Superstition and Asset Markets: Evidence from Singapore Housing

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Abstract

Superstitious beliefs persist if they are not exposed as untrue. This paper investigates whether Chinese superstition that the number 4 is unlucky and number 8 is lucky affects the Singapore housing market. We find that Singaporean Chinese are less likely to buy units and on floors with numbers ending in 4. The prices of residential units with numbers ending in 4 exhibit a discount of 1.1% while those with numbers ending in 8 exhibit a premium of 0.9%. Residents of lucky-numbered homes are no less likely to experience car accidents as residents of unlucky-numbered homes, which suggest that equilibrium choices and prices are in fact based on irrational beliefs.

Keywords: Superstition, real estate, prices, clientele effect, behavioral economics, asset markets

JEL Codes: D1, R3, Z1

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1. Introduction

"The most fundamental reason [for Western Europe overtaking China by the eighteenth century] was the recognition of human capacity to transform the forces of nature by rational investigation and experiment. Thanks to the Renaissance and the Enlightenment, Western elites gradually abandoned *superstition*, magic and submission to religious authority. The Western scientific tradition that underlies the modern approach to technical change and innovation had clearly emerged by the seventeenth century and begun to impregnate the educational system" (Maddison 2007) [emphasis added].

Superstition continues to hold back human and economic development. Some Pakistani parents, believing that polio infection is determined by fate, refuse to let their children be vaccinated against polio (*Dawn*, 2012). Among the people of Madagascar, it is taboo to work on specific days. In 2003-04, an additional taboo day was associated with 6 percent lower per capita consumption and 5 percent lower rice productivity. However, educated households were more likely to ignore the taboo and engage in work (Stifel et al. 2011).

Given its potential impact on human and economic development, it is important to gauge the magnitude of superstition, which would help to quantify the benefits from investment in education (to the extent that education reduces superstition as well as developing skills and building knowledge). Even in advanced countries, people are prone to superstition -- daily newspapers publish horoscopes to guide their readers, most high-rise U.S. hotels skip "13" in numbering their floors (*USA Today*, 2007), and experimental subjects behaved more cautiously in making decisions on Friday the thirteenth as compared with Tuesday the nineteenth (Kramer and Block 2008).

Why does superstition persist in advanced countries and even among educated people? Fudenberg and Levine (2006) theorize that superstitious beliefs can persist if the probability of being exposed as untrue is sufficiently low. If there is always some chance of a bad outcome when following superstition and some chance of a good outcome when not following superstition, the individual might never realize that the belief is untrue, and, persists in the superstition.

Following the attempted assassination of U.S. President Ronald Reagan in March 1981, his wife, Nancy Reagan, regularly consulted an astrologer on President Reagan's schedule of appointments and travel (Vyse 1997). Coincidentally or consequently, there were no further

attempts to kill President Reagan. Research in psychology and anthropology suggests that individuals rely on superstition as a way to cope with misfortune and uncertainty, and to rationalize a complex world (Vyse 1997; Tsang 2004; Lepori 2009; Zhang et al. 2013).

Given the essential role of well-functioning asset markets in economic development, it is particularly important to know whether and the extent to which superstition affects asset markets. To the extent that superstitious beliefs affect price signals, the allocation of resources may be distorted, with negative implications for welfare and economic growth.

Hirshleifer et al. (2012) found that superstition affected the pricing of initial public offerings in China between 1991 and 2005. On the Shanghai and Shenzhen stock exchanges, listed companies are identified by a numerical code, which is the equivalent of the U.S. ticker. Consistent with superstition, newly listed shares with lucky listing codes (that included at least one lucky digit and no unlucky digit) initially traded at a premium, but the premium dissipated within three years.

Solar and lunar eclipses have been associated with lower trading volume and stock returns in U.S. and Asian equity markets, with larger effects when stock prices were more volatile and the eclipses were more publicized (Lepori 2009). These results are consistent with investors resorting to superstitious behavior when facing greater uncertainty and the uncertainty is more salient.

In advanced economies, far more people buy homes than directly invest in equities. Investigating the effect of superstition on residential property, a more widely-owned class of assets, would provide a much broader view of the effects of superstition. For most people, buying a home is their single largest financial commitment. However, it presents many uncertainties -- notably, the quality of the construction and maintenance, whether the home will fit the family's future needs, distance to children's school, the evolution of the neighborhood, and future trends in interest rates and housing prices. Given the large stakes and many uncertainties, people may well rely on superstitious cues when buying a home.

In independent research closest to ours, Fortin et al. (2013) investigated the effect of superstition on the prices of single-family homes in Greater Vancouver. Many Chinese people believe the number "4" to be unlucky and the number "8" to be lucky. In neighborhoods with relatively more Chinese residents and in repeated transactions, the sales prices of houses with street address numbers ending in "4" were 2.2% lower, while those

ending in “8” were 2.5% higher than other houses. However, these findings might possibly be confounded by unobservable differences between the houses. Houses numbered “4” were older, while those numbered “8” were newer and had better features. The difference in age might be related to rebuilding and renumbering of houses previously numbered “4”.

Lacking individual data on buyers, the previous research into superstition in asset markets has not addressed possible clientele effects. For instance, where capital gains are taxed at a lower rate than dividends, taxable investors prefer shares that yield low dividends and large capital gains, while tax-exempt investors are indifferent (Kalay 1982). Furthermore, when a U.S. tax reform in 2003 reduced the tax rate on dividends to the level of that on long-term capital gains, high-income investors re-balanced their equity portfolios towards higher-dividend shares (Kawano 2014). Home buyers could sort in a similar way, with superstitious people buying “lucky” homes and non-superstitious people buying “unlucky” homes.

We address the effect of superstition on asset markets in the context of Singapore housing. Singapore is very well suited for researching the issue for several reasons. First, the country is diversely populated, with a majority of Chinese and a minority of other ethnicities. Hence, with individual data on buyers, we can distinguish prices paid by Chinese vis-a-vis other ethnicities. Second, most homes are high-rise, with all floors being similar if not identical, and so, we can compare prices *within a building*, and thus, avoid unobserved heterogeneity related to addresses. Third, the government strictly regulates the numbering of high-rise buildings according to a fixed format. Hence, the addresses are strictly exogenous, and there are plenty of lucky and unlucky addresses to analyze. By contrast, it would be challenging to study the pricing of (non-existent) 13th floors in the United States.

We draw on the legal filings of 49,784 transactions of new residential units in the Singapore private high-rise real estate market between 2000-2009. Using an ethnic classification system built for this project, we identify the ethnicity of the buyer in every transaction. We find evidence of sorting on unlucky numbers -- relatively fewer Singaporean Chinese bought units and on floors with numbers ending in “4”. We also find evidence of superstition in prices: On a per square meter basis, units with numbers ending in “4” were discounted by 1.1%, units on floors with numbers ending in “4” were discounted by 0.5%, while units with numbers ending in “8” commanded a 0.9% premium.

Furthermore, we find some evidence that the preference for lucky numbers is a luxury good --

the premium for units with numbers ending in "8" was higher in more expensive areas. We also find some evidence that home buyers acted more superstitiously in times of misfortune and uncertainty: the premium for units with numbers ending in "8" was higher when GDP was below trend and the volatility of GDP was above average.

Finally, we show that the Chinese preference against "4" and for "8" is indeed pure superstition. Residents of units with numbers ending in "8" were no less likely to meet with car accidents than residents of units with numbers ending in "4". Specifically, we show that ex-post, they were equally likely to meet with car accidents. This directly allows us to address the issues raised by Fudenberg and Levine (2006) on why superstition may persist and show that in our case the probability of having negative events is as likely for people buying unit "8" versus unit "4".

Our paper directly contributes to a growing theoretical and empirical literature that studies the role of superstition in the market place (e.g. Fudenberg and Levine 2006; Hirshleifer et al. 2012; and Kawano 2014). More generally, we also contribute to the broader behavioral economics literature that studies the role of non-fundamental factors in explaining economic outcomes. For instance, Agarwal, Duchin and Sasuria (2013) show that mortgage loan officers in cities that win the Super Bowl or the American Idol are more likely to make loans, which loans are more likely to default. Weather affects personal mood, and in turn affects stock returns (Hirshleifer and Shumway 2003), risk attitudes in capital markets (Kliger and Levy 2003), and household spending (Agarwal, Chomsisenghet, and Xin 2013).

The rest of the paper is structured as follows. Section 2 explains Chinese numerology and Section 3 introduces Singapore's housing market. Sections 4-7 present the empirical methodology, data, and estimates, while Section 8 concludes.

