

Matching in Housing Markets: The Role of Ethnic Social Networks*

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Abstract

This paper investigates the role of ethnic matching between buyers and sellers in housing markets. Using unique public housing datasets in Singapore, we find that sellers sell homes in blocks with a high concentration of their own (other) ethnic group at significant premiums (discounts). Chinese sellers get more than 1.7% premiums when selling homes to Chinese buyers in housing blocks with high concentrations of Chinese residents, but Malay sellers accept 1.6% discounts from Malay buyers in the same blocks. We find that the high volume of the within-ethnicity transactions with the price discounts is supported by the ethnic social networks, i.e. through ethnicity-specialized real estate agents.

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1. Introduction

Ethnic segregation not only is a sensitive social issue in multi-racial societies but also has a significant impact on housing prices. Race-based distortionary price effects are prevalent in many neighborhoods in the US (King and Mieszkowski (1973)). The Singaporean government's ethnic-based supply quotas, which were designed to prevent ethnic segregation at the block and precinct (neighborhood) level, also have a significant impact on pricing (Wong (2013, 2014)). However, identifying the underlying mechanisms that drive the pricing impact has been challenging because of the endogenous nature of housing transactions. In this paper, we study the role of ethnic matching between buyers and sellers and its effects on ethnic-related housing price premiums. We examine how ethnic social networks increase potential search frictions in housing markets, thus boosting ethnic matching costs.

Singapore, a multi-racial society with Chinese, Malay, and Indian as the three major ethnic groups, is an ideal laboratory to test the roles of ethnic matching. The unique institutional features of Singapore's resale public housing market offer two advantages for our analyses. First, we are able to obtain clean identifications of buyers' and sellers' ethnicities by matching the resale public housing transaction data to a unique personal database of all Singaporean residents. Using the matched data, we construct repeat sales samples consisting of housing units that are sold two or more times to identify buyers' and sellers' ethnicities. Second, it is a common practice for a Singaporean seller to obtain an appraisal value on his/her public housing flat and then use this information to negotiate for an agreed price with a prospective buyer.¹ The transaction price and the corresponding "objective" value determined by a professional appraisal are available concurrently for each sample home in our database.² We are able to derive the "cash-over-valuation" (COV), which is defined as the difference

¹Unlike in the US, where an appraisal value is determined only after buyer-seller matching, in Singapore, the appraisal value is obtained before buyer-seller matching and widely used as a natural reference point to isolate an objective value.

²The objective values are usually not ex post observed in the market. Other studies use standard hedonic pricing models to predict the objective values. If observable variables on physical and spatial attributes are well represented in the models, the predicted values are in most cases highly correlated with the transaction prices.

between a transaction price and an appraisal value. COV is an equilibrium value negotiated between a buyer and a seller and is unique to each transaction. COV is independent of the values of observable physical and locational attributes, but contains the value of unobservable and subjective preferences for ethnic amenities and ethnicity-related factors.

Using a block-level measure of ethnic concentration, we find that the COV per square meter (psm) significantly increases with the concentration of a buyer's own ethnic group in housing blocks but decreases with the concentration of other ethnic groups in housing blocks. To address potential concerns of nonlinearity in ethnic concentration, we use discrete ethnic concentration dummies in the models³ and show that Chinese buyers pay an additional COV (psm) of S\$95.23 in Chinese quota blocks, and an additional COV (psm) of S\$115.3 if the block is subject to the neighborhood-level Chinese quota. Based on an average appraisal value of S\$3,976, the COV premiums are estimated at approximately 2.4% and 2.9%, respectively. For those blocks without binding Chinese quotas, Chinese buyers pay a COV premium of S\$66.45 in blocks with high Chinese concentrations and the COV premium is estimated at about 1.7%. The COV premiums are smaller but insignificant at S\$33.05 and S\$15.93 in the blocks with medium and low Chinese concentration, respectively, compared to prices in the blocks with the lowest Chinese concentration.

Ethnic concentration is correlated with the demand for ethnicity-related factors, such as Chinese-based amenities and incremental utilities derived from interacting with Chinese neighbors. However, the demand-side ethnicity factors alone cannot explain the COV premiums. We need to consider matched buyers and sellers, who value the same ethnicity-related factors, to obtain ethnicity premiums in housing transactions. For example, in the blocks with high Chinese concentration, Chinese buyers pay a COV premium of S\$67.24 when buying homes from Chinese sellers, but they do not pay any COV premium when buying homes from non-Chinese sellers. In the same blocks with high Chinese concentration, Malay buyers enjoy COV

³We sort the sample blocks into 6 groups by ethnic concentration, which are represented by two quota-binding groups (Quota Block, Quota Neighborhood), and four non-binding groups denoted by the discrete dummies: High ("4/4"), Medium ("3/4"), Low ("2/4") and Lowest ("1/4"), where the "1/4" is the reference group in the COV models.

discounts only when buying homes from Malay sellers, but they do not enjoy COV discounts when buying homes from non-Malay sellers. Ethnic concentration premiums are only found in the within-ethnicity transactions. Therefore, ethnic matching between buyers and sellers is a necessary condition for explaining the results.

From the sellers' perspective, the ethnic-matching mechanism that amplifies the within-ethnicity COV premiums gives rise to an important question. Why would Malay sellers sell their homes in the blocks with high Chinese concentration to Malay buyers at discounts but not to Chinese buyers, who will pay premiums for the homes? Since COVs are significantly lower when Malay sellers trade with Malay buyers in the blocks with high Chinese concentration, we should expect fewer within-Malay transactions. On the contrary, however, we find a high volume of within-Malay transactions in the blocks with high Chinese concentration. We find that 89.7% Malay sellers sold their homes to Malay buyers in the blocks. The results imply that Malay sellers are willing to accept COV discounts to trade with Malay buyers. Based on an average unit with an area of 97.04 sqm, the welfare losses (COV discounts) in the within-ethnicity transactions for Malay sellers are estimated at -S\$6,059 ($=97.04 \times -S\62.44).

Housing markets are the only asset markets that exhibit within-ethnicity discounts. In these markets, search is not frictionless; it is a costly process. We rule out heterogeneity in housing quality and downpayment constraints as possible explanations for the differential prices observed between the within-ethnicity transactions and the cross-ethnicity transactions. However, we were unable to reject the hypothesis that the search friction from ethnic social networks is connected to the COV discounts and the high intensity of within-ethnicity transactions. One example is the ethnic social network formed by real estate agents. In a segmented housing market, when inexperienced sellers rely on agents specializing in a single ethnic group, they are locked into the agents' ethnic social networks. Using the agents' property listing data in Singapore, we find that significant fraction of real estate agents are specializing in a certain ethnic customer base and the specialized agents tend to be less competitive agents with older customers in their customer bases. These specialized real estate agents, via their ethnic so-

cial networks, increase the number of within-ethnicity transactions, which would attract COV discounts in the transactions due to incomplete search effort.

Our paper makes three contributions to the literature. First, we find new evidence on the conditions for the existence of ethnicity-related housing price premiums. Our results augment the existing literature that has examined various supply-side factors, such as the whites' discriminatory rental practices in the US (King and Mieszkowski (1973)) and the Ethnic Integration Quota policies in Singapore (Wong (2013, 2014)), and demand-side factors, such as the preference for "hard" and "soft" ethnicity-specific amenities⁴ (Macpherson and Sirmans (2001)), the information spillovers from the ethnic network (Bertrand et al. (2000)), and the incremental utilities from interactions with neighbors of one's own ethnic group (Wong (2013), Li (2014)). We show that ethnic matching between buyers and sellers is a necessary condition to generate price premiums for the demand-side ethnicity-related factors in housing transactions.

Second, we contribute to the economic behavior literature on social interactions in activities ranging from financial decisions (Hong et al. (2004), Madrian and Shea (2001), Duflo and Saez (2002)) to social problems (Case and Katz (1991), Glaeser et al. (1996)). We find empirical evidence of the roles of social interaction in influencing housing location choice, where households mostly trade with buyers of their own ethnic group despite having to take significant discounts. Third, our contribution is related to the literature on bargaining power, where Harding et al. (2003) find that the bargaining power of buyers and sellers is race neutral. We, however, find evidence to suggest that ethnic matching adds significant premiums to housing prices through the preference matching effects, such as sharing a common "taste" for unit characteristics, and/or the agglomeration of the same social amenities in a neighborhood.

The paper is organized as follows: Section 2 provides background information of the two

⁴The "hard" ethnic amenities, such as schools, places of worship, and markets, are orthogonal to the ethnic-neutral physical and spatial (locational) variables usually found in standard hedonic housing models. The "soft" ethnic amenities are activity-based social interactions, such as sharing the same cultural interests, following the same religious faiths, and/or joining the same social events including classes in dancing, *Taiji* and various sports.

institutional features: COV practices and the Ethnic Integration Policy (EIP) in the public housing market in Singapore. Section 3 describes the data and the derivations of key variables. Section 4 discusses the empirical methodologies and analyzes the empirical results. Section 5 concludes the study.

2. Public Housing Market in Singapore

The government of Singapore, via its housing agency, the Housing and Development Board (HDB), is responsible for providing affordable housing for more than 80% of the population. The HDB builds and sells public housing flats at concessionary prices to eligible residents. Currently, only Singaporeans with a monthly income of below \$12,000 are eligible to buy subsidized housing flats directly from the HDB. This successful public housing policy has contributed to a high homeownership rate of nearly 90% in the island state. In addition to the regulated primary market, there is a parallel resale (secondary) market that operates in a laissez-faire environment. Singaporeans and permanent residents, who do not meet the eligibility criteria, can buy resale housing flats at market prices. Singaporean homeowners can sell their housing flats in the resale market only after fulfilling the 5-year minimum occupation period (MOP) requirement.

COV and the EIP are two unique institutional features in Singapore's public housing market that are important in our experimental set-up to empirically examine ethnicity-related factors.

2.1. Cash-Over-Valuation (COV)

COV is a unique phenomenon in the secondary public housing market in Singapore. Unlike in the US, it was formerly common for owners of public housing to obtain an appraisal of their flats from a panel of accredited appraisers (valuers) when they plan to sell their flats.⁵

⁵The HDB passed a new policy to ban COV practices that came into effect on March 10, 2014, by disallowing sellers to obtain an appraisal prior to signing an option to purchase (OTP). The HDB also stopped publishing

Owners would use the appraisal value to negotiate with prospective buyers to arrive at an agreed transaction price. In this way, the appraisal value serves as a natural reference point to determine the objective value of the flat.

In the appraisal process, professional appraisers find evidence on the past sales of comparable homes and adjusted the transacted prices to account for differences in observable factors, such as housing attributes (e.g. unit size, age) and location and neighborhood amenities (e.g. distances to nearby primary schools, subway stations), between the comparable observations and the subject house. The appraisal process is likened to using the standard hedonic model to predict quality-adjusted prices (*objective* value) for homes. Unobservable factors, such as cultural amenities, and social interactions are, however, neglected in the derivation of the *objective* values for the subject house. The HDB and commercial banks use the appraisal values, which are deemed the *fair values*, to determine the loan quantum.⁶

COV is defined as the difference between the final agreed price, which is freely negotiated and determined on the basis of “a willing buyer and a willing seller” (the *subjective* value), and the appraisal value (the *objective* value). Paying COV is not a necessary condition in resale transactions. The HDB comments on its InfoWEB that “*resale price may be above, at or below market valuation depending on the outcome of negotiation between a buyer and seller, and there is no need to pay any COV should the resale transaction be at or below market valuation of the unit.*”⁷ COV captures the marginal premiums for the ethnicity-related factors, such as cultural amenities and/or social interactions among people within the same ethnic group. These ethnicity-related factors are orthogonal to the hedonic attributes and neighborhood amenities and usually not observed in other market set-ups. We exploit variations in COV to value the ethnic factors in our analysis.

HDB and commercial bank loans cannot be used to pay the COV. Buyers usually pay the

COV information after that date.

⁶The HDB caps the loan ceiling at 90% of the sale price or the appraisal value, whichever is lower. As of August 28, 2013, the loan-to-value ratio for 25-year commercial bank loans is capped at 80%, based on the sale price or the appraisal value, whichever is lower.

⁷(HDB InfoWeb, “Median Cash-Over-Valuation (COV) by Town and Flat Type,” September 2011. Source: <https://weaponlcp.files.wordpress.com/2011/09/cov.pdf>)

COV upfront in cash; in some cases, COV payments can be economically burdensome to the buyers, if the COV sum is large. However, the rising trend in COV since 2007 (Lee and Yeo (2013)) has triggered some concerns by the government that *unreasonably* high COVs could drive prices away from fundamentals, and adversely affect the affordability of public housing for buyers, especially younger buyers. On March 11, 2014, the HDB scrapped COV practices by banning sellers from obtaining appraised values of their flats for the purpose of negotiating sale prices with buyers.⁸ With the new practices, the two parties can only request for an appraisal report after agreeing on the final sale price.

2.2. Ethnic Integration Policy (EIP)

As a multi-racial society, Singapore's government takes a strong position on maintaining a balanced mix of ethnic groups within a block and in a neighborhood. On March 1, 1989, the government introduced the EIP with the goals of preventing the formation of racial enclaves and fostering harmonious living among ethnic communities in public housing estates.

The government adheres strictly to the neighborhood quota and the block quota in the allocation of new public housing flats, as shown in Table 1. Being the largest ethnic group in the country, the Chinese neighborhood-level and block-level quotas are set at 84% and 87%, respectively. Malay concentrations at the neighborhood and the block levels must not exceed 22% and 25%, respectively. As of March 5, 2010, the HDB increased the Indian neighborhood-level quota from 10% to 12% and the block-level quota from 13% to 15%. Buyers from a selected ethnic group will not be allowed to book a flat in a block and/or a neighborhood that has reached its ethnic quota during the selection of new flats.

The EIP limits the supply of new housing units for a selected ethnic group in a neighborhood or a block and, as a result, imposes a binding constraint on the resale activities of buyers from that ethnic group. The supply constraint translates into housing premiums that are specific to the affected ethnic group. For example, in housing blocks with a concentration

⁸Sumita Sreedharan, "HDB resale: Parties must agree on price before valuation," Today Online, March 11, 2014.

of Chinese residents above 87%, a prospective Chinese buyer is not allowed to buy a resale housing flat from a non-Chinese seller. However, Chinese buyers can still buy resale flats from Chinese sellers in the block. Wong (2013, 2014) use the price discontinuity near the EIP quota to identify the ethnicity-specific taste for unobserved amenities; whereas we use the EIP to separate the effect of supply constraint in blocks with significant ethnicity-based price premiums from the effects of other demand factors.

3. Data

We obtain the public housing resale transaction data in Singapore for the period from 2007 to 2012 from the Singapore Real Estate Exchange (SRX), a commercial real estate data company. The SRX data are provided by a consortium of 16 leading real estate agencies in Singapore (as of December 2016). The data contain information on transaction date, appraisal value, COV, and housing attributes, such as address, postal code, floor, unit size, and property type. We merge the HDB resale transaction data with a large personal database comprising more than 2 million Singaporean residents. The personal database is used to identify demographic attributes of buyers and sellers, such as gender, race, and date of birth.

