	48.96%	0.00%	0.00%
Japanese Yen	15.52%	35.29%	0.00%	0.00%