2. Chinese Numerology

Chinese is a language with a common written script, spoken in different ways by region. In some Chinese dialects, the number "8" is pronounced like the word "prosperity", while the number "4" is pronounced like the word "death". Consequently, "8" is considered to be lucky, and "4" to be unlucky. As Hirshleifer et al. (2012) observe, Chinese numerological symbolism, which derives from Confucian and Taoist beliefs, deviates from scientific notions of causality in two ways. The similarity in the pronunciation of a number to another word has causal import. Further, association with the number (and so, indirectly with the word)

will affect the likelihood of experiencing favorable outcomes.

The effect of Chinese numerological superstition has been quite extensively studied. The government of Hong Kong issues license numbers for motor vehicles that comprise a two-letter prefix and four-digit number, for instance, EP 7466. The government sells new license numbers by public auction. Ng et al. (2010) studied the auction prices between 1997 and 2009. The prices of license numbers including the lucky "8" were systematically higher, while prices of license numbers including the unlucky "4" were lower. However, the premium for "8" could also be interpreted as conspicuous spending to signal wealth or status (Feltovich et al. 2002). The interpretation as conspicuous spending is consistent with the premium for "8" falling after 2006, when the government introduced vanity license numbers, and so, providing another way by which car owners could signal their wealth and status. Moreover, the analysis also revealed that the prices of license numbers including the digit "5" were systematically lower, which cannot be interpreted in terms of superstition.

Most research into Chinese numerological superstition has focused on real estate. Between 1989-96, single-family homes with lucky street addresses in areas of Auckland, New Zealand, with relatively more Chinese residents were sold at a 2.4% premium to equivalent homes in other areas (Bourassa and Peng 1999). Chau et al. (2001) compared the pricing of transactions in Taikoo Shing, a high-rise housing development in Hong Kong, over two 3-month periods, one in which overall real estate prices bottomed and another in which prices overall prices peaked. The prices of apartments on the 8th, 18th, and 28th floors were relatively higher in the boom period.

Vancouver, Canada, is like Singapore in being ethnically diverse, but unlike Singapore in that most housing is low-rise. Fortin et al. (2013) analyzed the prices of about 117,000 sales of single-family homes in the Greater Vancouver area between 2000 and 2005. In neighborhoods with relatively more Chinese residents and in repeated transactions, the sales prices of houses with street address numbers ending in "4" were 2.2% lower and those ending in "8" were 2.5% higher than houses with other addresses. However, these findings might possibly be confounded by unobservable differences between houses and racial homophily. Houses numbered "4" were older, while those numbered "8" were newer and had better features. The difference in age might be related to people buying houses numbered "4", rebuilding and then, petitioning to renumber. In neighborhoods with more Chinese, house numbers ending in "0", "5", and "8" were more frequent (Fortin et al. 2013: Figure 3).

Further, the premium for houses with numbers ending in "8" might reflect a preference among Chinese to cluster with other people of the same ethnicity.[1]

Shum et al. (2012) studied a random sample of high-rise residential sales in Chengdu, a large city in southwest China, between 2004 and 2006. The prices of units on floors with numbers ending in "8" were 8.7% higher when sold as second-hand but not significantly higher when sold as new. There was no significant difference for units on floors with numbers ending in "4". More superstitious buyers (as identified by the number of 8's in their mobile telephone number) were more likely to buy units on the lucky 8 floor. However, it is quite possible that the individual's willingness to pay more for floor numbers ending in "8" was a form of conspicuous consumption to signal wealth or status (Feltovich et al. 2002).

The previous research into the effect of superstition on housing leaves open the question of how the premia for lucky numbers and discounts for unlucky numbers are sustained. Although Vancouver is an ethnically heterogeneous community, Fortin et al. (2013) relied on area-wide demographic characteristics to identify the impact of Chinese buyers. The previous research could not investigate sorting -- non-Chinese buying units with unlucky numbers and Chinese buying units with lucky numbers -- which would be an obvious market response to superstition among some buyers. Moreover, the previous research could not distinguish the prices paid by superstitious and non-superstitious buyers.

By contrast with the studies that focused on housing, Hirshleifer et al. (2012) investigated the effect of superstition on equity markets -- in the context of initial public offerings in China between 1991 and 2005. On the Shanghai and Shenzhen stock exchanges, listed companies are identified by a numerical code, which is the equivalent of the U.S. ticker. For instance, the listing code of the Industrial and Commercial Bank of China is 601398.SS. Consistent with superstition, the proportion of issuers with lucky listing codes (that included at least one lucky digit and no unlucky digit) was abnormally high and the proportion of issuers with unlucky listing codes was abnormally low. Moreover, newly listed shares with lucky listing codes initially traded at a premium to shares with unlucky listing codes, but the premium dissipated within three years.[2]

[1] Wong (2013) finds strong preferences for ethnic homophily among residents of Singapore's public housing.

[2] Apparently, the Chinese vary in their definition of which numbers are lucky. Shum et al. (2012) defined both "6" and "8" as lucky, while Hirshleifer et al. (2012) considered "6", "8", and "9" to be

3. Singapore Housing Market

Singapore is an island nation with land area of about 716 square kilometers (projected to increase to 766 square kilometers by the year 2030). As of June 2012, the population of the country was 5.31 million, including 3.29 million citizens and 533,000 permanent residents. The resident population is ethnically diverse, comprising 74% Chinese, 13% Malays, 9% Indians, and 3% of other races.[3]

Singapore's ethnic diversity provides a natural experiment to investigate the effect of superstition among Chinese people in their decision to buy a home. The non-Chinese population provide a ready control group to test whether the effect of lucky and unlucky numbers on housing choice and prices is specific to Chinese buyers.

Singapore's home ownership rate of over 90% is among the world's highest. The residential market comprises two segments. About 77% of housing units were built by the government's Housing and Development Board, mostly for direct sale to eligible citizens at subsidized prices, with a small proportion for rental. These public housing units are primarily owner-occupied. The government closely regulates the sale and resale of public housing units and tightly controls information on sale prices.[4]

The remaining 23% of residential units are in the private housing market. The private housing market is laissez-faire, except that foreigners are not allowed to buy low-rise residential units such as single-family homes. Private housing may be bought for investment – to rent or re-sell. Information on sales of private housing, including the price and physical characteristics of each transaction, is readily available. Accordingly, like previous studies of superstition in the Singapore housing market, we focus on private housing, where preferences for lucky and unlucky numbers are more likely to be fully revealed.

The Singapore government strictly regulates street addresses and the numbering of high-rise residential units, and so, facilitates study of the effect of superstition on housing prices. The Inland Revenue Authority of Singapore (IRAS), which is responsible for collecting taxes on

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lucky. The common thread in the previous research is that "8" is lucky and "4" is unlucky.

[3] These and the following statistics of Singapore's population and housing market are drawn from the *Yearbook of Statistics 2013*, Department of Statistics, Singapore.

[4] A unique feature of Singapore's public housing is an explicit policy to ensure ethnic diversity (Wong 2013). The Housing and Development Board regulates the resale of apartments by building and area to prevent the percentage of any particular race from exceeding specified benchmarks.

real estate and real estate transactions, has stipulated a specific format for the numbering of all high-rise buildings. The format comprises a block number, and then a unit number comprising a sequence of two digits or characters designating the floor, a hyphen, and two or three digits or characters designating the unit on the floor. For instance, unit number 08-05 is the 5th unit on the 8th floor.

The IRAS enforces compliance with the numbering plan. With regard to the numbering of floors, the IRAS states unequivocally, "'01' is normally assigned to the first level of a building where the main entrance is located, followed by '02' for the second level and so on. … Omission of any numbers is not allowed" (IRAS 2013: Paragraph 3B(1)). The IRAS is equally firm with regard to the numbering of units on each floor: "Units are generally numbered sequentially in a clock-wise direction starting from "01". A unit number will be provided for each distinct unit shown on the floor plan. Omission and reservation of any numbers is not allowed for a residential development" (IRAS 2013: Paragraph 3B(3)). In addition, the IRAS assigns a unique 6-digit postal code to every building.[5]

4. Empirical Strategy

Previous research into residential housing prices identified superstition among Chinese with regard to the house number (Fortin et al. 2013) and the last digit of the floor number (Shum et al. 2012). To encompass both aspects of superstition, we specified the following measures of superstition:

- U4 = 1 if the last digit of the unit number is "4", else = 0;
- U8 = 1 if the last digit of unit number is "8", else = 0;
- FL4 = 1 if the last digit of the floor number is "4", else = 0; and
- FL8 = 1 if the last digit of the floor number is "8", else = 0.