3.1. Ethnicity of Buyers

Based on the merged database containing transactions with the personal information, we formulate our empirical strategy to construct the household-level ethnicity variables using the identification of buyers' and sellers' demographic details (including ethnicity and date of birth). First, we identify each resale transaction by its address; we assign the same ethnicity identification to the household, if all the members at the registered address are of the same ethnic group. For example, if all members living in a home (having the same registered address) are Chinese, we identify the household as a Chinese household. Households with members of a single ethnic group constitute approximately 89% of the resale transaction

sample.

Second, if a household has members of different ethnic groups (which could be due to cross-ethnicity marriages), we assign the ethnicity identification based on a simple majority of 50% or more of the members of a selected ethnic group in the household. Households with mixed-ethnicity members constitute approximately 6% of the resale transaction sample. Third, if the numbers of mixed ethnicity members in a household are the same, we use the ethnic group of the eldest member in the household for identification. This group constitutes approximately 4% of the resale transaction sample.

We drop approximately 1% of the remaining sample for which we cannot assign the household-level ethnicity indicator following the above rules. We also remove data with incomplete information on COV, unit size, and unit floor from the transaction samples.

3.2. Ethnic Concentration

The samples consist of 8,194 blocks, and each is identified with a unique 6-digit postal code. We construct the block-level ethnic concentration measure by aggregating the number of households of a selected ethnic group at the block level. The household ethnicity information is obtained from a comprehensive personal database that covers all Singapore residents 18 years of age and above.

Based on the unique postal code, we construct the block-level ethnic concentration measures for Chinese, Malays, and Indians by year. Figure 1 shows that the composition of Singaporean residents by ethnic group has remained relatively stable since independence in 1965. Chinese is the largest ethnic group, followed by Malays and Indians; the composition ratios for Chinese, Malays and Indians are estimated at 74.4%, 13.5%, and 9.1%, respectively, for the sample period from 2007 to 2012. The block-level ethnicity ratios are relatively stable over time. Figure 2 displays the distributions of the block-level ethnic concentrations for the three major ethnic groups. Panel A shows that the block-level shares of Chinese vary from 50% to 100%; Panel B shows that the block-level shares of Malay range from 0% to 40%; and

Panel C shows that the block-level shares of Indians are mostly below 10%.

Since its implementation in 1989, the EIP has played an instrumental role in promoting racial harmony and integration in Singapore. For a block and a neighborhood with binding quotas on a selected ethnic group, the HDB will reject any transaction that will further increase the concentration of that ethnic group in the block and the neighborhood.

Based on the block-level ethnic concentration, a Chinese quota block is a block comprising more than 87% of Chinese residents. In this Chinese quota-binding block, non-Chinese households are not allowed to sell their units to Chinese buyers. There are 2,280 blocks with binding Chinese quotas, which represent approximately 25% of the 8,194 sample blocks. The right-tailed distributions of ethnic concentration, as indicated by the red bars in Panel A of Figure 2, represent blocks that are subject to the Chinese block-level binding quota. The red bars in Panel B of Figure 2 represent the blocks that are subject to the Malay quota constraints. Based on the Malay block-level quota of 25%, 1,368 blocks (approximately 10% of all blocks) are subject to the Malay quota constraints. In these blocks, non-Malay households are not allowed to sell their flats to Malay buyers. The Indian block-level quota increased from 13% to 15% as of March 12, 2010. Prior to this change of the Indian quota, 90 blocks were subject to the Indian-quota constraints; the number of Indian quota-binding blocks declined to 71 blocks after the revision in 2010. The red bars in Panel C of Figure 2 represent the Indian quota-binding blocks, which are determined based on the previous threshold of 13% (before March 2010).

Similarly, we define the neighborhood ethnic quota indicators by aggregating the ethnic concentration share at the neighborhood level. Using the first 4 digits of the postal code to represent a neighborhood, a neighborhood that has an ethnic concentration ratio in excess of the stipulated ceiling is identified as “a quota binding neighborhoods”. For example, a Chinese quota-binding neighborhood is identified if Chinese households constitute more than 84% of the households in that neighborhood. Non-Chinese households in this neighborhood are not allowed to sell their flats to Chinese buyers. A neighborhood typically comprises

several contiguous blocks, and some blocks may be subject to the neighborhood-level ethnic quota but not subject to the block-level ethnic quota.

3.3. COV in the Full Sample

Figure 3 plots the time series of the average monthly transaction price, appraisal value, and COV. In Panel A, both the average monthly transaction price (psm) (the solid blue line) and the average monthly appraisal value (psm) (the red dashed line) show strong upward trends during the sample period. The average transaction price increases from S\$2,580 psm in 2007 to S\$4,909 psm in 2013.

We compute the average monthly COV (psm) by taking the difference between the average monthly transaction price (psm) and the average monthly appraisal value (psm), and we depict it with the blue solid line in Panel B. The average monthly COV (psm) fluctuates within a range from S\$43 to S\$412 during the sample period. The red dashed line in Panel B represents the ratio of COV to total transaction price, which varies between 1% and 8% over the sample period. The COV (psm) (blue line) and the ratio of the COV to the total transaction price (red line) exhibit similar time series trends over the sample period, which implies that the COV explains most of the variations in the transaction prices.

As in the standard hedonic pricing models, appraisers use the past sales evidence of comparable observations to derive the *objective* value of a house. They tend to under-estimate values in a market with an upward price trend. Therefore, if a buyer agrees to pay the COV in cash, he/she indirectly causes an upward bias in the sale price. We thus conjecture that an increase in COV predicts an increase in the appraisal value in a rising market.

We use Fama-Macbeth regression to test the relationship between changes in the current COV and changes in the future appraisal value using town-level data.⁹ The results are summarized in Table 2. Column (1) reports the result with the annual % change in average appraisal value (psm) in an HDB town from t to $t + 1$ as the dependent variable. The main independent

⁹There are 26 public housing towns distributed across the island, where the smallest town (Bishan) comprises a population of 65,700, and the largest town (Jurong West) comprises a population of 260,000.

variable is the annual % change in average COV (psm) in the HDB town from $t - 1$ to t ; other independent variables include the annual % change in average appraisal value (psm) from $t - 1$ to t , unit size (sqm), floor level, distance to the nearest mass rapid transit (MRT) station, the quality of primary schools in 1km and 1-2km radius, and building age.¹⁰ We find that increases in the current COV are significantly correlated with one-year-ahead (future) increases in appraisal value. In economic terms, for every 1 standard deviation change in COV (psm) in the previous year, the appraisal value (psm) increases by 2.8 standard deviations.

Columns (2) to (6) report the results estimated using the quarterly data. The dependent variable is the quarterly % change in appraisal value (psm) from t to $t + 1$. The main independent variable is the quarterly % change in COV (psm) but with different lags, which include Column (2): from $t - 1$ to t ; Column (3): from $t - 2$ to $t - 1$; Column (4) from $t - 3$ to $t - 2$; and Column (5): from $t - 4$ to $t - 3$. Column (6) includes all four lags in the quarterly % change in COV (psm). Our results are consistent with those reported in Column (1), where we find that the % Change in COV in the two most recent quarters has a stronger effect on the % change in appraisal value, but the effects weaken thereafter.

COV reflects the buyers' and sellers' expectations of future price appreciations, which offset the under-estimation in the appraisal values. Therefore, it would be naive to assume that COV captures only the values of ethnicity-related factors. We include additional controls in our empirical setup to disentangle the expectations from the ethnicity-related value in the COV. Detailed discussions will be included in the subsequent empirical methodology section.

There are two features in the distributions of COV (psm) in Figure 4. First, we find that a large fraction of homes is transacted with zero COV, which means that the price is equal to the objective value. Therefore, the results imply that COV is not a necessary condition for resale transactions. Second, if buyer and seller were randomly matched and the COV (psm) were idiosyncratic, we should expect a symmetric distribution of the COV (psm) at around the zero COV point. However, we observe positive COVs (psm) in a large fraction of transactions,

¹⁰The variables are explained in detail in the summary statistics section.

but with no clustering of COVs (psm) at the zero COV point. The red dotted vertical line represents the average COV (psm), which is estimated at S\$253, which is significantly different from zero at less than the 1% level.

3.4. Repeat-Sale Sample

If the matching between buyer and seller is not random, the COV is likely to be endogenous, and the buyer and seller characteristics would jointly determine the value of ethnicity-related factors. We construct the repeat-sale samples comprising housing units that are sold two or more times and use the samples to empirically test the effects of the ethnic matching of buyers and sellers on COV variations. Our repeat-sale samples consist of 3,652 units that are sold twice, 99 units that are sold 3 times, and 3 units that are sold 4 times.

For each pair of repeated transactions, we match the ethnicity of buyers in the first (preceding) transaction to the ethnicity of sellers in the second (subsequent) transaction for the same housing unit. Based on demographic information of the matched buyer and seller pairs in 3,859 repeated transactions, we find that 289 of the transactions are cross-ethnicity transactions, and 3,570 are within-ethnicity transactions.

Figure 5 shows the distributions of the within-ethnicity COV (psm) (Panel A) and the cross-ethnicity COV (psm) (Panel B) for the repeated transactions. As in Figure 4, we find a discernible spike at the zero COV premium in the two panels. The density of zero-COV transactions is higher for the cross-ethnicity transactions (3.81%) than for the within-ethnicity transactions (2.02%). The results imply that buyers and sellers are more likely to trade at the appraisal value (or the zero COV) when they are from different ethnic groups. The red dotted vertical lines in the histograms represent the average COV, and we find that the COV for the within-ethnicity group (Panel A) is higher, at S\$336.15, than the average COV of S\$292.88 for the cross-ethnicity group (Panel B). The differences in the two mean COV values are statistically different from zero at the 1% level; these results imply that buyers and sellers from the same ethnic group are more likely to agree on a higher COV (psm) on average.

3.5. Summary Statistics

Table 3 reports the summary statistics for the 3,859 public housing repeat-sale samples. Panel A shows the sample composition, which is sorted into 3,570 within-ethnicity transactions and 289 cross-ethnicity transactions. Dividing the transactions by buyer ethnicity, we have 2,741 transactions by Chinese buyers (71%), 848 transactions by Malay buyers (22%), and 225 transactions by Indian buyers (6%). Dividing the transactions by seller ethnicity, we have 2,667 transactions by Chinese sellers (69%), 893 transactions by Malay sellers (23%), and 247 transactions by Indian sellers (6%).

Panel B reports the summary statistics for the key variables. The average appraisal value is estimated at S\$378,098, and the values vary from S\$160,000 to S\$685,000.¹¹ The average COV is estimated at S\$31,090, which is equivalent to approximately 8% of the average appraisal value. The COV varies widely from -S\$22,000 to S\$90,000. On a psm basis, the appraisal value psm is estimated at S\$3,975.94, and the COV psm is estimated at S\$332.91, on average.

Other key variables include “Unit Floor”, “Size (sqm)”, “Age of the Block”, and “Distressed Seller”. “Unit Floor” denotes the floor level of a transacted unit; the average floor level (height) is 7.19, reflecting the high-density and high-rise nature of the public housing in Singapore. “Size (sqm)” denotes the area of internal space in a housing unit; the average unit size is 97.04 square meters (sqm), and the range is from 31 sqm to 243 sqm. “Age of the Block” captures the building age of the sample housing block, which is computed as the difference in years between the transaction date and the lease commencement date. The average age of the sample housing blocks is estimated at 22.95 years. “Distressed seller” is a dummy variable identifying sellers who filed for bankruptcy during the sample period. To identify bankrupt sellers, we match individuals in our resale transaction data to the 65,147 personal bankruptcy filing records at the Supreme Court of Singapore from 1980 to 2012.¹² For each bankruptcy case, we obtain personal information that includes the debtor’s name

¹¹To ensure the robustness of the results, we winsorize the appraisal value and COV at the 1% level on both tails.

¹²Agarwal et al. (2016a) use the same dataset in their study of the gender gap in personal bankruptcy risk.

and his/her personal identification number, the creditor’s name (usually an institution), the total bankruptcy amount, and the three bankruptcy event dates (filing of statutory demand, petition, and hearing). We find that only 2% of the repeated transactions involve bankrupt sellers during our sample period.

Based on the 6-digit postal code, we construct the spatial variables that represent neighborhood amenities, which include “Distance to Nearest MRT”, “Primary School Quality within 1 km”, and “Primary School Quality within 1-2 km”. “Distance to Nearest MRT” is a linear measure of the distance of a sample housing block to the nearest MRT station, and the average distance is estimated at 900 meters, with a range of between 5 meters and 3,340 meters. The school qualities – “Primary School Quality within 1 km” and “Primary School Quality within 1-2 km”, capture the proximity to good (preferred) primary schools.¹³ School quality is measured based on the Primary School Leaving Examination (PSLE) results¹⁴ and estimates the average rankings of primary schools located within 1km and 1-2km from the sample blocks. The “Primary School Quality” scores are proxies for the quality of primary schools located near the sample housing blocks. A positive score is correlated with good-quality schools. There are some blocks with missing school quality since there is no primary schools located within the 2km boundary from the selected housing blocks.

We report the shares of the block-level ethnicity in Table 3. Compared to the country’s ethnic composition during the sample period, 74.4% Chinese, 13.5% Malay, and 9.1% Indian (as in Figure 1), the average block-level shares by ethnicity in the repeat-sale samples are higher for Chinese (78.69%) and Malays (16.54%), but lower for Indians (3.71%).

Panel C of Table 3 reports the distributions of the sample transactions sorted based on the HDB housing type classifications into 1-bedroom to 5-bedroom, and “Jumbo” and “Ex-

¹³The Singapore government implements a distance-based allocation policy for private school placements (Agarwal et al. (2016b)), which give priority to families living first within a 1 km radius and then within 1 km to 2 km band.

¹⁴Based on the data obtained from “Kiasuparents.com”, a private education consultant portal in Singapore, we construct the “Primary School Quality Index” using the (standardized) academic performance score. Source: “<https://www.kiasuparents.com/kiasu/article/singapore-primary-schools-ranked-by-academic-excellence/>”.

ecutive” for the large housing flat types. 4-bedroom flats are the most popular housing type, which constitute approximately 33.95% of the sample transactions, followed by 3-bedroom and 5-bedroom housing flats, which constitute 31.28% and 24.28% of the sample transactions, respectively.

4. Empirical Methodology and Results

4.1. Expectations of Future Price Appreciations

In our empirical model that predicts COV (psm) changes with respect to the ethnic concentration and other observable factors, we need to specifically control for the future price expectations in the COV. We first use the interaction of the block-level share of an ethnic group with the buyer’s ethnicity dummy to measure the economic effects of ethnic factors embedded in the COV. A buyer falls into one of the k ethnic groups, where $k = [\text{Chinese, Malay, and Indian}]$. The model specification with the COV (psm) as the dependent variable is written as:

$$COV_{psm} = \alpha + \beta \cdot X_{i,t} + \gamma \cdot BuyerEthnicity + \delta \cdot EthnicConcentration + \zeta \cdot BuyerEthnicity \times EthnicConcentration + \tau_t + \epsilon_{i,t}, \quad (1)$$

where $X_{i,t}$ is a vector of regressors representing hedonic attributes, which include “Size (sqm)”, “Unit Floor”, “Distance to Nearest MRT”, “Primary School Quality within 1 km”, “Primary School Quality within 1-2 km”, “Property Type”, two building age dummies – “Age of the Block (20-40 years)” and “Age of the Block (above 40 years)”, and the “Distressed Seller” dummy. We include year and month fixed effects, τ_t , to control for time variations in the models.