So, for instance, unit 08-05 in a building would be coded as FL4 = 0, FL8 = 1, U4 = 0, and U8 = 0, while unit 23-04 would be coded as FL4 = 0, FL8 = 0, U4 = 1, and U8 = 0.

First, to investigate the effect of superstition on buyers' choice of residential units, we

[5] By contrast, the authorities in other countries are more flexible. In the United States, many high-rise hotels lack a 13th floor (*USA Today*, 2007). The Hong Kong authorities are particularly accommodating of real estate developers in floor numbering. The sales brochure for the Arch, a new development in West Kowloon, boldly advertises that "[t]here are no 14, 24, 34, 40-49, 53-54, 58, 60-61, 64 & 74F". In the absence of units with unlucky numbers, a study of superstition would be limited to investigating the effects of lucky numbers.

estimate a multinomial logit model of the buyer's choice by unit and floor number. Specifically, we suppose that buyer *i* receives the latent utility,

$$Y_{ij}^{*} = \alpha_j + \sum_m \beta_{jm} S_{mi} + X_i \gamma_j + \eta_{ij}, \quad (1)$$

from a residential unit with unit/floor number ending in *j*. The S_{mi} are indicators of buyer *i*'s nationality and ethnicity among the four segments (m = Singaporean Chinese, Singaporean non-Chinese, foreign Chinese, and foreign non-Chinese), X_i are transaction-level attributes, and η_{ij} is a random variable with a type-1 extreme value distribution. Further, the $\alpha_j, \beta_{jm}, \gamma_j$ are coefficients.

We classify units, $j = 4,8,\text{other}$, into three categories -- according to whether the unit/floor numbers end in "4", "8", or other digits. Buyer *i* chooses *j*, i.e. $Y_i = j$, if $Y_{ij}^{*} \geq Y_{ik}^{*}$, for all $k \neq j$. We model the probability that the buyer chooses *j* by the multinomial logit,

$$\text{Prob}(Y_i = j) = \frac{\exp(\alpha_j + \Sigma_m \beta_{jm} S_{mi} + X_i \gamma_j)}{1 + \Sigma_{k=4,8} \exp(\alpha_k + \Sigma_m \beta_{km} S_{mi} + X_i \gamma_k)}, \quad (2)$$

in which unit/floor numbers not ending in "4" or "8" are the reference group.

Although the buyer ethnicity's is exogenous, her decision to buy a unit with a particular unit/floor number could be correlated with physical attributes of the unit. If buyers of different nationality or ethnicity differ in their preference for these physical attributes, the estimated effects of nationality and ethnicity might be biased. Accordingly, we include controls, X_i, for these physical attributes.

Second, to investigate the effect of superstition on pricing, we estimate the logarithm of the transaction price (in Singapore dollars per square meter) paid by buyer *i* for unit *j* at time *t* as a function of measures of superstition, the buyer's nationality and ethnicity, physical attributes of the residential unit, as well as fixed spatial and time effects:

$$\ln P_{ijbt} = \alpha + \sum_{u=4,8} \phi_u I_u + \sum_{f=4,8} \phi_f I_f + S_{mi}\beta + X_i \gamma + \lambda_b + \mu_t + \nu_t + \varepsilon_{ijt}, \quad (3)$$

where the I_u and I_f are indicators of whether the unit/floor number ends in "4" or "8".

In (3), to control for heterogeneity in transactions, X_i are physical attributes of the unit, specifically, size and floor level, S_{mi} are indicators of buyer *i*'s nationality and ethnicity. Further, the building fixed effects, λ_b, control for non-time varying differences between buildings such type of development, location, and legal tenure, the transaction year effects, μ_t, control for changes over time in exogenous factors, such as the macro-economy and interest rates, that affect all residential real estate transactions in the same way, and the transaction

quarter effects, ν_t, control for potential seasonality. The $\alpha, \beta, \phi_u, \phi_f, \gamma$ are coefficients of the explanatory variables. We allow the residual, ε_{ijt}, to be correlated within a building.

Our identifying assumption is that, in the absence of superstitious beliefs, transaction prices should not depend on unit/floor numbers after controlling for size, floor, and building-level variables. Hence, the coefficients of the lucky and unlucky numbers, U4, U8, FL4, and FL8, represent the effect of superstition on pricing of residential units *within buildings*.

To justify the identifying assumption, we note that the design of Singapore high-rise residential buildings is fairly uniform, with the design of each floor being the same. So, the "04" unit is the same on every floor of the building, and similarly, the "08" unit is the same on every floor. Further, the government's strict regulation and clockwise numbering rule prevents real estate developers from selectively numbering more desirable units (for instance, closer to or further from the elevator) and home-owners from renumbering their units. Accordingly, the controls for size, floor, and building almost completely eliminate heterogeneity among units.

5. Data

Our study combines four sources of data. The first is a proprietary dataset of legal filings of private housing transactions with the Registry of Land Titles between January 1995 and December 2012. The records include the address of the residential unit including name of the building, and floor and unit number, attributes of the unit, and details of the transaction. The unit attributes are the legal tenure (freehold or leasehold), type of development (apartment, condominium, or landed), and size in square meters.[6] The transaction details are the date, names and personal identifiers of buyers and sellers (distinguishing between Singapore citizens and permanent residents, non-resident foreigners, and businesses), type of sale (new sale, sub-sale, or resale -- as explained below), and the price.

A "new sale" is the sale of the unit by the real estate developer, which may occur before or after the government issues the "temporary occupation permit", which allows the unit to be

[6] Condominiums are high-rise buildings with exclusive access to amenities such as parking, sports facilities, and children's playgrounds. Apartment buildings are high-rise buildings without such exclusive amenities. Landed properties are single-family homes, and have unique street addresses and 6-digit postal codes. Freehold is an unlimited tenure of ownership, while leasehold is a limited tenure of ownership, typically 99 years, after which ownership reverts to the government.

lived in. A "sub-sale" is the sale of a unit before the government issues the temporary occupation permit, by someone who bought the unit from the developer. A "resale" is the sale of the unit after the issuance of the temporary occupation permit, by a party who is not the developer.

The second source of data is a system that we built to classify any person by name into one of four ethnicities – Chinese, Malay, Indian, and others. The classification is based on the value of a linear combination of the characteristics of the data. We used a proprietary data-set of personal information to train the ethnic classifier system. When validated against a data set of 1327 persons with confirmed ethnicity, the system achieved accuracy of over 99% in recognizing Chinese names and 82.7% in recognizing non-Chinese names (over 99% of persons classified as Chinese were actually Chinese, and 82.7% of those classified as non-Chinese were actually not Chinese). Appendix A describes the system. We used the classification system to identify the ethnicity (Chinese or non-Chinese) of buyers named in the legal filings with the Registry of Land Titles.

The third source is a proprietary data-set of court records of civil actions against personal defendants involved in car accidents. For each case, the record includes the filing date and the names and personal identifiers of the parties. We link this data to residential property transactions through the buyer's personal identifier. We use the data on car accidents to investigate whether lucky and unlucky numbers are pure superstition, and specifically, whether people living at unlucky addresses actually experience more car accidents than those living at lucky addresses.

The fourth source is a proprietary data-set of home insurance policies issued by a major insurer. We use this data to investigate the relation, if any, between the amount of insurance coverage and home number.

Like Shum et al. (2012), we focus on high-rise residential developments. The plans of the various floors in high-rise buildings are quite similar, if not identical. Possible departures from a common floor plan include first floor units which might include a terrace and top floor units which might include a terrace or comprise two floors. By contrast, single-family homes are heterogeneous and may differ in unobservable ways that correlate with the house number (e.g. Fortin et. al. 2013).

Unlike previous studies in the Asian context, we consider only the primary market, i.e., new

sales. Apart from a few transactions with missing data or errors, the data on new sales are quite complete. Importantly, all new units in a building are sold by the same seller, and so, within-building estimates would not be confounded by differences among sellers. In addition, the quality of new residential units is uniform within a building. By contrast, studies of the secondary market are subject to possible selection bias in sub-sales and resales, and differences among sellers. Moreover, resale units might differ in ways that we cannot observe, such as maintenance, and which might be correlated with unit or floor number.