Table 4 reports the regression results on the relationships between the COV and ethnic concentration. Columns (1)-(3) report the results for Chinese buyers. In Column (1), we

interact the Chinese buyer dummy with Chinese share in a block and find that Chinese buyers pay S\$3.23 more in COV (psm), on average, for every 1% increase in Chinese in the block.¹⁵ We interact the Chinese buyer dummy with the Malay share in Column (2) and with the Indian share in Column (3) and find that Chinese buyers pay S\$3.39 less in COV (psm) for every 1% increase in Malays in the block, but we observe no significant difference in Chinese buyers' COV (psm) for every 1% increase in Indians in the block.¹⁶ Chinese buyers pay a high COV for blocks with more Chinese neighbors but a low COV for blocks with more Malay neighbors. Similar results are found for Malay buyers (Columns (4)-(6)) and Indian buyers (Columns (7)-(9)).¹⁷ The results imply that the COV captures the values of the unobservable ethnicity-related factors.

Regarding the other control variables, the coefficient on “Distressed Seller” is negative and statistically significant. We find that buyers pay less in COV when buying homes from bankrupt sellers. As appraisers derive values for homes based on the “*willing seller*” assumption, the weak seller’s attributes should be unobservable in the appraisal process. Therefore, the negative effect of bankrupt sellers reflected in the COV is likely to be an informed outcome in the negotiation process. We find significant premiums in the COV with respect to observable attributes, which include old buildings (age), high floor unit, short distance to an MRT station, and the presence of good-quality primary schools near the block. We also observe significant discounts with respect to units with large floor area (size). However, if the COV were orthogonal to the observable factors, we should not find these results.

The high premiums (discounts) in the COV are closely correlated with the under- (over-) estimations of the observable factors in appraisal values. The mis-estimations in the appraisal values are not uniformly distributed across housing units. Housing attributes with higher

¹⁵We demean the dependent variables, meaning that the coefficient on the Buyer Ethnicity dummy measures the average block effects in our results. The same approach applies to Tables 4, 5, 6 and the tables in the Appendix.

¹⁶The weaker results associated with the Indian share in Columns (3), (6), and (9) are partly caused by the lack of variation in the Indian share in the blocks, as shown in Figure 2.

¹⁷As an external validity check, we use the full sample of 73,107 observations and find similar results, which are reported in the Appendix.

price appreciations are more likely to attract larger under-estimations in appraisal values than other attributes. For example, high floor and small-sized units are expected to appreciate more in a rising housing market. Older housing blocks and housing blocks in locations with better amenities, such as proximity to MRTs and good-quality primary schools, have higher appreciation rates.

We add additional fixed effects, which include “Town \times Year \times I_Floor” fixed effects, “Town \times Year \times I_Size” fixed effects, and “Town \times Year \times I_MRT” fixed effects, using the decile dummies for unit floor (“I_Floor”), unit size (“I_Size”), and distance to MRT station (“I_MRT”), to tighten the controls for heterogeneity in the COV that could be associated with the degree of appraisers’ under-estimation in the repeat-sale models. Table 5 reports the panel regression results of the effect of ethnic concentration on the COV with the additional fixed effects controls. The observations decrease to 2,922 after including the additional fixed effects controls in the models. We find larger effects in the interactions of buyer ethnicity and ethnic concentration relative to those found in the Models in Table 4. The coefficient on “Distressed Seller” is still negative and statistically significant, but the magnitude of the effect is larger. We find that the premiums on all the other observable variables disappear after including the additional fixed effects in the models. The results affirm that the COV (psm) captures unobservable ethnic factors that are orthogonal to observable factors.¹⁸

Table 6 reports the regression results using the appraisal values, instead of the COV, as the dependent variables. The regression specifications are the same as those in the models in Table 5. We find no significant effect of ethnic concentration on the appraisal values, which implies that the ethnicity factors are not observed in the appraisal process. The coefficient on the “Distressed Seller” dummy that represents sellers’ financial constraints is not statistically significant; the results affirm that the sellers’ attributes are not considered in the appraisal process. However, all the other observable variables remain significant in explaining

¹⁸We conduct further robustness checks that are reported in the Appendix. First, we randomize buyer ethnicity and find no effects of the ethnic concentration. Second, we control for appraisal value (psm) in the regressions, and also find no significant differences in the results.

the variations in the appraisal values, and they have the expected signs.

As the default set up for our models in the subsequent analyses, we include “Town \times Year \times I.Floor” fixed effects, “Town \times Year \times I.Size” fixed effects, and “Town \times Year \times LMRT” fixed effects to control for potential bias in the COV that could be caused by expectations of future appreciations in appraisal values.

4.2. A Nonlinear Relationship between Ethnic Concentration and COV

Equation (1) assumes a linear regression specification that predicts the incremental effects of a 1% increase in ethnic concentration on COV. Figure 2 above, however, shows that the distributions of the block-level ethnic share are not linear in blocks with concentrations of different ethnic groups. The Chinese concentration is generally above 50%; the Malay concentration is generally below 40%; and the Indian concentration is generally below 10%. The EIP, which imposes supply constraints on the blocks at the right tail of the distribution of the ethnic concentration, also contributes to the nonlinearity in the ethnic concentration effects on COV.

We model the nonlinear effect of ethnic concentration by first sorting the sample blocks into 6 discrete groups according to ethnic concentration. For the Chinese concentration groups, we identify the blocks with more than 87% Chinese residents as the “Chinese Quota Blocks”; blocks with less than 87% Chinese residents but that are located in a neighborhood with more than 84% Chinese residents are designated “Chinese Quota Neighborhoods”. For other blocks not included in the two “quota-binding” groups, we sort the blocks into four Chinese block quartiles by the fraction of Chinese households in the blocks: High (“4/4”); Medium (“3/4”); Low (“2/4”) and Lowest (“1/4”). We then include the two quota dummies and three concentration dummies for the Chinese blocks and use the lowest Chinese concentration blocks (“1/4”) as the reference group in the COV models.

Similarly, we sort the Malay concentration blocks into 6 groups represented by the two

Malay quota binding dummies and four Malay block concentration dummies. “Malay Quota Blocks” covers blocks with 25% or more Malay households; “Malay Quota Neighborhoods” includes blocks with less than 25% Malay households but that are located in a neighborhood with more than 22% Malay households. We include the four Malay block quartiles based on the fraction of Malay households. For Indian concentration blocks, “Indian Quota Blocks” is defined as blocks with an Indian household share exceeding 13%(15%); an “Indian Quota Neighborhoods” is defined as blocks with less than 13%(15%) Indian households but more than 10%(12%) Indian households in the neighborhood. We also define the four block quartiles based on the block-level shares of Indian households.

4.3. Extended Regression Specifications

Based on the baseline specification in Equation (1), the extended specifications include additional controls that include fixed effects controlling for the expectations of future price appreciations in COV, the 5 discrete dummies on the ethnic concentration, [*I_Concentration* = (“Quota Blocks”, “Quota Neighborhoods”, “4/4”, “3/4”, and “2/4” Blocks)], and the interaction of the ethnicity dummies with the buyer ethnicity indicators.

With COV (psm) as the dependent variable, the model specification is written as:

$$COV_{psm} = \alpha + \beta \cdot X_{i,t} + \gamma \cdot BuyerEthnicity + \delta \cdot I_Concentration + \zeta \cdot BuyerEthnicity \times I_Concentration + \eta_{fe} + \tau_t + \epsilon_{i,fe,t}, \quad (2)$$

where $X_{i,t}$ is a vector of hedonic attributes that represent heterogeneities in the blocks (unit size, floor level, building age, and flat type), and the neighborhoods (distance to the nearest MRT stations, surrounding primary school quality within a 1 km radius and a 1-2 km band). The building age is represented by two dummies: “Age of the Block (20-40 years)” and “Age of the Block (above 40 years)”. We also include “Distressed Seller” to allow for sellers’ heterogeneity and a list of fixed effects controls, such as τ_t , the month fixed effects that control

for seasonal variations, and η_{fe} , which are “Town \times Year \times LFloor” fixed effects, “Town \times Year \times LSize” fixed effects, and “Town \times Year \times LMRT” fixed effects.

The COV (psm) model with additional interactive variables to capture the role of ethnic matching between the buyer and seller on COV is written as follows:

$$\begin{aligned} COV_{psm} = & \alpha + \beta \cdot X_{i,t} + \gamma \cdot BuyerEthnicity + \delta \cdot I_Concentration \\ & + \zeta \cdot BuyerEthnicity \times I_Concentration + \theta \cdot BuyerEthnicity \times Within \\ & + \kappa \cdot BuyerEthnicity \times Within \times I_Concentration + \eta_{fe} + \tau_t + \epsilon_{i,fe,t}, \quad (3) \end{aligned}$$

where “*Within*” is the matching indicator that takes a value of 1, if the buyer and the seller in a transaction are from the same ethnic group; 0 otherwise.

4.3.1. Effect of Ethnic Concentration and Buyers’ Ethnicity on COV

Panel A of Table 7 reports the regression results on the effect of ethnic concentration and buyer ethnicity on COV (psm) based on Equation (2). It shows the interaction effects of buyer ethnicity with the five discrete ethnic concentration indicators (“Quota Blocks”, “Quota Neighborhoods”, and block quantiles “4/4”, “3/4” and “2/4”), where the “1/4” block quantile is used as the reference group in the models.

Columns (1) to (3) report the results with the Chinese concentration dummies. In Column (1), we find that Chinese buyers pay monotonically high COV in the blocks with a high Chinese concentration. Chinese buyers pay the highest premiums of S\$95.23 and S\$115.3 in the blocks with the block-level Chinese quota and the neighborhood-level Chinese quota, respectively. For the blocks without the Chinese quota, Chinese buyers pay a premium of S\$66.45 in the high (“4/4”) Chinese quantile blocks, but the premium is lower than the premiums they pay in the Chinese quota-binding blocks.¹⁹ The premiums are smaller and insignificant in

¹⁹As this high quantile group could be subject to the block-level constraints, even though the estimated Chinese concentration in the blocks is still below the quota limit, some may argue that the effects of the COV premiums could be caused by supply effects imposed by the potential quota constraints, not by ethnic concentration in the blocks. We conduct a robustness check using 8 discrete ethnic concentration dummies,

the medium (“3/4”) Chinese quantile blocks (S\$33.05) and the low (“2/4”) Chinese quantile blocks (S\$15.93).

Column (2) reports the results that interact the Malay buyers with the discrete Chinese concentration block dummies. We find that Malay buyers pay negative COV (or discounts) in the high Chinese concentration blocks. The largest COV (psm) discounts are paid in the blocks subject to the block-level Chinese quota (-S\$88.48) and the neighborhood-level Chinese quota (-S\$128.2). The COV discounts decrease monotonically with the decreases in Chinese concentration in the blocks, which include “4/4” Chinese blocks (-S\$63.71), “3/4” Chinese blocks (-S\$45.36), and “2/4” Chinese blocks (-S\$23.15). We find similar patterns in the COV discounts for Indian buyers in Column (3). The results show that non-Chinese buyers obtain larger COV discounts when buying homes in the higher Chinese concentration blocks.

We find similar results when interacting the other ethnic concentration dummies with buyers of different ethnic groups. Columns (4)-(6) report the results using the discrete Malay concentration dummies. We find that Malay buyers pay the highest premiums in the blocks subject to the block-level Malay quota (S\$147.4) and the neighborhood-level Malay quota (S\$116.1). For the blocks that are not subject to the Malay binding quotas, Malay buyers pay a premium of S\$88.37 in the high “4/4” Malay block, which is lower relative to the premiums in the Malay quota-binding blocks. The premium decreases in the “3/4” and “2/4” Malay quantile blocks. We find that non-Malay buyers pay relatively lower COV (psm) for homes in the high Malay concentration blocks. Columns (7)-(9) report the results with the discrete Indian concentration block dummies, but the results are relatively weak due to the small sample size constraint.²⁰ The coefficients on the block-level quartile dummies in Indian concentration blocks are insignificant due to the lack of variation in the share of Indian concentration blocks (as shown in Panel C of Figure 2 above).

instead of 4 discrete dummies, and find the same effect in the upper quantile dummies in the models (i.e. “6/8”, “7/8” and “8/8”).

²⁰On the “Indian Quota Block” dummy, we only have 6 transactions by Chinese buyers in Column (7), 5 transactions by Malay buyers in Column (8), and 4 transactions by Indian buyers in Column (9). We cannot estimate the “Quota Neighborhood” effect because we only have 1 transaction during the sample period in that group.

The results in Panel A of Table 7 obtained using the discrete ethnic concentration dummies are not dissimilar to the results in Table 5 obtained using the continuous measures of block ethnic concentration. With the discrete dummies, however, we were able to separate the supply-constraint effects from possible demand-side confounding effects through the two dummies on the “block-level quota” and the “neighborhood-level quota”. While the supply-side and the demand-side factors are likely to be correlated with the COV premiums in the blocks with binding ethnicity quotas, the confounding effects, if they exist, should be weaker in the blocks not subject to the ethnicity quota constraints. Therefore, we argue that the monotonic relationship between the COV premiums (discounts) and the concentration of own (other) ethnic groups should be caused by the demand-side ethnicity factors, and not by the supply constraints.²¹

4.4. Within-Ethnicity Transactions

Panel B of Table 7 reports the regression results using the specification in Equation (3), where the triple interactions of the five discrete ethnic concentration dummies, the buyer ethnicity dummy, and the within-ethnicity transaction dummy capture the effects of ethnic matching between buyers and sellers on COV (psm).

The results in Columns (1)-(3) show that ethnic matching is significant in explaining COV premiums (discounts) in the Chinese concentration blocks. Surprisingly, Column (1) shows that the positive interactive effects of the Chinese buyer indicator and the Chinese concentration block are only significant in the within-Chinese transactions. This result implies

²¹It is not the goal of this study to differentiate multiple demand-side factors that may explain the results. First, ethnic amenities clustering around high ethnic concentration blocks attract COV premiums (discounts) from buyers of the same (different) ethnic group. In a typical self-contained public housing estate in Singapore, the supply of local amenities, such as schools, supermarkets, clinics, hawker centers, and sports and recreational facilities, is highly inelastic, and given the limited land set aside for the amenities, amenities for one ethnic group can be increased only at the expense of reducing amenities for another ethnic group.