The Urban Redevelopment Authority (URA), a government agency, publishes limited data on all private housing transactions in the online database, REALIS. Importantly, REALIS does not publish the names of buyers and sellers. Figure 1 compares the numbers of new sales of private housing in the REALIS database and our proprietary dataset of legal filings. Evidently, the legal filing dataset provides good coverage from 2000 onward and up to 2009. Accordingly, we focus our study on transactions in the period, 2000-09. Transactions were cyclical, peaking in 2002, and falling sharply in 2003, the year of the SARS (Severe Acute Respiratory Syndrome) crisis. Transactions recovered gradually to a new peak in 2007, before falling sharply in 2008, on the advent of the global financial crisis.

[Insert Figure 1 here]

As catalogued in Table 1, the dataset of legal filings covers 91,112 new sales of high-rise residential units between 1995-2012. We exclude transactions with incomplete or obviously wrong information, those in which the buyer was a company, and those with mixed lucky and unlucky address, such as 04-18, which left 77,140 transactions. If the buyers were two people of mixed (Chinese and non-Chinese) ethnicity, we coded them as Chinese.

[Insert Table 1 here]

Finally, we limit the main analysis to units on the 29th floor and below in buildings with 6 or more floors.[7] To explain, Figure 2 plots the estimated coefficients of the floor levels in a regression of the logarithm of unit price per square meter on floor-level indicators. Overall, the price increases with the floor level, but the relationship is weaker at the 4th and 5th floors, and above the 30th floor.

[Insert Figure 2 here]

[7] In a robustness check, we confirm our findings in the larger sample of all units in all buildings.

The 2008 Master Plan raised the maximum height of buildings in low density areas from 4 to 5 floors, which rendered 4th floor units in buildings approved before and after the change not comparable. Moreover, the minimum road buffer space for buildings with 6 or more floors is 25% larger than for those with 5 or fewer floors. In addition, buildings with 4 or fewer floors are not required to be equipped with an elevator. The relationship between price and floor level likely depends on elevator access. Lacking information on the provision of elevators, including these buildings in our analyses might bias the estimated effects of FL4 and FL8. Accordingly, we exclude buildings with 5 or fewer floors.

Many residential developments in the Central Business District have 30 or more floors. Units on higher floors may include a terrace or have a two-storey layout. Such features might explain the non-monotonicity of price above the 30th floor in Figure 2. Accordingly, we exclude these units from our analysis. However, we keep the lower units to ensure a proper representation of the Central Business District.[8] Our final sample comprises 49,784 new sales.

[Insert Table 1 here]

Table 2 presents summary statistics. The average price was S$8,546 per square meter or about US$484.31 per square foot (converted at the average exchange rate of one Singapore dollar to 61 U.S. cents during the period 2000-09). The size of the average unit was 117.5 square meters or 1264.8 square feet, and so, it cost US$612,532. Regarding unlucky and lucky numbering, 10.2% of the units had numbers ending in "4", while just over 7.1% had numbers ending in "8", while 10.1% had floor numbers ending in "4", and almost 8.9% had floor numbers ending in "8".

[Insert Table 2 here]

For a first look at the data, Figure 2 plots the estimated coefficients of the floor levels in a regression of the logarithm of unit price per square meter on floor-level indicators. As discussed above, the price increases with the floor level, but the relationship is weaker at the 4th and 5th floors, and above the 30th floor. Figure 3 plots the estimated coefficients of the unit number last digits in a regression of the logarithm of unit price per square meter on

[8] While units in buildings with 30 or more floors account for 16% of all new sales, they account for more than 29% of new sales in the Central Business District.

indicators of unit number last digits. These estimates are not sensitive to whether we include building with less than 6 floors and units on the 30th floor or higher. Clearly, the prices of units with numbers ending in "4" were lower, while the prices of units with numbers ending in "8" were higher.

[Insert Figure 3 here]

With regard to nationality and ethnicity, 70.5% of the buyers were Singaporean Chinese. Of the remaining buyers, just over 6% were Singaporean non-Chinese, 15.5% were foreign Chinese, while 7.8% were foreign non-Chinese. The ethnic classifier system is less accurate in classifying the ethnicity of foreigners. Among the foreign buyers, there are Indonesian Chinese with Malay-like names, and Thai Chinese with Thai names which the ethnic classifier would classify wrongly as non-Chinese. So, the estimates with respect to foreign buyers should be interpreted with caution.

6. Estimates

To investigate the influence of superstition on buyer's choice, we estimated the multinomial logit model, (2), for choice of units and floors, and report the results in Tables 3 and 4 respectively. To save space, Tables 3 and 4 present the results in two columns, with the estimated coefficients for choice of units with unit/floor number ending in "4" in one column and the estimated coefficients for choice of units with unit/floor number ending in "8" in another column. In all of the multinomial logit regressions, the reference (omitted) segment by nationality and ethnicity is Singaporean Chinese.

Table 3, columns (1)-(2), report the simplest specification with the buyer's ethnicity and nationality as the only covariates. Relative to Singapore Chinese buyers, Singaporean non-Chinese and foreign Chinese were more likely to buy U4 units (with numbers ending in "4"). However, compared to Singaporean Chinese buyers, others were not significantly less likely to buy U8 units (with numbers ending in "8"). Apparently, buyers sorted on the unlucky number but not the lucky number.

[Insert Table 3 here]

Units might differ in level, size and price, and these differences might be correlated with unit numbers. (Indeed, as we show below, the prices of U4 units were discounted, while U8 units commanded a premium.) Accordingly, the next specification includes floor fixed effects as

well as the logarithm of unit size and price per square meter. As reported in Table 3, columns (3)-(4), the effects of nationality and ethnicity were uniformly larger for choice of U4. Relative to Singapore Chinese, the most likely to buy U4 units were, in decreasing order, foreign non-Chinese, Singaporean non-Chinese, and foreign Chinese. This order is quite consistent with superstitious beliefs among ethnic Chinese. Foreign Chinese include people from Northern China and from Western countries, who might be less superstitious than Singaporean Chinese, who are mostly descendants of immigrants from Southern China, among whom superstitions regarding "4" and "8" are strongest.

One challenge in estimating equation (2) is that the transaction price may be endogenous. While we are not interested in the effect of price as such, failing to correct the endogeneity could bias the estimated effect of ethnicity if buyers' superstitions are correlated with their willingness to pay. To address such endogeneity, we instrument for price. As the model is not linear, we include the residual of the first stage regression as an additional control variable in the second stage regression.[9] In the first stage regression, the instruments for price were the proportion of U4 units sold to date relative to the total number of U4 units, the proportion of U8 units sold to date, and the proportion of all units sold to date. These proportions reflect the overall demand for the units, and so, would affect the price, but would be unrelated to buyer preferences among units with different numbers.

As reported in Table 3, column (5), the first-stage regression fit very well and the *F*-statistic for the exclusion of the three instrumental variables is 18.99. Table 3, columns (6)-(7), present the instrumental variable estimates. The estimated coefficients of nationality and ethnicity were quite similar to the estimates without instruments for price, suggesting that any endogeneity of price had little effect on the measured effect of nationality and ethnicity.

[Insert Table 4 here]

Next, we turn to the buyers' choice of floor. Table 4, columns (1) and (2), report the simplest specification. Relative to Singapore Chinese buyers, Singaporean and foreign non-Chinese were more likely to buy FL4 units (units on floors with numbers ending in "4"). Relative to Singapore Chinese buyers, Singaporean non-Chinese were less likely and foreign Chinese buyers were more likely to buy FL8 units.

[9] In this context, Terza (2008) shows that the estimated coefficient of the potentially endogenous variable is consistent with inclusion of the residual from the first stage regression as an additional control. However, the estimate is not consistent if the potentially endogenous variable is replaced with the predicted value from the first stage regression.

The preceding results might be confounded by differences between floors, particularly in price (higher floors commanding a higher price). Accordingly, the estimate in Table 4, columns (3) and (4), included controls for unit size, price, floor (in quadratic rather than floor fixed effects, which would not allow FL4 and FL8 to be identified), and fixed effects for the last digit of the unit number. With the addition of these controls, the evidence of sorting on choice of U4 became stronger. Relative to Singapore Chinese buyers, in decreasing order, foreign non-Chinese, Singaporean non-Chinese, and foreign Chinese were more likely to buy FL4 units. This pattern is very similar to that for choice of U4. With regard to choice of FL8 units, Singaporean non-Chinese were less likely and foreign Chinese buyers were more likely than Singaporean Chinese to buy FL8 units. Further, as reported in Table 4, columns (6) and (7), all but one of these findings were robust to estimation with instruments for price. The exception was foreign Chinese being more likely to buy FL8 units than Singaporean Chinese.

To sum up, we find significant evidence of sorting on unlucky numbers. Singaporean Chinese buyers were less likely to purchase U4 and FL4 units than all other buyer segments by nationality and ethnicity. We find limited evidence of sorting on lucky numbers -- Singaporean Chinese buyers were more likely to purchase FL8 units than Singaporean non-Chinese buyers. Choices are consistent with Singaporean Chinese choosing residential units according to superstitious beliefs about "4" being unlucky and "8" being lucky.

Next, to investigate the influence of superstition on prices, Table 5 reports regressions of the OLS model, (3), of the logarithm of price (in Singapore dollars per square meter). To control for differences in price due to differences in physical attributes and purchase timing, all estimates include indicators for even-numbered floors, first floor, top floor, fixed effects for groups of two floors (1-2, 3-4, 5-6, etc.), logarithm of the unit size in square meters, and fixed effects for transaction year and quarter. Referring to Figure 2, it is evident that higher floors command higher prices. However, we could not include indicators for every floor, as that would prevent FL4 and FL8 being identified. So, we include fixed effects for groups of two floors as well as an indicator of even-numbered floors. Within each group of two floors, the even-numbered floor, being higher, should command a higher price.

We begin with a specification that identifies the effect of superstition across and within buildings and is comparable to previous studies (Shum et al. 2012 and Fortin et al. 2013). This specification also includes legal tenure of property (leasehold/freehold) and type of development (condominium/apartment) as covariates. Table 5, column (1), reports the results.

As expected, even-numbered floors were more expensive. Prices of first floor and top floor units were discounted, perhaps because many include terraces, which inflate the size and deflate the price per square meter.[10]

With regard to superstition, the prices of U4, U8, and FL8 units were not significantly different from those of other units, while FL4 units exhibited a 2.8% discount. Interestingly, relative to Singaporean Chinese, the other buyers paid higher prices -- in increasing order, Singaporean non-Chinese, foreign Chinese, and foreign non-Chinese, with the latter paying a premium that seems rather too large.

[Insert Table 5 here]

The preceding estimate did not control for differences between buildings such as location and quality. The apparently large premium paid by foreign non-Chinese buyers might be due to their choosing more expensive developments. To control for such spurious correlation, the next specification includes fixed effects for each building. The building fixed effects control for differences between buildings in legal tenure, type and quality of development, and location. Hence, this specification identifies the effects of superstition (as represented by the coefficients of U4, U8, FL4, and FL8) *within buildings*.

Table 5, column (2), reports the estimate with building fixed effects. The coefficient of size was negative, which means that larger units were cheaper on a per square meter basis (while being more expensive in terms of total cost). Otherwise, the estimated effects of the other physical attributes were more muted. The estimate also revealed discrimination in pricing within buildings: in increasing order, Singaporean non-Chinese, foreign Chinese, and foreign non-Chinese paid relatively higher prices, with the latter paying the highest premium of about 1.6%.

Regarding the measures of superstition, the coefficients of U4, -0.011 (s.e. 0.001), and U8, 0.009 (s.e. 0.001), were somewhat larger and very precisely estimated, the coefficient of FL4, -0.005 (s.e. 0.002), was almost an order of magnitude smaller but still significant, while coefficient of FL8, -0.002 (s.e. 0.002), was negative and not significant. The discounts for U4 and FL4, and premium for U8, all of the order of 1%, are consistent with Chinese numerological superstition. We preferred this estimate as it identifies the effects of

[10] The average size of unit is 138.96 square meter on the 1st floor, 158.58 square meter on the top floor, and 114.14 on all other floors.

superstition within buildings, and so, controls for most sources of heterogeneity between residential units.

Apparently, the superstitious effect of unit numbers was stronger than floor numbers. This is perhaps because the Singapore numbering system stipulates the address to comprise the floor number followed by the unit number. So, the unit number, being last, may be more salient.

The next four estimates, reported in Table 5, columns (3)-(6), distinguished the pricing of unlucky and lucky addresses among Singaporean Chinese vis-a-vis other segments of buyers. Apparently, all buyers received discounts for U4 and paid premia for U8, but the discounts and premia were most pronounced among Singaporean Chinese buyers. This pattern of prices suggests that Singaporean Chinese were the marginal buyers and established the market prices for U4 and U8 units. The discount for FL4 was most pronounced among foreign Chinese buyers, which is somewhat at odds with our finding, in Table 3, that they were more likely to choose FL4 units than Singaporean Chinese.

6.1 Robustness

The analysis so far focused on the pricing of new residential units on the 29th floor or lower in buildings with at least 6 floors in the years, 2000-09. Table 6 reports various robustness tests to check the sensitivity to these sampling restrictions. For convenience, Table 6, column (1), reports the preferred estimate from Table 5, column (2).

[Insert Table 6 here]

As reported in Table 6, column (2), with the sample expanded to all new sales between 2000-09, the estimated coefficients of U4 and U8 are almost identical to the preferred estimate. However, by contrast with the preferred estimate, the coefficients of FL4 and FL8 are positive and significant and the coefficient of even-numbered floors is negative and significant. These puzzling results are possibly due to the implicit restriction that the impact of floor level on the price is the same in high- and low-rise buildings and for units located on very high floors.

Table 6, column (3), reports an estimate with the sample further expanded to all new sales in all the years for which we have data, 1995-2012. The results are almost identical to that for all sales between 2000-09, reported in Table 6, column (2). However, if we exclude units on the 30th floors or above and buildings with 5 or fewer floors, the coefficients of U4, U8, FL4

and FL8 are virtually the same as in the preferred estimate. This further confirms our conjecture that the impact of the floor level on price differs between high- and low-rise buildings and between units located at very high floors and lower floors.

6.2 Exploration

Having checked the robustness of the preferred estimate, we turn to explore the extent of superstition in pricing and consider alternative and complementary explanations of the discounts for unlucky numbers and premia for lucky numbers.

While we explain the discounts for U4 and FL4 and premia for U8 in terms of Chinese numerology, another possible explanation is conspicuous consumption (Feltovich et al. 2002; Charles et al. 2009). Paying more for lucky numbered car licenses and homes is credible way to show off wealth and perhaps signal to potential life partners and business associates. The more expensive and less intrinsically valuable is the item, the more effective it might be as a signal of wealth. And what could be intrinsically less valuable than a number? Feltovich et al. (2002) model conspicuous consumption and show that only middle classes engage in signaling. The top class need not, while the low class cannot afford to. Our data-set comprises only private housing, so, we can only investigate the effect of house numbers on the high end of the housing market.

Table 6, column (4), reports an estimate limited to new sales in the "core central region", which comprises the most expensive areas of Singapore. Compared to the preferred estimate for all of Singapore, the discount for U4 was smaller while the premium for U8 was twice as large, but there was no significant discount for FL4 and no significant premium for FL8. Apparently, the premium for lucky unit numbers was even stronger in expensive areas than in the overall market. This result might be interpreted as conspicuous consumption overlaid on superstition, but not signaling in the sense of Feltovich et al. (2002).

Finally, we report analyses that provide further support for our interpretation of the discounts for U4 and FL4 and premia for U8 as superstition. Research in psychology and anthropology suggests that individuals rely on superstition as a way to cope with bad luck and uncertainty (Vyse 1997; Tsang 2004; Lepori 2009; Zhang et al. 2013).

Table 6, column (5), addresses the impact of bad luck, characterized by real GDP falling below its four-quarter moving average. Bad luck was associated with a significantly larger premium for U8, but had no effect on discounts for U4 or FL4. Table 6, column (6),

addresses the impact of uncertainty, characterized by the standard deviation of the difference of GDP from its four-quarter moving average being higher than average.[11] Uncertainty was associated with a significantly larger premium for U8, but had no effect on discounts for U4 or FL4. The results are consistent with theory from psychology and anthropology that people rely more on superstition when facing misfortune and uncertainty.

7. Rationality

All previous research into the effects of lucky and unlucky numbers on the behavior of Chinese people assumed implicitly that the beliefs were pure superstition, with no rational basis. To complete our analysis, we explore the rationality of the superstition about lucky and unlucky numbers. Specifically, we investigate the effect of home number on the demand for home insurance and the incidence of traffic accidents. This allows us to directly test the model predictions of Fudenberg and Levine (2006) and show if there could be rational reasons for superstition to persist.

One of Singapore's leading providers of general insurance provided us with limited information on all home insurance policies in force as of the year 2011. The data included age, gender, ethnicity (Chinese or non-Chinese), postal code, amount of insurance coverage, and whether the unit number ended in "4" or "8".