Second, incremental utilities from interactions with own ethnic neighbors explain COV premiums (discounts) for blocks with high (low) ethnic concentration. Wong (2013) finds an inverted U-shaped utility curve in high ethnic concentration neighborhoods, which implies that buyers have diminishing marginal utilities for frequent interactions with the own ethnic group. The lower COV premiums in the Chinese block-level quota-binding blocks relative to the Chinese neighborhood-level quota-binding blocks is consistent with the inverted U-shaped utility curve found by Wong (2013).

that Chinese buyers pay COV premiums in the high Chinese concentration blocks but only if they trade with Chinese sellers.

The magnitude of the triple-interaction coefficients is not significantly different from the magnitude of the coefficients on the interaction terms (between buyer ethnicity and ethnic concentration) in Panel A. The within-Chinese transaction effects seem to dominate the Chinese concentration effects in the models. These results imply that the demand-side ethnic factors, associated with either Chinese amenities or incremental utilities derived from interacting with Chinese neighbors, are not a sufficient condition to generate high COV premiums without matching between buyers and sellers who share ethnic values.²²

Conditioning on the ethnic matching, we find a monotonic increase in COV with Chinese concentration. We convert the economic value of the block-level ethnic concentration into comparable elasticity effects in observable factors on the appraisal values (in Table 6). The COV premium of S\$67.24 on the within-Chinese transaction in high “4/4” Chinese quantile blocks translates into economic effect that is equivalent to a 200m reduction in the linear distance of a home to the nearest MRT station or a difference of 2 floors in height between two homes in a block.

We also find that the buyers’ COV discounts in the other ethnic concentration blocks disappear in the cross-ethnicity transactions. Column (2) shows that Malay buyers pay significantly less COV when they trade with Malay sellers in the high Chinese concentration blocks. However, there is no COV discount in the high Chinese concentration blocks when Malay buyers trade with non-Malay sellers. Chinese sellers are less likely to agree to low COV compared to non-Chinese sellers, since Chinese ethnic amenities in the high Chinese concentration blocks are valued more by Chinese sellers than by non-Chinese sellers. The

²²The results imply that the optionality (or constraints to sell homes to buyers of a selected ethnic group) in future sales of property is not valuable. In the Chinese quota-binding blocks, for example, Chinese sellers have an option to sell their housing units to Chinese, Malay, or Indian buyers, whereas Malay and Indian buyers in these blocks could sell their homes only to Malay or Indian buyers. Due to the additional optionality in future sales, we should expect Chinese buyers to pay more COV than other buyers regardless of sellers’ ethnicity. However, to the contrary, we find that COV premiums are only observed in the within-ethnicity transactions; the results are not consistent with the expectation associated with the optionality in future sales.

COV discounts in Column (2) of Panel A reflect the two COV effects that are different in the within-ethnicity transactions and the cross-ethnicity transactions. We also find the same results in the transactions between Indian buyers and Indian sellers in Column (3).

Columns (4)-(6) report the results for the Malay concentration blocks, and Columns (7)-(9) report the results for the Indian concentration blocks. COV premiums (discounts) in blocks with a high concentration of the same (other) ethnic group are only significant in the within-ethnicity transactions. The results affirm that ethnic matching is a necessary condition in explaining the COV in the transactions.

Since COV is only paid by buyers in cash, will the cash constraints of buyers from different ethnic groups affect the COV premiums in transactions? Using a proprietary dataset obtained from a leading bank in Singapore from 2010 to 2012 (Agarwal and Qian (2014)), we find significant variations in the average checking account balances across the three ethnic groups.²³ If cash-on-hand were a binding constraint, Malay and Indian buyers with lower checking account balances would be unlikely to pay high COV in the transactions.

There are three reasons that we argue that our results on the ethnicity-related COV premiums are not driven by the cash constraints of buyers. First, our analyses are not related to high-income Chinese buyers paying higher COV relative to buyers of other ethnic groups. We find evidence to support the ethnic concentration effects by showing that Malay buyers pay more COV and Chinese buyers pay less COV in the high Malay concentration blocks. Second, as households have self-selected to participate (buy homes) in the housing market, their decisions to pay COVs are not likely to be affected by credit constraints. Third, the unconditional data show that, on average, Chinese buyers pay a higher COV of S\$353 compared to Malay buyers' and Indian buyers' COVs of S\$280 and S\$299, respectively; the results seem to suggest an ordering in the ethnic groups by their liquid asset holdings. However, when conditioning the samples on seller ethnicity, we find that the differences in the COVs paid by

²³Chinese customers have S\$34,660 on average in their checking accounts, with a standard deviation of S\$70,888; Malay customers have S\$10,519 on average, with a standard deviation of S\$34,984; Indian customers have S\$22,523 in their checking accounts on average, with a standard deviation of S\$58,110. We thank Agarwal and Qian for sharing the dataset.

buyers of different ethnic groups become insignificant.²⁴ The cash constraint effects disappear when we condition the COV payments by matching the buyers and the sellers by their ethnic groups in the transactions.

4.5. Sellers' Incentives to Trade

To further investigate the results in Table 7 from the sellers' perspective, we substitute the buyers' ethnicity with the sellers' ethnicity in the models and report the regression results in Table 8. Panel A shows the joint effect of ethnic concentration and seller ethnicity on COV (psm) using the specification in Equation (2), and Panel B shows the effects of within-ethnicity transactions on COV (psm) using the specification in Equation (3).

The results are similar to those reported in Table 7 but from the perspective of sellers. For example, Chinese sellers sell their homes with significantly higher COV in the high Chinese concentration blocks but significantly lower COV in the blocks with a high concentration of Malay and/or Indian households. Positive COVs are associated with the within-Chinese transactions in the high Chinese concentration blocks, and negative COVs are associated with the within-Chinese transactions in blocks with a high concentration of Malay and/or Indian households. Similar results are also observed in the transactions by Malay sellers and Indian sellers.

However, the results in Table 8 give rise to two questions relating to sellers' incentives to trade. First, why do they sell to buyers of other ethnicities at a discount in the blocks with a high concentration of their own ethnic group? Second, why do they sell to own-ethnicity buyers at a discount in the blocks with a high concentration of other ethnic groups?

²⁴While Chinese buyers pay S\$358 to Chinese sellers, Malay and Indian buyers pay S\$337 and S\$371 to Chinese sellers, respectively. Similarly, when Indian buyers pay S\$293 to Indian sellers, Malay buyers and Chinese buyers pay S\$314 and S\$258 to Indian sellers, respectively.

4.5.1. Cross-ethnicity trades in the high seller's ethnic concentration blocks

The first question relates to cross-ethnicity transactions in the blocks with a high concentration of the seller's own ethnic group. If buyers only pay higher COVs in blocks with a high concentration of the same seller's ethnic group, we should not observe cross-ethnicity transactions. High ethnic concentration has the dual effect of increasing the chances of matching with buyers of the same ethnic group and the COV premiums paid by buyers of the same ethnic group. A seller has an option to wait for buyers of the same ethnic group in blocks with a high concentration of the own ethnic group.

One plausible explanation is the heterogeneous quality of the transacted units. Are units in the cross-ethnicity transactions of lower quality? Do we observe differences in the quality of homes in the within-ethnicity transactions and the cross-ethnicity transactions? We run two different analyses and find no evidence showing significant differences in the observable quality of homes sold in the within-ethnicity transactions and the cross-ethnicity transactions. The results do not suggest that sellers choose to sell lower quality homes to buyers of other ethnic groups and not wait for buyers of the own ethnic group.

In Table 9, we compare the average characteristics of housing units in the cross-ethnicity transactions and the within-ethnicity transactions.²⁵ Panel A compares the average characteristics of the transactions between Chinese buyers and non-Chinese sellers (Column 1); between non-Chinese buyers and Chinese sellers (Column 2); and between Chinese buyers and Chinese sellers (Column 3). In addition to the housing and the neighborhood characteristics, we include variables representing the government's main upgrading programs for public housing estates ("MUP").²⁶ We construct the two MUP dummies, where "MUP Announced"

²⁵The housing characteristics include "Size (sqm)", "Unit Floor", "Distressed Seller", "Primary School Quality within 1 km", "the Primary School Quality within 1-2 km", "Distance to Nearest MRT", and "Age of the Block". Due to the data limitations, we are not able to show the unit-level heterogeneity; our results show only the univariate comparisons based on the block-level characteristics.

²⁶In 1990, the Singapore government introduced the main upgrading programme (MUP) that was designed to renovate and improve older public housing estates and housing blocks. The MUP covers improvements that range from changing existing fittings, bathroom retiling, and extension of internal space to repainting, enhancement of block facades, and adding new amenities, such as elevators, playgrounds, and covered walkways. The government heavily subsidizes the MUP program and bears 86% to 93% of the costs. In 2007, the MUP

indicates the announcement that a block is included in MUP, and “MUP Completed” indicates the completion of an MUP project in a block. We note that the MUP dummy variables are correlated with the age of the blocks, because older blocks have a higher chance of being selected for the MUP.

Column (5) reports the t-statistics on the differences between Column (3) and Column (2), and we find that all the characteristics, except for the floor level, are similar between the within-Chinese transactions and the cross-ethnicity transactions by Chinese sellers.²⁷ The results do not show significant differences in the housing characteristics in the transactions involving Malay (Panel B) and Indian (Panel C) buyers and sellers.

Figure 6 shows the distributions of the within-ethnicity transactions (red vertical bars), the total transactions (blue vertical bars), and the fraction of the within-ethnicity transactions to the total transactions in blocks (darkened line) with respect to the age of blocks. We do not find significant differences in the fraction of within-ethnicity transactions across blocks of age range, and the graphical distributions are consistent with the results in Table 9.

Table 10 reports logit regression results with the within-ethnicity transactions as the dependent variable, which is defined by a dummy variable that equals 1 for a within-ethnicity transactions, and 0 otherwise. The control variables include the five discrete dummies for ethnic concentration, the bankrupt seller dummy, size, floor level, distance to the nearest MRT station, surrounding primary school quality (within a 1km and a 1-2km boundary), the MUP announcement and completion dummies, and the building age dummies (20-40 years and above 40 years).

Columns (1)-(3) report the results using the samples of Chinese buyers, Malay buyers, and Indian buyers, respectively. Most of the variables are statistically insignificant, thereby

was subsequently replaced with the home improvement programme (HIP), which is a scaled-down version of the MUP that covers repairs to internal space, changing fittings and new finishes for flats. The two programs are collectively henceforth referred to as “MUP”.

²⁷The average floor of the within-Chinese transactions by Chinese sellers is 2.2 floors higher compared to the average floor of the cross-ethnicity transactions by Chinese sellers. Due to culture and lifestyle, Malay households usually prefer to live on lower floors; Chinese households are more likely to live in high floor units. However, the floor level alone could not drive the main results, as the floor is included as a control variable in the model.

indicating that these characteristics do not predict the within-ethnicity transactions. Interestingly, we find a significant negative effect of “Distressed Sellers” on the within-ethnicity transactions. Bankrupt sellers facing financial constraints are not likely to wait for buyers of their own ethnic group, and the likelihood of cross-ethnicity transactions is higher for the bankrupt sellers.

While unobservable quality differences in units cannot be completely ruled out, the results suggest that other factors that are unrelated to the unit quality, i.e. the seller’s financial condition, can explain why the cross-ethnicity transactions happen.

4.5.2. Within-ethnicity trades in the low sellers’ ethnic concentration blocks

The second question relates to the within-ethnicity transactions in the blocks with a low concentration of the sellers’ ethnic group. If Chinese buyers pay high COVs in Chinese concentration blocks, why do Malay sellers still sell their units to Malay buyers, and not to Chinese buyers, in these blocks? One possible and straightforward answer is that Chinese cannot buy units from non-Chinese in the blocks subject to the binding Chinese quota.

In the high Chinese concentration blocks that are not subject to the Chinese binding quota, we should expect to have fewer within-Malay transactions. The results in Column (2) in Panel B of Table 8 show that COVs are significantly lower when Malay sellers trade with Malay buyers in the high Chinese concentration blocks (“4/4” (-S\$62.44), and “3/4” (-S\$54.35)). Malay sellers should wait for Chinese buyers and sell their homes to them for higher COVs in the high Chinese concentration blocks.

However, to the contrary, we still observe a significantly high number of within-ethnicity transactions in the blocks with a high concentration of other ethnic groups, but without the ethnicity quota constraint. Figure 7 reports the matching frequency by the ethnicity of buyers and sellers. Panel A reports the fraction of buyers’ ethnicity in different Chinese concentration blocks (“4/4”, “3/4”, “2/4” and “1/4” Chinese blocks) and sorted by the sellers’ ethnicity. Note that Figure 7 excludes blocks that are subject to the Chinese block-level and/or the

neighborhood-level binding quotas. With reference to the sellers of different ethnic groups (horizontal axis), we report the fractions of transactions involving Chinese buyers, Malay buyers, and Indian buyers.

In the top-left panel (“4/4” Chinese blocks), we find that 95.9% of the Chinese transactions, 81.3% of the Indian transactions, and 89.7% of the Malay transactions are within-ethnicity transactions, despite that Malay or Indian sellers sell their homes at significant COV discounts to buyers of the own ethnic groups in these blocks. Based on an average size unit with an area of 97.04 sqm and the estimated COV discount of -S\$62.44 (reported in Column (2) in Panel B of Table 8), the economic losses to Malay sellers for selling their homes to Malay buyers are equivalent to -S\$6,059 ($=97.04 \times -S\62.44) relative to selling their homes to Chinese buyers in the high Chinese concentration blocks. A high frequency of within-ethnicity transactions is also observed in other blocks (“3/4”, “2/4” and “1/4” Chinese blocks).

Panel B reports the fraction of buyer ethnicity matching in different Malay concentration blocks sorted by seller ethnicity. In the high (“4/4”) Malay concentration blocks, we find that 96.8% of transactions by Chinese sellers are within-Chinese transactions, who sell at a lower average COV of -S\$90.95, as shown in Column (4) in Panel B of Table 8. Panel C shows the shares of buyer ethnicity in different Indian concentration blocks sorted by the sellers’ ethnicity. In the high (“4/4”) Indian concentration blocks, we find that 96.3% of Chinese transactions are within-Chinese transactions, and 88.1% of the Malay transactions are within-Malay transactions.

The results strongly suggest that the high frequency of within-ethnicity transactions magnifies the effect of ethnic matching on COV. In Tables 7 and 8, we find strong COV premiums (discounts) in blocks with a high concentration of the same (another) ethnicity group. The effects are only observed in the within-ethnicity transactions; the results are weaker in the cross-ethnicity transactions. If there were more cross-ethnicity transactions, we would find much weaker results instead. We will further examine the mechanism driving the high intensity of within-ethnicity transactions despite the COV discounts in the next section.

There are two additional points to be made from the results. First, there is no evidence suggesting that sellers choose to sell their homes to buyers based on their willingness to pay premiums for the ethnic amenities in the blocks. In fact, sellers prefer to sell their homes to buyers of the same ethnic groups, rather than to wait and sell the homes for premiums to buyers from different ethnic groups. The COV discounts in the within-ethnicity transactions indicate that the value of waiting option is not economically significant. Second, the ethnic quota policy may have had the unintended consequence of creating persistence in segregation. Despite the quota policy that was introduced to prevent segregation in 1989, strikingly, many blocks remain segregated. This may be because the quota policy has an unintended effect of encouraging within-ethnicity trades, thereby leading to persistence in segregation.²⁸ This could contribute to the high fraction of within-ethnicity transactions outside the quota-binding blocks, as depicted in Figure 7.