[Insert Table 7 here]

Table 7, column (1), reports a regression of the logarithm of insurance coverage (in thousand Singapore dollars) on gender, age, ethnicity, U4, U8, and the interactions of U4 and U8 with Chinese ethnicity. Table 7, column (2), includes 2-digit postal code fixed effects to control for differences between neighborhoods in the likelihood of burglary, fire, and other losses. Chinese living in units with number ending in "8" bought relatively less insurance coverage. One possible explanation is that the Chinese home owner felt lucky and so, arrange of lower insurance coverage.[12]

In our second exploration, we check for any effect of unit or floor number on the incidence of traffic accidents. For Singaporeans, we link court records of traffic accidents to the data on residential transactions by the buyer's personal identifier. We could not link the accident and

[11] The standard deviation of GDP is calculated in a 4-quarter rolling window, beginning in 1999.
[12] Unfortunately, we could only investigate the amount of insurance coverage, and did not have data to investigate the effect of home number on buying insurance at all.

residential transactions for foreigners.

[Insert Table 7 here]

Table 8, column (1), applies a binomial logit model with the dependent variable being a traffic accident involving the home buyer after they bought the unit. The coefficients of U4 and FL4 were negative, but not significant, while the coefficient of FL8 was positive but not significant. These results suggest that the number of the individual's home address, whether lucky or unlucky, had no effect on the likelihood of a traffic accident. Table 8, column (2), estimates the binomial logit including 2-digit postal code fixed effects to control for differences between neighborhoods such as traffic conditions.

8. Conclusion

Our analysis of over 49,000 transactions in Singapore high-rise residential units between 2000-2009 suggests that buyers paid 1.1% less for units with numbers ending in "4", and 0.9% more for units with numbers ending in "8". Based on the average unit size of 117.5 square meters and average price of S$8,546 per square meter, the discrepancies amount to a discount of S$11,045, and premium of S$9,037 respectively. These amounts range between 6.2%-7.6% of the average income from work, S$145,788, of households living in high-rise homes in the year 2004, which was the mid-point of our study period.[13]

Further, we found significant evidence of clientele effects by unlucky numbers. Singaporean Chinese were relatively less likely to buy units and on floors with numbers ending in "4" than, in increasing order, foreign Chinese, Singaporean non-Chinese, and foreign non-Chinese. There was some evidence of clientele effects by lucky numbers. Singaporean Chinese were relatively more likely to buy units on floors with numbers ending in "8" than Singaporean non-Chinese. The racial sorting by home numbers is interesting as such, and also supports the hypothesis that the price differences are due to superstition and not unobserved heterogeneity among units with different unit or floor numbers. Moreover, absent the sorting, for instance, if all buyers were Singapore Chinese, the price effects would likely have been larger.

Collectively, Singaporean and non-Singaporean non-Chinese accounted for just over 14% of purchases; while U4 and FL4 add up to over 20%, so, possible that all unlucky numbers go to

[13] Source of household income: Singapore Department of Statistics, *Key Household Income Trends*, 2012.

non-Chinese. However, this ignores preferences over buildings. Singaporean Chinese might be willing to trade off unlucky number for building location and other characteristics, so, they still buy units with unlucky numbers, albeit at a discount.

Further, we showed that buying and living in a home with a lucky number was not associated with fewer car accidents, nor was buying and living in a home with an unlucky number associated with more car accidents. So the beliefs about lucky and unlucky numbers are indeed pure superstition. We also find some real consequences to the superstition. Chinese living in units with numbers ending in "8" bought less insurance coverage. In event of fire or theft, they would be under-insured.

An intriguing public policy question is whether and how to address superstition (which is a universal issue, and not limited to numbering of homes in communities with a large proportion of Chinese). Should the government follow Hong Kong and allow flexible numbering to cater to individual superstition, so that real estate developers can skip numbering any floors with "4"? Would such a policy increase welfare? It is difficult for us to comment as such a policy would increase the supplies of units with other numbers, resulting in a new (general) equilibrium in the housing market. In addition, flexible numbering of high-rise buildings need not be innocuous. In the event of a fire in a high-rise building, people might count floors to an escape route. For them, non-sequential floor numbering could be tragic.

Our research raises several large questions. One is the extent to which superstition continues to impede innovation and economic growth. A related issue is the extent to which differences in superstition account for the striking disparities in economic growth between countries. Further, to the extent that superstition hinders innovation and economic growth, it is important to understand how to correct superstitious beliefs and practices. Recent developments in behavioral economics might help tackle some of these issues. For instance, we could think of two suggestions to correct superstitious beliefs: (i) debias superstitious beliefs through early education, and (ii) changing the numbering system to make the unit and floor numbers less salient. We believe there are significant policy implications from our research, but they are beyond the scope of this study and we leave them for future research.

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Table 1. Data screens

Criteria	Observations
New sales of condominiums and apartments in years 1995-2012.	91,112
Delete records lacking key information such as unit or floor number, or with obvious errors such as negative price.	82,463
Delete records of purchases by companies, and mixed lucky and unlucky numbers, eg, 04-18.	77,140
Limit to years 2000-2009.	61,457
Limit to units on 29th floor and lower in buildings with at least 6 floors.	49,784

Table 2. Summary statistics

Variable	Mean	Std deviation	Min	Max
Price (Singapore dollars per square meter)	8,546	4,685	1,897	52,102
Size (square meters)	117.5	41.47	30	768
Condominium	0.764	0.425	0	1
Freehold	0.422	0.494	0	1
U4 (unit number ending 4)	0.102	0.303	0	1
U8 (unit number ending 8)	0.0714	0.258	0	1
FL4 (floor number ending 4)	0.101	0.302	0	1
FL8 (floor number ending 8)	0.0889	0.285	0	1
Singaporean non-Chinese	0.0623	0.242	0	1
Non-Singaporean Chinese	0.155	0.362	0	1
Non-Singaporean, non-Chinese	0.078	0.268	0	1
Highest floor	19.09	10.13	6	68
Car accident	0.04	0.197	0	1
Sold the units	0.201	0.401	0	1
Number of observations	49784			

Notes: The sample comprises units on 29th floor and lower in buildings with at least 6 floors. Transaction prices are denominated in Singapore dollars per square meter (at the average exchange rate in the period 2000-09 of one Singapore dollar to 61 U.S. cents, a price of S$1000 per square meter is equivalent to US$56.75 per square foot). The measures of superstition: U4 = 1 if the last digit of the unit number is 4, else = 0; U8 = 1 if the last digit of the unit number is 8, else = 0; FL4 = 1 if the last digit of the floor number is 4, else = 0; and FL8 = 1 if the last digit of the floor number is 8, else = 0.

Table 3. Buyer choice of unit

	(1) Multinomial logit	(2)	(3) Multinomial logit	(4)	(5) OLS	(6) Multinomial logit	(7)
VARIABLES	U4	U8	U4	U8	Price 1st stage	U4	U8
Singaporean non-Chinese	0.183***	-0.052	0.222***	-0.048	0.001	0.234***	-0.014
	(0.064)	(0.079)	(0.064)	(0.077)	(0.002)	(0.071)	(0.080)
Foreign Chinese	0.144***	0.063	0.170***	0.105*	0.007***	0.169***	0.093
	(0.051)	(0.064)	(0.051)	(0.062)	(0.001)	(0.059)	(0.062)
Foreign non-Chinese	0.116	0.055	0.290***	0.095	0.013***	0.346***	0.144
	(0.074)	(0.091)	(0.073)	(0.087)	(0.002)	(0.085)	(0.089)
Size (log)			-0.915***	0.175	-0.151***	-0.678***	0.147
			(0.118)	(0.140)	(0.002)	(0.143)	(0.153)
Price (log)			-0.156*	-0.111		0.194	0.232
			(0.086)	(0.099)		(0.390)	(0.461)
Residual price (log)						-0.374	-0.106
						(0.431)	(0.499)
U4 units sold to date/total U4 units					-0.020***		
					(0.006)		
U8 units sold to date/total U8 units					-0.001		
					(0.006)		
All units sold to date/total units					0.050***		
					(0.011)		
Constant	-2.136***	-2.459***	3.654***	-2.096*	9.560***	-0.565	-4.900
	(0.033)	(0.043)	(1.081)	(1.190)	(0.010)	(3.762)	(4.414)
Floor fixed effects	No	No	Yes	Yes	Yes	Yes	Yes
Building fixed effects	No	No	No	No	Yes	No	No
Year and quarter fixed effects	No	No	No	No	Yes	No	No
Observations	49,784	49,784	49,784	49,784	39,835	39,835	39,835
Log pseudo-	-28811	-28811	-28214	-28214		-23671	-23671

likelihood	
R-squared	0.969
F-statistic	18.99

Notes: Estimated by multinomial logit regression, where dependent variable is choice of unit by ending digit, and reference group is units with numbers not ending in 4 or 8. To save space, the multinomial logit regression estimates are reported in separate columns, with one column for buyer choice of U4 and another column for buyer choice of U8. Column (1): Multinomial logit regression estimates for U4; Column (2): Multinomial logit regression estimates for U8; Column (3): Multinomial logit regression estimates for U4; Column (4): Multinomial logit regression estimates for U8; Column (5): 1st stage regression with price as dependent variable; Column (6): Multinomial logit regression estimates for U4 with instruments for price; Column (7): Multinomial logit regression estimates for U8 with instruments for price. Standard errors clustered by building in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