4.6. Search Frictions and Ethnic Social Networks

The within-ethnicity discount is probably a unique phenomenon observed only in the housing market, not in other asset markets. What are the unique features of housing markets that have contributed to this phenomenon? For example, why do Malay sellers in the Chinese concentration blocks not wait and sell their homes to Chinese buyers but, instead, accept discounts by selling their homes to Malay buyers? There are three possible explanations for the ethnic matching puzzle, which has had a large price impact in the public housing market in Singapore.

The first explanation pertains to the selection bias (taste preferences) of buyers for different ethnic groups. Unlike other financial assets, housing assets are not homogeneous; homes sold in the Malay-to-Malay transactions in Chinese concentration blocks may have some attributes

²⁸For example, in a Chinese-quota binding block, Chinese buyers can only trade with Chinese sellers, but such a constraint is not applicable to non-Chinese buyers, who can trade with sellers of any ethnic group. However, as non-Chinese buyers are still sorted with non-Chinese sellers in this block, we can only argue that non-Chinese buyers, who could not outbid Chinese buyers, are compelled to trade with non-Chinese sellers. As a result, the ethnic quota policy encourages within-ethnicity trades.

that are not preferred by Chinese buyers. In this case, the Malay sellers will not wait for Chinese buyers; instead, they may find it easier to sell their homes to Malay buyers. However, in Table 9, we find no evidence showing significant differences in the observable quality of homes sold in the within-ethnicity transactions and the cross-ethnicity transactions.²⁹ Moreover, we still cannot exclude the possibility that buyers may also come from another ethnic group, although not from the same ethnic group, i.e., an Indian buyer instead of a Malay buyer in this case.

The second explanation relates to the downpayment constraints. Since housing purchases requires a lump-sum cash payment upfront, we may conjecture that Malay buyers buying homes in high Chinese concentration blocks from Malay sellers are systematically poorer than other Malay buyers in high Malay concentration blocks. However, our results show that the average Malay buyers in the high (“4/4”) Chinese concentration blocks pay more COV (psm) than the average Malay buyers in the Malay quota-binding blocks. The results cannot explain why Malay sellers do not wait for Chinese buyers in high Chinese concentration blocks.

The third explanation relates to the market segmentation hypothesis. Housing search is not a frictionless process. Households with only limited housing transaction experience in a lifetime could face high search costs in the process. We argue that ethnic social networks could be a source of search frictions that could explain the COV discounts and the high intensity of the within-Malay transactions in high Chinese concentration blocks.

An ethnic social network develops among people who speak the same language and/or with have the same educational backgrounds. Engaging in ethnic social networks could facilitate and improve network-specific information spillovers (Bertrand et al. (2000)). Although English is a prevalent business language in Singapore, buyers and sellers are nevertheless more comfortable using their own native languages when negotiating housing transactions. For example, Chinese households may discuss and share information on Chinese amenities with people in the Chinese network. The sharing of experience helps reduce information asym-

²⁹We nevertheless cannot exclude possible differences in the unobservable qualities of homes.

metries in the housing market for Chinese households. The ethnic social network could also improve the matching of sellers and buyers from the same ethnic group and encourage within-ethnicity transactions. However, the flip side is that buyers and sellers can be locked into the ethnic social network. In the search process, they may have limited access to information outside the network and may risk trading at sub-optimal prices, i.e., with COV discounts in within-ethnicity transactions. The ethnic social network indirectly reinforces and exacerbates the ethnic segregation in the housing market.

An ethnic social network can also be formed by real estate agents specializing in a selected ethnic group (Palm (1985)).³⁰ For example, in Singapore, real estate agents create customized real estate web portals that serve only a selected ethnic group. The specialized agents maintain a client base consisting of buyers and sellers from the same ethnic group; they also reach out to the networks of other agents servicing the same ethnic group.

We merge the subsample of COV data with a dataset on property listings by real estate agents in Singapore and use the merged dataset to investigate the ethnic social networks formed by real estate agents in Singapore. The property listing dataset covering the period from 2007 to 2012 contains information on size (sqm), floor level, property type, postal code, asking price, valid date of listing, and real estate agent ID; however, some of the variables are incomplete. In merging the property listing data with the COV data, we require all available variables, such as floor level, unit number, property type, and postal code, in the two datasets to be correctly matched. We obtain 8,292 matched listing-transaction observations that contain complete information on buyers and real estate agents. There are 2,505 real estate agents with a unique identification numbers in the database. We find that real estate agents sell 2.65 homes, on average, in the sample; the transaction numbers range from 1 to 175. The top 25% of real estate agents sell more than 2 homes, and the top 10% of real estate agents sell more than 5 homes.

³⁰Based on the survey in Denver, Palm (1985) finds that 1) the seller ethnicity is highly correlated with the ethnicity of real estate agents; 2) real estate agents operate mostly in the areas with a high concentration of their own ethnic group; and 3) real estate agents have more business contacts with people from the same ethnic group.

While the demographic profiles of the agents are unknown, we can identify the buyers' ethnicity from the transaction data. We compute the number of customers by the ethnic group serviced by the real estate agent. Based on 616 real estate agents, who sold more than 3 homes,³¹ we plot the fraction of customers by ethnic group in Figure 8. Panel A shows the distributions of the shares of Chinese customers (left panel), Malay customers (middle panel), and Indian customers (right panel) for all the real estate agents. We find that 96% of the real estate agents have at least one Chinese customer, 36% of them have no Malay customers, and 75% of them have no Indian customers. The results seem to suggest that real estate agents specialize in servicing a selected ethnic group.

Conditional on agents having least one customer from an ethnic group, Panel B shows the compositions of customers by ethnicity in the agent listings. If the agent-customer matching is random, we should expect the ethnic composition of the customers in the agent listings to be correlated with the ethnic composition of Singapore's residents. The red dashed vertical lines in Panel B represent the country's resident ethnic composition, which includes 74.4% Chinese, 13.5% Malays, and 9.1% Indians, on average. We find that the customer ethnicity percentages are above the red line and mostly distributed in the right-tail. The skewed distributions of the customer composition in a selected ethnic group in real estate agents' listings are consistent with the agents' ethnic social network story. Agents specializing in a selected ethnic group of customers increase real estate transactions within the same ethnic group; and as a result, sellers may end up with some welfare losses because of the COV discounts in the within-ethnicity transactions.

If the ethnic-centric matching technology is not optimal, why do we not see the presence of bilingual agents, who can bridge the cultural and language divide, to arbitrage in the market and reduce search frictions? To answer this question, we investigate the agent effects by measuring the degree of deviations between the customers' ethnic compositions and the ethnic composition of the country's residents.

³¹The results do not change when we increase the minimum number of transactions to 5 or 10.

Let us define the customer ethnic composition in the agent listings as a three-dimensional Cartesian coordinate (Figure 9), i.e., $(x, y, z) = (\text{Fraction of Chinese Customers}, \text{Fraction of Malay Customers}, \text{Fraction of Indian Customers})$, where $x + y + z \leq 1$.³² By setting the ethnic composition of the country's residents as a reference point, (74.4%, 13.5%, 9.1%), we measure the distance between the agents' customer ethnic composition and the reference point using the distance metric: $\text{DEVIATION} = \{(\text{frac_Chinese Customers} - 0.744)^2 + (\text{frac_Malay Customers} - 0.135)^2 + (\text{frac_Indian Customers} - 0.091)^2\}^{1/2}$. We interpret a high "DEVIATION" as indicating that an agent has a high ethnic concentration in his/her customer composition and we refer him as a network agent.

Table 11 reports the results of univariate regressions of "DEVIATION" on the characteristics of real estate agents. In Column (1), we find that "Size of Agency", which is measured by the number of agents employed by an agency, increases with "DEVIATION". Agents working in large agencies are more likely to be the network agents. The results are statistically and economically significant: a 1 SD increase in "DEVIATION" increases 14% of 1 SD of the agency size. In Column (2), we find that "Number of Searches per Customer", which is the number of home report searches divided by the number of customers serviced by an agent, decreases with "DEVIATION". This implies that the network agents put less searching effort but rely on private information to find potential buyers for their listing customers. For example, top 1/3 of agents with high "DEVIATION" searches 10 reports per customers on average, while bottom 1/3 of agents searches 22 reports per customers. In Column (3), we find that "HDB Fraction in Search Volume", which represents the fraction of home report searches on public housing units (HDB) relative to the total searches (including both public and private homes), decreases with "DEVIATION". This indicates that network agents are less likely to specialize only in the public housing (HDB) market.

The results imply that agents with a high deviation in the customer base composition from the national reference point are less competitive, but they tend to specialize in an ethnic

³²We can explain Figure 8 as the marginal distributions of customers by the shares of Chinese/Malay/Indian customers.

group and work in a large agency firm. These agents are also more likely to increase within-ethnicity transactions via their ethnic social networks, at the expense of their customers due to incomplete search effort.

Note that agents' ethnic social network is not completely substitutable by non-network agents if customers self-select to hire network agents. In Column (4) of Table 11, where customer age is defined by the median age of customers in an agent's listings, we find that customers in the high "DEVIATION" agents' listings are, on average, older, and that a 1 SD increase in "DEVIATION" increases 10% of 1 SD of the customer age. The results imply that older customers are more likely to be locked into the networks of real estate agents specializing in servicing customers of the same ethnic group. This may come from the stronger relationships between older customers and their agents in the housing market or from the stronger preference of older customers for agents specializing in the same ethnic group.

5. Conclusion

This paper uses a unique institutional setup of the resale public housing market in Singapore to test the significance of ethnic social networks in explaining within-ethnicity transactions. Based on a large and unique dataset containing information on Cash-Over-Valuation (COV) in resale housing transactions, we find that sellers sell their homes at significant premiums (discounts) in blocks with a high concentration of the own (other) ethnic group. Our results are independent of other possible supply-side factors in explaining the COV premiums. We show that the ethnicity-related premiums are also independent of the credit conditions (constraints) of buyers.

However, high ethnic concentration alone is not a sufficient condition to explain the premiums for the ethnicity-related factors, such as ethnic amenities and/or ethnic interactions. We show that ethnicity-related COV premiums are only observed in within-ethnicity transactions involving buyers and sellers of the same ethnic group. The matching of buyers and sellers of

the same ethnic groups is necessary to generate positive premiums in blocks with high ethnic concentrations.

We find a high volume of transactions by sellers and buyers of the same ethnic group in blocks with a high concentration of other ethnic groups. In these transactions, sellers sell their homes at discounts to buyers from the same (own) ethnic group, instead of waiting for buyers of another ethnic group, who will pay premiums for the ethnic amenities. The findings support the market segment hypothesis through ethnic social network. While an ethnic social network amplifies the ethnicity matching between buyers and sellers, it consequentially hinders efficient search in the housing market. The intensity of the within-ethnicity transactions is reinforced by the ethnic social networks, which renders the sellers' option to wait for buyers from other ethnic group less valuable.

We provide new evidence on the ethnic social networks formed by real estate agents in Singapore. We find significant concentrations in real estate agents' customer ethnic compositions. We also find that agents with a high ethnic concentration in their customer base are less competitive and have more older customers in their listings. These agents indirectly contribute to a high volume of the within-ethnicity transactions through their ethnic social networks, which comes at the expense of customers.

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Table 1: Population Composition of Singapore and the Ethnic Integration Policy

We report the population composition of Singapore in 1989 and 2010 and the maximum ethnic limits imposed by the Ethnic Integration Policy. From March 1989, the Ethnic Integration Policy imposed maximum ethnic limits in neighborhoods and blocks in Singapore. As of March 12, 2010, the limit for Indian group has been increased from 10% to 12% for neighborhoods and from 13% to 15% for blocks.

Ethnic Group	Population Composition		Maximum Ethnic Limits			
	1989	2010	From 1 March 1989		From 5 March 2010	
			Neighborhood	Block	Neighborhood	Block
Chinese	77.80%	74.10%	84.00%	87.00%	84.00%	87.00%
Malays	14.20%	13.40%	22.00%	25.00%	22.00%	25.00%
Indians	7.00%	9.20%	10.00%	13.00%	12.00%	15.00%

Table 2: % Change in COV and % Change in Appraisal Value

We report Fama-Macbeth regression results on the effect of the change in COV (psm) on the change in future appraisal value, using town-level data. Column (1) reports the result with the annual % change in average appraisal value (psm) in an HDB town from t to $t + 1$ as the dependent variable. The main independent variable is the annual % change in average COV (psm) in the HDB town from $t - 1$ to t . Other independent variables include the annual % change in average appraisal value (psm) from $t - 1$ to t , and the averages of Size (sqm), Unit Floor, Distance to Nearest MRT, Primary School Quality within 1 km, Primary School Quality within 1-2 km, Age of the Block. Columns (2)-(6) report the results using the quarterly data. The dependent variable is the quarterly % change in appraisal value (psm) from t to $t + 1$; and the main independent variable is the quarterly % change in COV (psm) but with different lags, which include Column (2): from $t - 1$ to t ; Column (3): from $t - 2$ to $t - 1$; Column (4) from $t - 3$ to $t - 2$; and Column (5): from $t - 4$ to $t - 3$. Column (6) includes all four lags in the quarterly % change in COV (psm). The table reports point estimates with t-statistics in parentheses. All standard errors are from the Newey-West with two years of lag length. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Variables	(1) Annual	(2) Quarterly	(3) Quarterly	(4) Quarterly	(5) Quarterly	(6) Quarterly
	% Change in Appraisal Value (psm) $_{t,t+1}$					
% Change in COV (psm) $_{t-1,t}$	0.07** (3.74)	0.05*** (5.23)				0.04*** (3.06)
% Change in COV (psm) $_{t-2,t-1}$			0.03*** (4.99)			0.04*** (3.76)
% Change in COV (psm) $_{t-3,t-2}$				0.01** (2.94)		0.01 (1.62)
% Change in COV (psm) $_{t-4,t-3}$					0.02*** (4.31)	0.01 (0.95)
% Change in App Value (psm) $_{t-1,t}$	-0.02 (-0.17)	-0.22*** (-4.92)				-0.29*** (-3.12)
% Change in App Value (psm) $_{t-2,t-1}$			0.06 (1.34)			0.01 (0.21)
% Change in App Value (psm) $_{t-3,t-2}$				0.002 (0.07)		0.07* (1.98)
% Change in App Value (psm) $_{t-4,t-3}$					0.004 (0.07)	0.10 (1.00)
Size (sqm)	-0.001** (-3.39)	-0.001** (-2.92)	-0.001** (-2.73)	-0.001*** (-5.62)	-0.001*** (-3.56)	-0.002*** (-3.11)
Unit Floor	-0.006** (-5.74)	-0.005*** (-3.54)	-0.004** (-2.60)	-0.004** (-2.70)	-0.003 (-1.40)	-0.004*** (-4.47)
Distance to Nearest MRT	0.0004 (0.09)	0.004 (1.10)	0.001 (0.15)	0.002 (0.65)	0.003 (1.32)	0.006** (3.02)
Primary School Quality within 1 km	0.004 (1.22)	0.003 (1.10)	-0.001 (-0.30)	0.006** (2.36)	0.005** (2.88)	0.0005 (0.14)
Primary School Quality within 1-2 km	0.002* (2.95)	0.003 (0.78)	-0.001 (-0.23)	-0.005* (-2.13)	-0.001 (-0.69)	0.004* (1.96)
Age of the Block	-0.002 (-1.57)	-0.002 (-1.70)	-0.001 (-1.44)	-0.002** (-2.64)	-0.002*** (-3.28)	-0.003** (-2.44)
Constant	0.33** (5.34)	0.34*** (5.53)	0.24*** (4.16)	0.27*** (7.95)	0.25*** (4.33)	0.39*** (4.98)
Observations	104	416	390	364	338	338
R-squared	0.612	0.473	0.445	0.399	0.383	0.717

Table 3: Summary Statistics

We construct our data by merging the public housing resale transaction data from Singapore Real Estate Exchange with a proprietary big database on Singapore residents. Our sample period is from 2007 to 2012. We construct the repeat-sale samples based on housing units sold twice or more during the sample period. Panel A shows the sample composition of buyers and sellers by the ethnicity. Panel B reports the summary statistics for the key variables. The Appraisal Value is an appraisal value of a housing unit from a panel of accredited appraisers, which is similar to the standard hedonic models. Appraisal Value (psm) is the Appraisal Value per square meter. COV is the cash-over-valuation, which is the difference between the final agreed price and the appraisal value. COV (psm) is the COV per square meter. Unit floor is the floor level of a transacted unit. Size (sqm) is the area of internal space in a housing unit. Age of the Block captures the building age of the sample housing block, which is computed as the difference in years between the transaction date and the lease commencement date. Distressed Seller is a dummy variable identifying sellers who filed for bankruptcy during the sample period. Distance to Nearest MRT is the linear measure of distance of a sample housing block to the nearest MRT station. Primary School Quality within 1 km and Primary School Quality within 1-2 km capture the proximity to good (preferred) primary school education. Fraction of Chinese in a Block is the share of Chinese residents in a block. Fraction of Malay in a Block is the share of Malay residents in a block. Fraction of Indian in a Block is the share of Indian residents in a block. Panel C reports the distributions of the sample transactions sorted based on the HDB housing type classifications into 1-bedroom to 5-bedroom, and “Jumbo” and “Executive” for the large housing flat types. We winsorize the Appraisal Values and the COVs at the 1% level on both side of the distribution.

Panel A: Buyer and Seller Ethnicity Composition

	Seller Ethnicity				Total
	Chinese	Malay	Indian	Others	
Chinese	2,583	101	37	20	2,741
Malay	57	778	12	1	848
Indian	18	9	188	10	225
Others	9	5	10	21	45
Total	2,667	893	247	52	3,859

Panel B: Summary Statistics

	Obs	Mean	Std.Dev.	Min	Max
Appraisal Value	3,859	378,098	104,845	160,000	685,000
Appraisal Value (psm)	3,859	3,975.94	804.41	1,739.13	8,782.05
COV	3,859	31,090	18,813	-22,000	90,000
COV (psm)	3,859	332.91	195.61	-500.00	1,323.53
Unit Floor	3,859	7.19	4.70	1.00	39.00
Size (sqm)	3,859	97.04	26.55	31.00	243.00
Age of the Block	3,111	22.95	9.38	2.00	45.00
Distressed Seller	3,859	0.02	0.13	0.00	1.00
Distance to Nearest MRT	3,859	0.90	0.55	0.05	3.34
Primary School Quality within 1 km	3,749	-0.11	0.59	-0.85	3.66
Primary School Quality within 1-2 km	3,824	-0.11	0.42	-0.85	3.54
Fraction of Chinese in a Block	3,859	78.69	9.33	0.00	100.00
Fraction of Malay in a Block	3,859	16.54	9.02	0.00	88.89
Fraction of Indian in a Block	3,859	3.71	2.41	0.00	29.41

Panel C: Property Type

	1 Rooms	2 Rooms	3 Rooms	4 Rooms	5 Rooms	Executive	Jumbo
	12	38	1207	1,310	937	347	8
	0.31%	0.98%	31.28%	33.95%	24.28%	8.99%	0.21%

Table 4: COV and the Ethnicity Fraction in a Block

We report the panel regression results on the effect of buyer ethnicity and ethnic concentration on COV (psm). The dependent variable is COV (psm). Columns (1)-(3) include a dummy variable for Chinese buyer and its interactions with the fractions of Chinese, Malay or Indian in a block. In column (1), we interact the Chinese buyer dummy with Chinese share in a block. Independent variables include Distressed Seller, Size (sqm), Unit Floor, Distance to Nearest MRT, Primary School Quality within 1 km, and Primary School Quality within 1-2 km. We also include two building age dummies: Age of the Block (20-40 years) and Age of the Block (above 40 years). We include year fixed effects, month fixed effects, and property type fixed effects. In column (2), we interact the Chinese buyer dummy with Malay share in a block. In column (3), we interact the Chinese buyer dummy with Indian share in a block. Columns (4)-(6) report the results for Malay buyers and Columns (7)-(9) report the results for Indian buyers. The table reports point estimates with t-statistics in parentheses. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent Variable: COV (psm)								
Buyer Ethnicity	53.81*** (8.59)	53.67*** (8.57)	53.20*** (8.88)	-52.43*** (-7.50)	-52.17*** (-7.37)	-49.86*** (-7.82)	-32.25*** (-3.24)	-32.54*** (-3.39)	-28.27*** (-2.73)
Buyer Ethnicity × Fraction of Chinese	3.23*** (5.57)			-3.26*** (-5.34)			-1.83* (-1.81)		
Buyer Ethnicity × Fraction of Malay		-3.39*** (-5.48)			3.38*** (5.15)			2.19** (2.04)	
Buyer Ethnicity × Fraction of Indian			0.32 (0.11)			0.38 (0.15)			-2.60 (-0.53)
Fraction of Chinese	-0.50 (-1.10)			2.48*** (6.73)			2.16*** (6.78)		
Fraction of Malay		0.45 (0.93)			-2.61*** (-6.83)			-2.36*** (-7.02)	
Fraction of Indian			-0.51 (-0.28)			-1.00 (-0.54)			-0.24 (-0.14)
Distressed Seller	-37.47** (-2.17)	-37.05** (-2.16)	-37.42** (-2.19)	-39.41** (-2.24)	-38.80** (-2.21)	-40.99** (-2.33)	-41.60** (-2.35)	-41.50** (-2.35)	-41.53** (-2.32)
Size (sqm)	-1.14*** (-3.24)	-1.16*** (-3.30)	-1.43*** (-4.04)	-1.14*** (-3.20)	-1.17*** (-3.29)	-1.41*** (-3.94)	-1.11*** (-3.05)	-1.13*** (-3.13)	-1.42*** (-3.89)
Unit Floor	7.10*** (10.88)	7.10*** (10.87)	7.71*** (11.78)	7.39*** (11.47)	7.44*** (11.53)	7.94*** (12.26)	8.18*** (12.73)	8.16*** (12.67)	8.88*** (13.86)
Distance to Nearest MRT	-33.89*** (-7.24)	-33.57*** (-7.17)	-38.17*** (-7.94)	-34.58*** (-7.40)	-34.30*** (-7.34)	-38.93*** (-8.13)	-36.85*** (-7.79)	-36.22*** (-7.65)	-41.34*** (-8.53)
Primary School Quality within 1 km	6.06 (1.11)	5.72 (1.04)	8.85 (1.61)	6.13 (1.12)	5.85 (1.07)	8.80 (1.61)	7.98 (1.45)	7.51 (1.36)	10.57* (1.92)
Primary School Quality within 1-2 km	12.88 (1.53)	12.58 (1.49)	16.02* (1.90)	11.93 (1.41)	11.84 (1.40)	15.47* (1.83)	11.43 (1.32)	11.35 (1.31)	15.78* (1.84)
Age of the Block (20 - 40 years)	31.05*** (4.38)	30.41*** (4.28)	32.64*** (4.55)	30.73*** (4.31)	30.52*** (4.27)	33.22*** (4.61)	33.23*** (4.61)	32.45*** (4.50)	36.14*** (4.97)
Age of the Block (above 40 years)	19.74** (2.24)	19.65** (2.26)	23.51*** (2.65)	18.85** (2.14)	19.16** (2.20)	23.12*** (2.59)	19.10** (2.15)	18.82** (2.14)	25.82*** (2.87)
Observations	3,715	3,715	3,715	3,715	3,715	3,715	3,715	3,715	3,715
R-squared	0.333	0.334	0.322	0.328	0.328	0.318	0.318	0.319	0.309
Fixed Effects	Year, Month, and Property Type								

Table 5: COV and the Ethnicity Fraction in a Block with Additional Fixed Effects

We report the panel regression results on the effect of buyer ethnicity and ethnic concentration on COV (psm), with additional fixed effects. The dependent variable is COV (psm). Columns (1)-(3) include a dummy variable for Chinese buyer and its interactions with the fractions of Chinese, Malay or Indian in a block. In column (1), we interact the Chinese buyer dummy with Chinese share in a block. Independent variables include Distressed Seller, Size (sqm), Unit Floor, Distance to Nearest MRT, Primary School Quality within 1 km, Primary School Quality within 1-2 km, and the two building age dummies: Age of the Block (20-40 years) and Age of the Block (above 40 years). We include month fixed effects, property type fixed effects, Town×Year×L.Floor fixed effects, Town×Year×L.Size fixed effects, and Town×Year×L.MRT fixed effects. L.Floor, L.Size, and L.MRT are the decile dummies for the unit floor, unit size, and the distance to MRT. In column (2), we interact the Chinese buyer dummy with Malay share in a block. In column (3), we interact the Chinese buyer dummy with Indian share in a block. Columns (4)-(6) report the results for Malay buyers and columns (7)-(9) report the results for Indian buyers. The table reports point estimates with t-statistics in parentheses. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent Variable: COV (psm)								
Buyer Ethnicity	39.44*** (4.89)	39.98*** (4.99)	31.34*** (3.89)	-40.92*** (-4.47)	-42.51*** (-4.68)	-30.38*** (-3.42)	-24.63* (-1.66)	-21.29 (-1.46)	-20.77 (-1.33)
Buyer Ethnicity × Fraction of Chinese	3.67*** (4.76)			-3.37*** (-4.18)			-2.79* (-1.87)		
Buyer Ethnicity × Fraction of Malay		-4.19*** (-4.92)			3.97*** (4.41)			3.54** (2.07)	
Buyer Ethnicity × Fraction of Indian			0.63 (0.20)			-0.92 (-0.28)			-1.32 (-0.22)
Fraction of Chinese	-2.38*** (-3.10)			0.99 (1.44)			0.14 (0.23)		
Fraction of Malay		2.86*** (3.38)			-0.96 (-1.30)			-0.02 (-0.03)	
Fraction of Indian			-0.92 (-0.34)			-0.80 (-0.36)			-0.67 (-0.36)
Distressed Seller	-68.23** (-2.52)	-67.39** (-2.50)	-67.85** (-2.51)	-68.10** (-2.50)	-66.36** (-2.44)	-70.84*** (-2.64)	-71.05*** (-2.64)	-71.76*** (-2.68)	-69.50** (-2.57)
Size (sqm)	-1.38 (-1.43)	-1.36 (-1.40)	-1.50 (-1.53)	-1.39 (-1.44)	-1.36 (-1.41)	-1.43 (-1.47)	-1.35 (-1.40)	-1.35 (-1.39)	-1.39 (-1.43)
Unit Floor	3.27 (0.84)	3.21 (0.83)	3.88 (1.01)	3.79 (0.98)	3.81 (0.99)	4.12 (1.07)	4.07 (1.06)	4.08 (1.06)	4.14 (1.08)
Distance to Nearest MRT	-17.06 (-0.68)	-16.75 (-0.68)	-19.05 (-0.76)	-20.90 (-0.86)	-21.25 (-0.88)	-21.77 (-0.89)	-21.08 (-0.84)	-21.48 (-0.86)	-21.02 (-0.84)
Primary School Quality within 1 km	-16.31 (-1.18)	-16.16 (-1.17)	-14.34 (-1.03)	-16.06 (-1.14)	-15.84 (-1.13)	-14.49 (-1.03)	-13.40 (-0.97)	-13.43 (-0.97)	-13.57 (-0.97)
Primary School Quality within 1-2 km	-4.05 (-0.23)	-4.21 (-0.24)	-5.72 (-0.32)	-2.11 (-0.12)	-1.82 (-0.10)	-5.36 (-0.30)	-8.78 (-0.48)	-9.08 (-0.50)	-8.12 (-0.44)
Age of the Block (20 - 40 years)	16.31 (1.12)	16.61 (1.14)	17.40 (1.18)	16.52 (1.13)	16.98 (1.16)	18.12 (1.23)	17.17 (1.17)	16.90 (1.16)	17.13 (1.17)
Age of the Block (above 40 years)	6.30 (0.50)	6.24 (0.50)	3.27 (0.26)	4.40 (0.35)	4.87 (0.39)	2.71 (0.22)	4.95 (0.40)	4.96 (0.40)	3.48 (0.28)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.684	0.685	0.680	0.683	0.683	0.680	0.678	0.678	0.678
Fixed Effects	Month, Property Type, Town×Year×L.Floor, Town×Year×L.Size, Town×Year×L.MRT								

Table 6: Appraisal Value and the Ethnicity Fraction in a Block with Additional Fixed Effects