Table 4. Buyer choice of floor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Multinomial logit		Multinomial logit		OLS	Multinomial logit	
VARIABLES	FL4	FL8	FL4	FL8	Price 1st stage	FL4	FL8
Singaporean non-Chinese	0.164***	-0.238***	0.161***	-0.191**	0.000	0.143**	-0.219**
	(0.056)	(0.075)	(0.057)	(0.075)	(0.002)	(0.066)	(0.086)
Foreign Chinese	0.063	0.150***	0.112***	0.105**	0.007***	0.168***	0.075
	(0.041)	(0.042)	(0.042)	(0.045)	(0.001)	(0.048)	(0.052)
Foreign non-Chinese	0.105*	0.068	0.227***	0.005	0.014***	0.281***	0.008
	(0.057)	(0.059)	(0.060)	(0.064)	(0.002)	(0.071)	(0.079)
Size (log)			-0.396***	0.004	-0.165***	-0.354***	-0.097
			(0.055)	(0.055)	(0.002)	(0.076)	(0.081)
Price (log)			-0.119***	0.068*		0.176	-0.213
			(0.038)	(0.039)		(0.171)	(0.210)
Residual price (log)						-0.303	0.397*
						(0.187)	(0.230)
U4 units sold to date/total U4 units					-0.013*		
					(0.007)		
U8 units sold to date/total U8 units					-0.006		
					(0.006)		
All units sold to date/total units					0.048***		
					(0.012)		
Constant	-2.108***	-2.226***	1.312***	-3.906***	9.681***	-1.519	-1.050
	(0.017)	(0.018)	(0.428)	(0.400)	(0.010)	(1.687)	(2.049)
Building fixed effects	No	No	No	No	Yes	No	No
Quadratic function of floor	No	No	Yes	Yes	Yes	Yes	Yes
Last digit of unit number	No	No	Yes	Yes	Yes	Yes	Yes
Year and quarter fixed effects	No	No	No	No	Yes	No	No
Observations	49,784	49,784	49,784	49,784	39,835	39,835	39,835

Log pseudo-likelihood	-30,749	-30,749	-29,928	-29,928		-23,697	-23,697
R-squared					0.968		
F-test					15.71		

Notes: Estimated by multinomial logit regression, where dependent variable is choice of floor by ending digit, and reference group is units on floors with numbers not ending in 4 or 8. To save space, the multinomial logit regression estimates are reported in separate columns, with one column for buyer choice of FL4 and another column for buyer choice of FL8. The last digit of unit number is included as a set of dummy variables. Column (1): Multinomial logit regression estimates for FL4; Column (2): Multinomial logit regression estimates for FL8; Column (3): Multinomial logit regression estimates for FL4; Column (4): Multinomial logit regression estimates for FL8; Column (5): 1st stage regression with price as dependent variable; Column (6): Multinomial logit regression estimates for FL4 with instruments for price; Column (7): Multinomial logit regression estimates for FL8 with instruments for price. Robust standard errors clustered by building in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$).

Table 5. Transaction prices

VARIABLES	(1)	(2) Including building f.e.	(3) Singaporean Chinese	(4) Singaporean non-Chinese	(5) Foreign Chinese	(6) Foreign non-Chinese
Even numbered floor	0.024***	0.012***	0.012***	0.005	0.009***	0.012**
	(0.004)	(0.001)	(0.001)	(0.005)	(0.003)	(0.005)
First floor	-0.060***	-0.062***	-0.065***	-0.059***	-0.044***	-0.075***
	(0.011)	(0.002)	(0.003)	(0.010)	(0.008)	(0.014)
Top floor	-0.177***	-0.062***	-0.065***	-0.064***	-0.046***	-0.053***
	(0.015)	(0.002)	(0.002)	(0.008)	(0.005)	(0.008)
Size (log)	0.013	-0.137***	-0.145***	-0.151***	-0.112***	-0.114***
	(0.031)	(0.002)	(0.002)	(0.008)	(0.004)	(0.008)
U4 (unit number ending in 4)	-0.009	-0.011***	-0.012***	-0.005	-0.007**	-0.007
	(0.009)	(0.001)	(0.001)	(0.005)	(0.003)	(0.006)
U8 (unit number ending in 8)	0.009	0.009***	0.010***	0.008	0.007*	0.009
	(0.011)	(0.001)	(0.002)	(0.007)	(0.004)	(0.007)
FL4 (floor number ending in 4)	-0.028***	-0.005***	-0.005**	0.013	-0.011**	-0.000
	(0.006)	(0.002)	(0.002)	(0.008)	(0.005)	(0.009)
FL8 (floor number ending in 8)	0.011*	-0.002	-0.003*	0.006	0.004	-0.011
	(0.006)	(0.002)	(0.002)	(0.009)	(0.005)	(0.009)
Singaporean non-Chinese	0.053***	0.003*				
	(0.007)	(0.001)				
Foreign Chinese	0.063***	0.008***				
	(0.008)	(0.001)				
Foreign non-Chinese	0.213***	0.016***				
	(0.014)	(0.001)				
Constant	8.656***	9.690***	9.635***	9.679***	9.635***	9.748***
	(0.143)	(0.009)	(0.011)	(0.041)	(0.023)	(0.045)
Freehold	Yes	No	No	No	No	No
Condominium	Yes	No	No	No	No	No
2-floor group fixed	Yes	Yes	Yes	Yes	Yes	Yes

effects						
Building fixed effects	No	Yes	Yes	Yes	Yes	Yes
Year and quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	49,784	49,784	35,067	3,104	7,740	3,873
R-squared	0.560	0.971	0.970	0.983	0.970	0.970

Notes: Dependent variable: logarithm of unit transaction price in Singapore dollars per square meter. Column (1): Baseline regression including tenure and building type; Column (2): Including building fixed effects to control for differences in location, age, building type, and tenure; Column (3): Singaporean Chinese buyers; Column (4): Singaporean non-Chinese buyers; Column (5): Foreign Chinese buyers; Column (6): Foreign non-Chinese buyers. Robust standard errors clustered by building in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 6. Robustness checks and heterogeneous effects

VARIABLES	(1) Preferred estimate	(2) All buildings 2000-09	(3) All 1995-2012	(4) Core central region	(5) Recession	(6) Uncertainty
Even numbered floor	0.012***	-0.004***	-0.004***	0.011***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
First floor	-0.062***	-0.102***	-0.099***	-0.060***	-0.062***	-0.062***
	(0.002)	(0.002)	(0.002)	(0.008)	(0.003)	(0.003)
Top floor	-0.062***	-0.056***	-0.046***	-0.048***	-0.061***	-0.061***
	(0.002)	(0.001)	(0.001)	(0.004)	(0.002)	(0.002)
Size (log)	-0.137***	-0.150***	-0.152***	-0.103***	-0.135***	-0.135***
	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.002)
U4 (unit number ending in 4)	-0.011***	-0.012***	-0.012***	-0.007**	-0.010***	-0.010***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.002)
U8 (unit number ending in 8)	0.009***	0.009***	0.009***	0.018***	0.008***	0.005**
	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)	(0.002)
FL4 (floor number ending in 4)	-0.005***	0.012***	0.012***	0.000	-0.005**	-0.003
	(0.002)	(0.002)	(0.001)	(0.004)	(0.002)	(0.002)
FL8 (floor number ending in 8)	-0.002	0.017***	0.017***	0.002	-0.002	-0.004
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)
Singaporean non-Chinese	0.003*	0.002	0.001	0.004	0.003*	0.003*
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)
Foreign Chinese	0.008***	0.009***	0.009***	0.010***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Foreign non-Chinese	0.016***	0.018***	0.017***	0.014***	0.015***	0.015***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Macroeconomy × U4					0.001	0.000
					(0.004)	(0.002)
Macroeconomy × U8					0.009**	0.006**
					(0.004)	(0.003)
Macroeconomy × FL4					0.004	-0.002