We report the panel regression results on the effect of buyer ethnicity and ethnic concentration on Appraisal Value (psm), with additional fixed effects. The dependent variable is Appraisal Value (psm). Columns (1)-(3) include a dummy variable for Chinese buyer and its interactions with the fractions of Chinese, Malay or Indian in a block. In column (1), we interact the Chinese buyer dummy with Chinese share in a block. Independent variables include Distressed Seller, Size (sqm), Unit Floor, Distance to Nearest MRT, Primary School Quality within 1 km, Primary School Quality within 1-2 km, and the two building age dummies: Age of the Block (20-40 years) and Age of the Block (above 40 years). We include month fixed effects, property-type fixed effects, Town×Year×IFloor fixed effects, Town×Year×ISize fixed effects, and Town×Year×LMRT fixed effects. IFloor, ISize, and LMRT are the decile dummies for the unit floor, unit size, and the distance to MRT. In column (2), we interact the Chinese buyer dummy with Malay share in a block. In column (3), we interact the Chinese buyer dummy with Indian share in a block. Columns (4)-(6) report the results for Malay buyers and columns (7)-(9) report the results for Indian buyers. The table reports point estimates with t-statistics in parentheses. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent Variable: Appraisal Value (psm)								
Buyer Ethnicity	10.60 (0.76)	13.87 (1.00)	19.54 (1.43)	-7.05 (-0.47)	-8.30 (-0.55)	-17.72 (-1.25)	-18.86 (-0.70)	-31.43 (-1.14)	-23.52 (-0.75)
Buyer Ethnicity × Fraction of Chinese	-1.43 (-0.96)			0.70 (0.44)			3.54 (1.29)		
Buyer Ethnicity × Fraction of Malay		1.28 (0.83)			-0.34 (-0.21)			-5.50 (-1.62)	
Buyer Ethnicity × Fraction of Indian			2.90 (0.55)			-5.33 (-0.96)			7.17 (0.81)
Fraction of Chinese	8.54*** (5.77)			7.48*** (6.02)			7.60*** (6.82)		
Fraction of Malay		-8.34*** (-5.41)			-7.46*** (-5.60)			-7.50*** (-6.29)	
Fraction of Indian			-7.54* (-1.72)			-4.57 (-1.31)			-6.58** (-2.03)
Distressed Seller	-38.83 (-0.85)	-32.13 (-0.70)	-27.05 (-0.58)	-40.87 (-0.89)	-33.95 (-0.74)	-28.43 (-0.61)	-36.43 (-0.79)	-27.12 (-0.59)	-28.70 (-0.62)
Size (sqm)	-10.01*** (-3.73)	-10.19*** (-3.74)	-9.87*** (-3.68)	-9.93*** (-3.69)	-10.10*** (-3.70)	-9.82*** (-3.67)	-10.02*** (-3.70)	-10.24*** (-3.73)	-9.79*** (-3.63)
Unit Floor	28.25*** (3.14)	28.16*** (3.13)	30.59*** (3.40)	28.18*** (3.13)	28.12*** (3.13)	30.76*** (3.42)	28.08*** (3.13)	28.06*** (3.13)	30.78*** (3.41)
Distance to Nearest MRT	-329.9*** (-6.55)	-333.2*** (-6.55)	-343.8*** (-6.58)	-330.5*** (-6.54)	-334.1*** (-6.54)	-345.7*** (-6.58)	-328.7*** (-6.52)	-331.6*** (-6.51)	-344.3*** (-6.58)
Primary School Quality within 1 km	70.22*** (3.16)	69.92*** (3.13)	72.90*** (3.18)	69.80*** (3.14)	69.56*** (3.11)	72.92*** (3.18)	69.67*** (3.14)	69.77*** (3.13)	73.23*** (3.19)
Primary School Quality within 1-2 km	-67.66** (-2.19)	-66.60** (-2.14)	-68.44** (-2.15)	-67.81** (-2.19)	-66.75** (-2.14)	-68.45** (-2.15)	-67.35** (-2.18)	-66.12** (-2.13)	-70.43** (-2.20)
Age of the Block (20 - 40 years)	-159.3*** (-6.65)	-161.7*** (-6.77)	-165.7*** (-6.78)	-159.1*** (-6.64)	-161.6*** (-6.76)	-164.7*** (-6.73)	-160.0*** (-6.67)	-162.1*** (-6.79)	-166.1*** (-6.78)
Age of the Block (above 40 years)	114.3*** (4.23)	118.7*** (4.39)	125.0*** (4.41)	115.0*** (4.25)	119.4*** (4.40)	125.0*** (4.42)	113.9*** (4.22)	118.0*** (4.37)	125.9*** (4.44)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.951	0.951	0.949	0.951	0.951	0.949	0.951	0.951	0.949
Fixed Effects	Month, Property Type, Town×Year×IFloor, Town×Year×ISize, Town×Year×LMRT								

Table 7: COV and Ethnic Concentration: by Buyer Ethnicity and by Within-Ethnicity Transactions

We report the panel regression results on the effect of buyer ethnicity and within-ethnicity transactions on COV (psm), by ethnic concentration. The dependent variable is COV (psm). In Panel A, the main independent variables are the interactions of buyer ethnicity with the five discrete ethnic concentration indicators (“Quota Block”, “Quota Neighborhood”, “4/4”, “3/4” and “2/4”), where the “1/4” block quantile is used as the reference group in the models. We report the results with the Chinese concentration dummies in column (1)-(3); and we report on Chinese buyers in column (1), on Malay buyers in column (2), and on Indian buyers in column (3). Other controls include the five dummies on the groups of ethnic concentration, bankrupt seller dummy, unit size (sqm), floor level, distances to the nearest MRT station, quality of surrounding primary School (within 1 km, and 1-2 km boundary), the two age dummies that indicate blocks between 20 and 40 years, and blocks above 40 years. In addition, we also include a list of fixed effect controls on time (month), property type, Town \times Year \times LFloor, Town \times Year \times LSize, and Town \times Year \times LMRT, where LFloor, LSize, and LMRT are the decile dummies for floor level, unit size, and distance to MRT, respectively. For brevity, we do not report the estimates for other controls in the Table. We report results with the Malay concentration in column (4)-(6), and with the Indian concentration in column (7)-(9). In Panel B, the main independent variables are the triple interactions of the five discrete ethnic concentration dummies, the buyer ethnicity dummy, and the within-ethnicity transaction dummy (Within). Regression specifications are same as in Panel A. The table reports point estimates with t-statistics in parentheses. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Panel A: By Buyer Ethnicity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Chinese Concentration			Malay Concentration			Indian Concentration		
Buyer Ethnicity:	Chinese	Malay	Indian	Chinese	Malay	Indian	Chinese	Malay	Indian
Buyer Ethnicity \times Quota Block	95.23*** (3.61)	-88.48*** (-2.94)	-63.85 (-1.34)	-128.6*** (-4.01)	147.4*** (3.69)	72.61 (1.43)	3.17 (0.02)	275.1* (1.72)	-281.2** (-2.38)
Buyer Ethnicity \times Quota Neighborhood	115.3*** (3.95)	-128.2*** (-4.01)	-44.24 (-0.88)	-95.99*** (-2.72)	116.1*** (2.69)	50.47 (0.88)	-	-	-
Buyer Ethnicity \times 4/4 Blocks	66.45*** (2.67)	-63.71** (-2.38)	-50.76 (-0.96)	-86.98*** (-2.63)	88.37** (2.15)	114.4** (2.13)	21.94 (0.99)	-36.39 (-1.55)	34.81 (0.53)
Buyer Ethnicity \times 3/4 Blocks	33.05 (1.48)	-45.36* (-1.94)	25.10 (0.63)	-51.40 (-1.48)	68.37 (1.60)	49.24 (0.90)	2.31 (0.10)	-9.86 (-0.43)	35.58 (0.53)
Buyer Ethnicity \times 2/4 Blocks	15.93 (0.67)	-23.15 (-0.93)	7.61 (0.16)	-46.19 (-1.29)	74.47* (1.73)	21.97 (0.36)	13.92 (0.61)	-14.23 (-0.59)	15.63 (0.24)
Buyer Ethnicity	-8.91 (-0.63)	9.66 (0.68)	-6.83 (-0.25)	114.8*** (3.97)	-133.4*** (-3.59)	-77.93* (-1.84)	21.65 (1.29)	-15.54 (-0.88)	-44.82 (-0.75)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.686	0.685	0.680	0.686	0.684	0.679	0.681	0.681	0.679
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 7 Continues

Panel B: By Buyer Ethnicity×Within	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Chinese Concentration			Malay Concentration			Indian Concentration		
	Chinese	Malay	Indian	Chinese	Malay	Indian	Chinese	Malay	Indian
Buyer Ethnicity×Quota Block	35.39 (0.55)	-6.41 (-0.04)	204.2 (1.61)	-27.46 (-0.36)	38.91 (0.33)	-51.24 (-0.49)	-	-	-528.6*** (-2.85)
Buyer Ethnicity×Quota Neighborhood	45.75 (0.83)	-123.3 (-1.01)	113.2 (0.98)	-53.11 (-0.62)	108.0 (0.95)	-92.08 (-0.97)	-	-	-
Buyer Ethnicity×4/4 Blocks	52.77 (1.07)	-34.03 (-0.48)	112.5 (0.96)	19.99 (0.24)	57.19 (0.50)	63.73 (0.65)	85.11* (1.69)	-140.3** (-2.18)	-241.7 (-1.53)
Buyer Ethnicity×3/4 Blocks	-9.11 (-0.19)	32.66 (0.48)	123.1 (0.93)	-3.76 (-0.05)	-40.73 (-0.37)	-45.05 (-0.47)	41.86 (0.77)	-104.7 (-1.47)	-183.8 (-1.20)
Buyer Ethnicity×2/4 Blocks	15.77 (0.30)	48.32 (0.67)	29.06 (0.26)	33.60 (0.40)	51.76 (0.35)	272.0*** (2.81)	42.89 (0.89)	-90.37 (-1.19)	-179.8 (-1.17)
Buyer Ethnicity	-18.84 (-0.65)	-15.50 (-0.30)	-101.9 (-1.02)	2.73 (0.04)	-55.38 (-0.54)	-5.43 (-0.08)	-47.82 (-1.24)	71.81 (1.49)	190.7 (1.31)
Buyer Ethnicity×Within×Quota Block	95.44*** (3.55)	-96.58*** (-3.14)	-109.8** (-2.14)	-129.6*** (-3.96)	171.9*** (3.90)	95.88* (1.66)	1.33 (0.01)	279.3* (1.74)	-227.9 (-1.49)
Buyer Ethnicity×Within×Quota Neighborhood	124.8*** (4.15)	-127.2*** (-4.08)	-56.44 (-1.02)	-95.30*** (-2.68)	133.2*** (2.82)	77.65 (1.16)	-	-	-
Buyer Ethnicity×Within×4/4 Blocks	67.24*** (2.63)	-67.24** (-2.42)	-78.14 (-1.23)	-88.42*** (-2.63)	107.5** (2.38)	122.8** (1.99)	17.45 (0.77)	-29.99 (-1.23)	73.38 (1.05)
Buyer Ethnicity×Within×3/4 Blocks	36.44 (1.60)	-51.96** (-2.15)	16.09 (0.38)	-50.01 (-1.43)	93.58** (1.98)	85.18 (1.39)	-0.09 (-0.004)	-4.80 (-0.21)	64.56 (0.90)
Buyer Ethnicity×Within×2/4 Blocks	17.31 (0.71)	-28.09 (-1.09)	27.94 (0.51)	-44.48 (-1.23)	89.89* (1.90)	4.36 (0.07)	13.63 (0.59)	-10.10 (-0.41)	35.65 (0.51)
Buyer Ethnicity×Within	-7.71 (-0.53)	11.94 (0.84)	1.66 (0.06)	117.8*** (4.03)	-155.6*** (-3.74)	-92.14* (-1.86)	27.18 (1.61)	-19.78 (-1.09)	-76.86 (-1.20)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.688	0.685	0.681	0.687	0.685	0.681	0.682	0.682	0.680
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: COV and Ethnic Concentration: by Seller Ethnicity and by Within-Ethnicity Transactions

We report the panel regression results on the effect of seller ethnicity and within-ethnicity transactions on COV (psm), by ethnic concentration. The dependent variable is COV (psm). In Panel A, the main independent variables are the interactions of seller ethnicity with the five discrete ethnic concentration indicators (“Quota Block”, “Quota Neighborhood”, “4/4”, “3/4” and “2/4”), where the “1/4” block quantile blocks is used as the reference group in the models. We report the results with the Chinese concentration in column (1)-(3); and we report on Chinese seller in column (1), on Malay seller in column (2), and on Indian seller in column (3). Other controls include the five dummies on the groups of ethnic concentration, bankrupt seller dummy, unit size (sqm), floor level, distances to the nearest MRT station, quality of surrounding primary School (within 1 km, and 1-2 km boundary), the two age dummies that indicate blocks between 20 and 40 years, and blocks above 40 years. In addition, we also include a list of fixed effect controls on time (month), property type, Town \times Year \times LFloor, Town \times Year \times LSize, and Town \times Year \times LMRT, where LFloor, LSize, and LMRT are the decile dummies for floor level, unit size, and distance to MRT, respectively. For brevity, we do not report the estimates for other controls in the Table. We report results with the Malay concentration in column (4)-(6), and with the Indian concentration in column (7)-(9). In Panel B, the main independent variables are the triple interactions of the five discrete ethnic concentration dummies, the seller ethnicity dummy, and the within-ethnicity transaction dummy (Within). Regression specifications are same as in Panel A. The table reports point estimates with t-statistics in parentheses. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Panel A: By Seller Ethnicity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Chinese Concentration			Malay Concentration			Indian Concentration		
Seller Ethnicity:	Chinese	Malay	Indian	Chinese	Malay	Indian	Chinese	Malay	Indian
Seller Ethnicity \times Quota Block	104.5*** (4.08)	-86.70*** (-2.84)	-128.1*** (-3.11)	-134.2*** (-4.45)	167.1*** (3.83)	106.4** (2.31)	-207.0 (-1.39)	295.9* (1.84)	-139.1 (-0.89)
Seller Ethnicity \times Quota Neighborhood	114.8*** (4.11)	-114.8*** (-3.78)	-57.24 (-1.30)	-87.09*** (-2.68)	119.7** (2.57)	83.36 (1.53)	-	-	-
Seller Ethnicity \times 4/4 Blocks	62.23** (2.52)	-51.89** (-1.96)	-88.01* (-1.65)	-86.71*** (-2.76)	108.0** (2.41)	124.2** (2.40)	-8.54 (-0.38)	-10.86 (-0.45)	92.05* (1.71)
Seller Ethnicity \times 3/4 Blocks	48.95** (2.24)	-49.50** (-2.15)	-11.19 (-0.28)	-64.08* (-1.96)	101.4** (2.20)	58.72 (1.14)	-8.83 (-0.40)	0.16 (0.01)	62.07 (1.11)
Seller Ethnicity \times 2/4 Blocks	21.44 (0.91)	-24.28 (-0.98)	3.17 (0.07)	-48.60 (-1.41)	97.19** (2.11)	27.26 (0.51)	1.60 (0.07)	-2.54 (-0.11)	62.78 (1.14)
Seller Ethnicity	-10.51 (-0.74)	2.04 (0.15)	15.60 (0.67)	120.6*** (4.53)	-159.1*** (-3.84)	-96.01** (-2.43)	39.42** (2.37)	-33.31* (-1.88)	-88.34* (-1.82)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.687	0.685	0.681	0.686	0.685	0.680	0.682	0.682	0.679
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8 Continues