					(0.004)	(0.002)
Macroeconomy × FL8					0.006	0.004
					(0.004)	(0.002)
Constant	9.690***	9.700***	9.810***	10.028***	9.588***	9.588***
	(0.009)	(0.009)	(0.012)	(0.018)	(0.009)	(0.009)
2-floor group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Building fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year and quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	49,784	60,328	75,626	11,257	48,470	48,470
R-squared	0.971	0.966	0.968	0.952	0.972	0.972

Notes: The sample comprises units on 29th floor or lower in buildings with at least 6 floors sold between 2000-09, except in columns (2) and (3). Dependent variable: logarithm of unit transaction price in Singapore dollars per square meter. Column (1): Preferred estimate from Table 5, column (2); Column (2): Buildings of all heights, including those with fewer than 6 floors or more than 29 floors; Column (3): All units in all buildings in all years, 1995-2012; Column (4): Buildings in the core central region (postal districts 1, 9, 10, and 11); Column (6): Macroeconomic recession = 1 if GDP is lower than 4-quarter moving average, else = 0; Column (7): Macroeconomic uncertainty = 1 if the standard deviation of the difference of GDP from 4-quarter moving average is higher than average, else = 0. Robust standard errors clustered by building in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 7. Home insurance

VARIABLES	(1) Superstition	(2) Postal code fixed effects
Female	-0.090***	-0.094***
	(0.023)	(0.023)
Age (log)	0.907***	0.839***
	(0.061)	(0.062)
Chinese	0.169*	0.176**
	(0.088)	(0.087)
U4	0.107	0.134
	(0.137)	(0.133)
U8	0.225	0.286*
	(0.160)	(0.161)
U4 × Chinese	-0.228	-0.243*
	(0.140)	(0.136)
U8 × Chinese	-0.319*	-0.360**
	(0.163)	(0.164)
Constant	1.651***	1.703***
	(0.270)	(0.406)
2-digit postal code fixed effects	No	Yes
Observations	5,437	5,437
R-squared	0.0712	0.1035

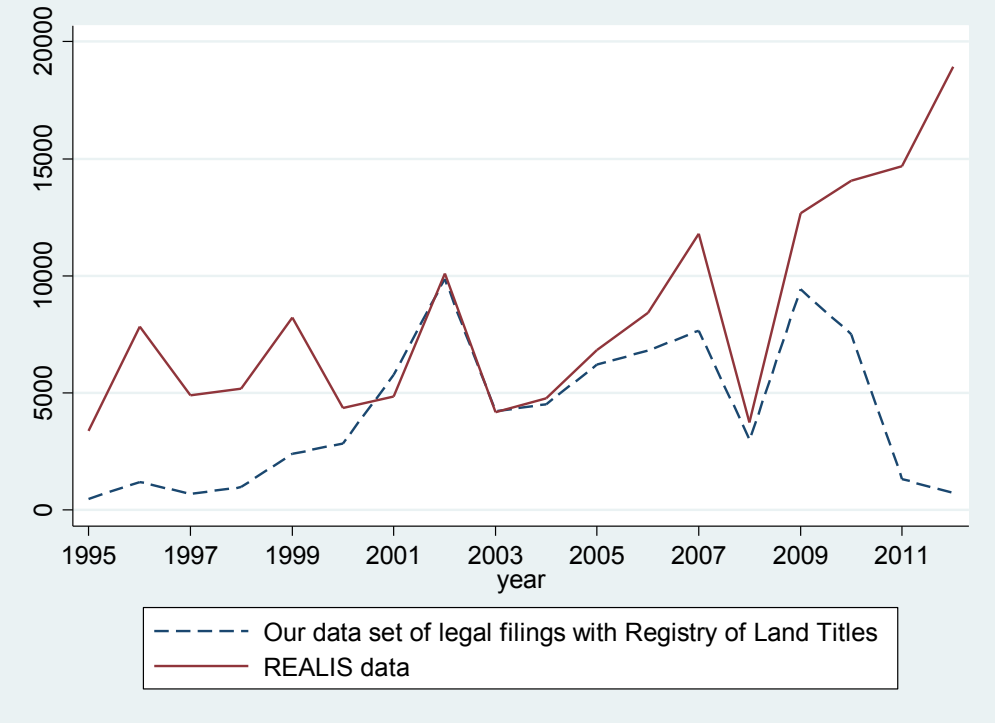
Notes: The sample comprises all private high-rise residential units covered by one insurer in 2011; Dependent variable: logarithm of home insurance coverage in thousand Singapore dollars; Robust standard errors in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 8. Car accidents

VARIABLES	(1) Accidents	(2) Postal code fixed effects
Size (log)	0.055	0.023
	(0.086)	(0.094)
Price (log)	-0.655***	-0.776***
	(0.072)	(0.107)
U4	-0.099	-0.101
	(0.077)	(0.077)
U8	-0.005	0.002
	(0.085)	(0.086)
FL4	-0.100	-0.100
	(0.080)	(0.080)
FL8	0.135*	0.131
	(0.080)	(0.081)
Singaporean non-Chinese	-0.924***	-0.932***
	(0.128)	(0.127)
Constant	2.686***	4.654***
	(0.812)	(1.191)
2-digit postal code fixed effects	No	Yes
Observations	38,171	38,150
Log pseudo-likelihood	-7758	-7714

Notes: Sample: New sales to Singaporeans matched with court records of traffic accidents, 2000-2009; Method: Binomial logit regression with dependent variable = 1 if the buyer had a car accident after buying the unit. Column (1): Demographic covariates and lucky/unlucky numbering; Column (2): Including 2-digit postal code fixed effects. Robust standard errors clustered by building in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Figure 1. Transactions by year



Note: Number of new sales, by year from 1995 to 2012. Solid red line depicts the number of new sales as recorded in the Urban Redevelopment Authority's REALIS database. Broken blue line depicts the number of new sales as recorded in our data-set of legal filings with the Registry of Land Titles.

Figure 2. Price and floor number

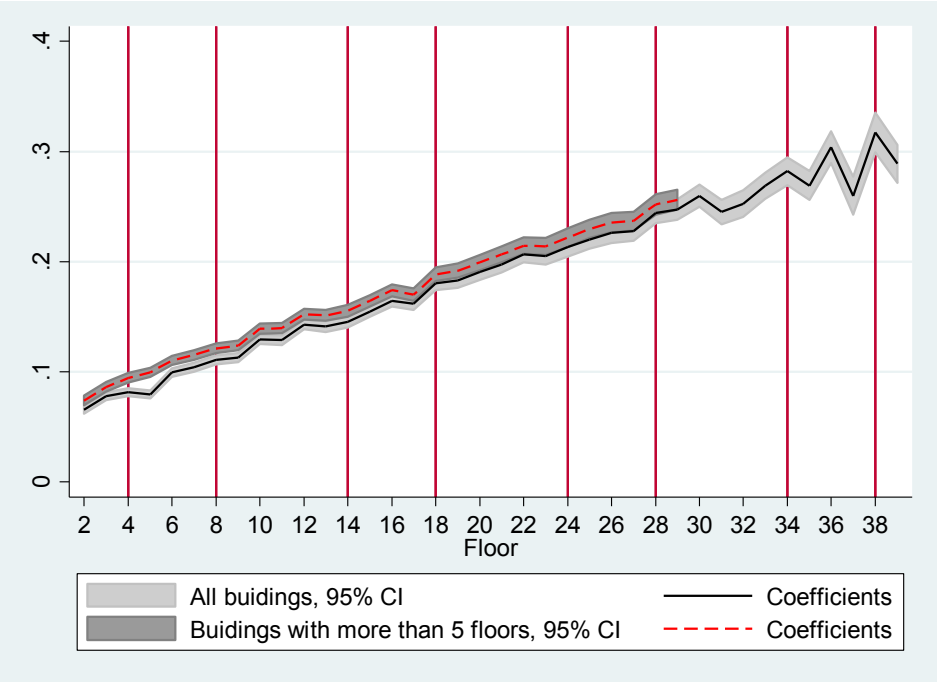


Figure 3. Price and unit number