Panel B: By Seller Ethnicity×Within Seller Ethnicity:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Chinese Concentration			Malay Concentration			Indian Concentration		
	Chinese	Malay	Indian	Chinese	Malay	Indian	Chinese	Malay	Indian
Seller Ethnicity×Quota Block	174.4 (1.20)	-6.44 (-0.05)	-160.2*** (-2.68)	-121.6 (-0.99)	134.8 (0.86)	124.1** (2.05)	-451.0*** (-3.08)	-	-
Seller Ethnicity×Quota Neighborhood	44.85 (0.43)	-42.75 (-0.58)	-61.94 (-1.02)	28.95 (0.24)	51.69 (0.32)	94.95 (1.28)	-	-	-
Seller Ethnicity×4/4 Blocks	45.42 (0.64)	45.46 (0.79)	-90.54 (-1.53)	24.44 (0.21)	129.5 (0.81)	121.1 (1.44)	-144.1** (-2.22)	78.08 (1.29)	111.1* (1.75)
Seller Ethnicity×3/4 Blocks	135.2* (1.91)	0.18 (0.003)	-113.3 (-1.19)	-119.6 (-1.00)	130.6 (0.81)	-10.41 (-0.14)	-59.15 (-0.77)	27.11 (0.43)	29.08 (0.41)
Seller Ethnicity×2/4 Blocks	72.77 (0.96)	21.29 (0.35)	-55.19 (-0.84)	-5.57 (-0.04)	153.0 (0.93)	94.31 (1.28)	-77.89 (-1.17)	44.03 (0.77)	133.5*** (2.02)
Seller Ethnicity	-56.30 (-0.99)	-59.33* (-1.67)	46.93 (1.31)	66.54 (0.60)	-172.5 (-1.12)	-99.59* (-1.91)	97.69* (1.94)	-93.11** (-2.07)	-97.30* (-1.88)
Seller Ethnicity×Within×Quota Block	103.0*** (4.01)	-95.29*** (-3.09)	-113.0** (-2.21)	-134.8*** (-4.38)	171.8*** (3.90)	98.44* (1.70)	-121.2 (-0.90)	291.1* (1.79)	-136.6 (-0.84)
Seller Ethnicity×Within×Quota Neighborhood	119.8*** (4.20)	-124.3*** (-3.95)	-58.12 (-1.05)	-91.27*** (-2.74)	129.5*** (2.74)	78.34 (1.17)	-	-	-
Seller Ethnicity×Within×4/4 Blocks	63.60** (2.54)	-62.44** (-2.25)	-79.18 (-1.24)	-90.95*** (-2.84)	105.2** (2.32)	123.4** (1.99)	-2.98 (-0.13)	-20.99 (-0.85)	83.06 (1.19)
Seller Ethnicity×Within×3/4 Blocks	45.49** (2.07)	-54.35** (-2.24)	15.56 (0.37)	-60.90* (-1.83)	97.61** (2.06)	85.13 (1.39)	-8.42 (-0.37)	-0.40 (-0.02)	70.83 (0.99)
Seller Ethnicity×Within×2/4 Blocks	19.31 (0.81)	-28.85 (-1.12)	29.55 (0.53)	-49.83 (-1.45)	88.48* (1.85)	3.94 (0.06)	4.16 (0.19)	-7.62 (-0.30)	44.45 (0.63)
Seller Ethnicity×Within	-8.77 (-0.61)	8.77 (0.61)	2.12 (0.08)	122.8*** (4.50)	-157.8*** (-3.79)	-92.88* (-1.88)	38.33** (2.28)	-27.00 (-1.49)	-84.18 (-1.31)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.689	0.686	0.682	0.688	0.687	0.680	0.684	0.683	0.679
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: Unit Characteristics: Cross-Ethnicity vs Within-Ethnicity

We report the average characteristics of housing units in the cross-ethnicity transactions and the within-ethnicity transactions. Panel A compares the average characteristics of the transactions between Chinese buyers and non-Chinese sellers (Column 1); between non-Chinese buyers and Chinese sellers (Column 2), and between Chinese buyers and Chinese sellers (Column 3). We report Size (sqm), Unit Floor, Distressed Seller, Primary School Quality within 1 km, Primary School Quality within 1-2 km, Distance to Nearest MRT, Age of the Block, MUP Announced, a dummy indicating the announcement that a block is included in MUP, and MUP Completed, a dummy indicating the completion of an MUP project in a block. We report the t-statistics for the difference between Column (3) and Column (1) in column (4), for the difference between Column (3) and Column (2) in column (5), and for the difference between Column (1) and Column (2) in column (6). Panel B reports the results for Malay buyer or Malay seller. Panel C reports the results for Indian buyer or Indian seller. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Panel A: Chinese		(1)	(2)	(3)	(4)	(5)	(6)
	Buyer Seller	Chinese Others	Others Chinese	Chinese Chinese	t-statistics		
					(3)-(1)	(3)-(2)	(1)-(2)
Size (sqm)		100.09	93.15	97.87	-0.94	1.48	1.94*
Unit Floor		4.90	6.57	7.82	7.05***	2.20**	-2.77***
Distressed Seller		0.03	0.01	0.01	-1.70*	-0.13	0.69
Primary School Quality within 1 km		-0.16	-0.11	-0.15	0.26	-0.53	-0.57
Primary School Quality within 1-2 km		-0.17	-0.16	-0.15	0.63	0.34	-0.11
Distance to Nearest MRT		0.93	0.90	0.88	-0.99	-0.27	0.35
Age of the Block		22.81	23.30	22.63	-0.20	-0.53	-0.37
MUP Announced		0.10	0.16	0.13	1.06	-0.68	-1.24
MUP Completed		0.05	0.09	0.09	1.66*	0.02	-1.16
Panel B: Malay		(1)	(2)	(3)	(4)	(5)	(6)
	Buyer Seller	Malay Others	Others Malay	Malay Malay	t-statistics		
					(3)-(1)	(3)-(2)	(1)-(2)
Size (sqm)		92.32	97.98	99.86	2.05**	0.65	-1.33
Unit Floor		5.80	4.77	5.06	-1.45	0.75	1.65*
Distressed Seller		0.00	0.04	0.02	1.06	-1.41	-1.57
Primary School Quality within 1 km		-0.12	-0.15	-0.16	-0.64	-0.19	0.37
Primary School Quality within 1-2 km		-0.19	-0.18	-0.13	1.00	1.17	-0.04
Distance to Nearest MRT		0.88	0.91	0.98	1.23	1.19	-0.24
Age of the Block		23.09	23.49	22.00	-0.81	-1.50	-0.27
MUP Announced		0.13	0.10	0.14	0.28	1.14	0.56
MUP Completed		0.07	0.04	0.08	0.11	1.15	0.76
Panel C: Indian		(1)	(2)	(3)	(4)	(5)	(6)
	Buyer Seller	Indian Others	Others Indian	Indian Indian	t-statistics		
					(3)-(1)	(3)-(2)	(1)-(2)
Size (sqm)		93.33	96.15	95.88	0.51	-0.06	-0.54
Unit Floor		5.27	5.28	5.48	0.27	0.29	-0.01
Distressed Seller		0.03	0.02	0.04	0.07	0.49	0.32
Primary School Quality within 1 km		-0.14	-0.20	-0.10	0.26	1.00	0.64
Primary School Quality within 1-2 km		-0.15	-0.12	-0.13	0.20	-0.18	-0.27
Distance to Nearest MRT		0.83	0.96	0.97	1.09	0.11	-0.90
Age of the Block		23.44	22.03	22.85	-0.32	0.53	0.69
MUP Announced		0.17	0.09	0.12	-0.77	0.57	1.08
MUP Completed		0.07	0.04	0.08	0.23	0.85	0.46

Table 10: Determinants of Within-Ethnicity Transactions

We report logit regression results on the determinants of the within-ethnicity transactions. The dependent variable is a dummy variable that equals 1 for a within-ethnicity transaction, and 0 otherwise. Columns (1)-(3) report the results using the samples of Chinese buyers, Malay buyers, and Indian buyers, respectively. Independent variables include the five discrete dummies on the ethnic concentration, bankrupt seller dummy, size, floor level, distance to the nearest MRT station, quality of surrounding primary schools (within 1km and 1-2km boundary), the MUP announcement and completion dummies, the building age dummies (20-40 years and above 40 years). We include year fixed effects, month fixed effects, and property type fixed effects. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Variables	(1) Chinese Buyer	(2) Malay Buyer	(3) Indian Buyer
	I.Within Ethnicity Transaction		
Quota Block	1.42*** (4.09)	1.19** (2.57)	0.34 (0.24)
Quota Neighborhood	0.20 (0.66)	1.05* (1.79)	-
4/4 Blocks	0.60* (1.93)	0.81* (1.80)	1.10 (1.37)
3/4 Blocks	0.25 (0.92)	0.51 (1.14)	1.83** (2.13)
2/4 Blocks	0.25 (0.91)	1.13* (1.94)	0.81 (0.97)
Distressed Seller	-1.13** (-2.09)		-0.67 (-0.41)
Size (sqm)	-0.01 (-1.01)	0.03** (2.00)	0.06* (1.82)
Unit Floor	0.18*** (5.30)	-0.05 (-1.44)	-0.002 (-0.05)
Distance to Nearest MRT	-0.16 (-0.90)	0.42 (1.48)	0.50 (0.92)
Primary School Quality within 1 km	0.19 (1.04)	-0.34 (-1.43)	-0.15 (-0.42)
Primary School Quality within 1-2 km	0.03 (0.12)	0.18 (0.59)	-0.01 (-0.01)
Age of the Block (20-40 years)	-0.35 (-1.49)	-0.10 (-0.27)	-1.00 (-1.58)
Age of the Block (above 40 years)	0.01 (0.03)	0.19 (0.40)	-0.12 (-0.14)
MUP Announced	-0.14 (-0.37)	0.68 (1.00)	-0.86 (-0.96)
MUP Completed	0.53 (1.10)	-0.31 (-0.39)	1.83 (1.54)
Observations	2,603	802	188

Table 11: DEVIATION and the Characteristics of Real Estate Agents

We report the univariate regression results of DEVIATION on the characteristics of real estate agents. We define the customer ethnic composition in the agent listings as a three-dimensional Cartesian coordinate, i.e., $(x, y, z) = (\text{Fraction of Chinese Customers}, \text{Fraction of Malay Customers}, \text{Fraction of Indian Customers})$, where $x + y + z \leq 1$. By setting the ethnic composition of the country's residents as a reference point, (74.4%, 13.5%, 9.1%), we measure the distance between the agents' customer ethnic composition and the reference point using the distance metric: $\text{DEVIATION} = \{(\text{frac_Chinese Customers} - 0.744)^2 + (\text{frac_Malay Customers} - 0.135)^2 + (\text{frac_Indian Customers} - 0.091)^2\}^{1/2}$. The characteristics of real estate agents include Size of Agency, Number of Searches per Customer, HDB Fraction in Search Volume, and Customer Age. Size of Agency is the number of agents employed by an agency. Number of Searches per Customer counts the number home report searches by the agent during 2009-2012 per customer. HDB Fraction in Search Volume is the fraction of home report searches on public housing units (HDB) relative to the total searches (including both public and private homes). Customer Age is the median age of customers in an agent's listings. For the robustness of results under small sample size, we winsorize variables at 10% level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Variables	(1) Size of Agency	(2) Number of Searches # per Customer	(3) HDB Fraction in Search Volume	(4) Customer Age
DEVIATION	654.8** (2.54)	-24.95*** (-2.62)	-13.08* (-1.68)	4.17* (1.75)
Constant	1,345*** (14.59)	27.68*** (8.13)	24.25*** (8.71)	45.05*** (53.05)
Observations	298	298	298	298
R-squared	0.021	0.023	0.009	0.010

Figure 1: Composition of Singapore's Resident Populations (1980-2016)

The figure shows the composition of Singapore's resident population from 1980 to 2016. The fractions of Chinese, Malay, and Indian are reported. The data is from the Department of Statistics Singapore. Vertical dotted lines indicate our sample period.

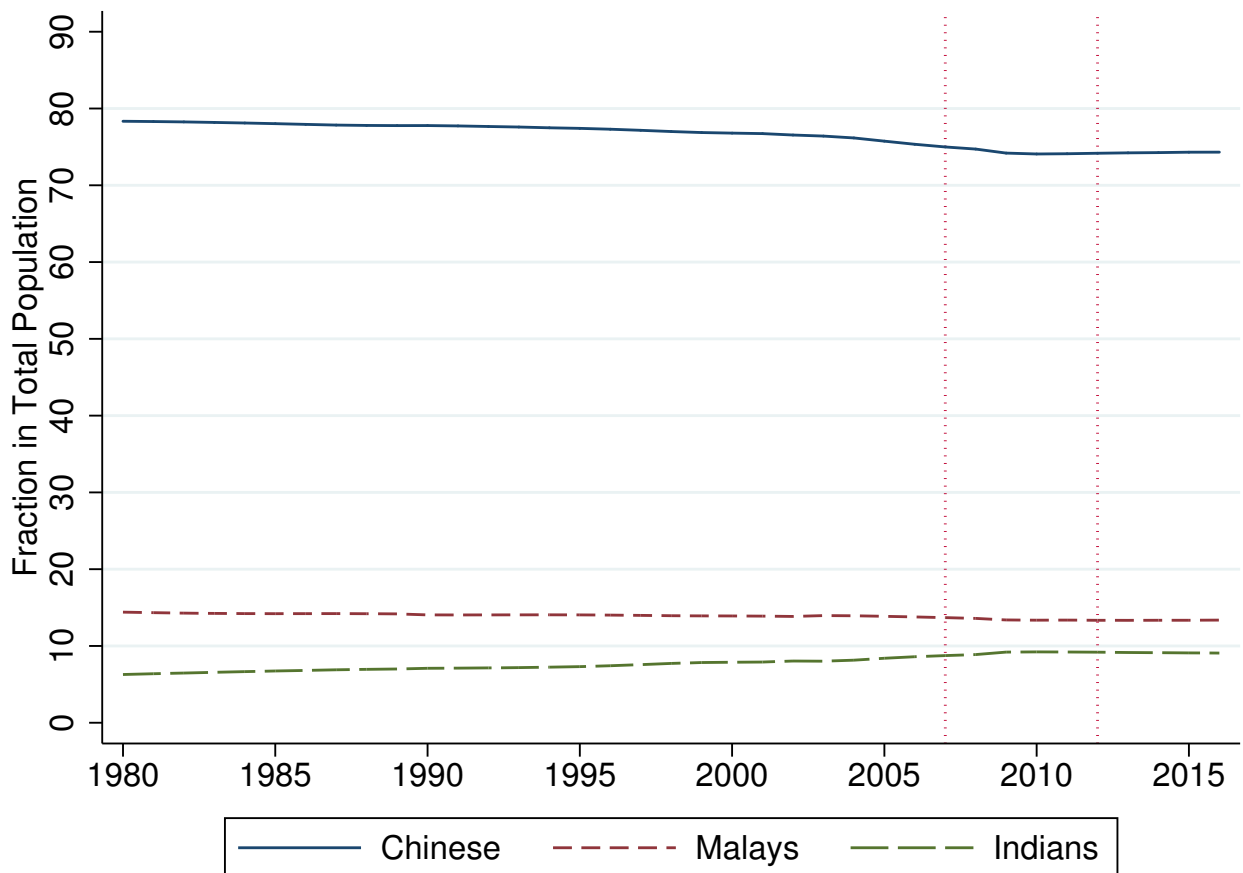


Figure 2: Distributions of the Block-level Concentrations for Ethnic Groups

The figure reports the distributions of the block-level concentrations for the three major ethnic groups. Panel A shows the distribution of the block-level shares of Chinese. Block-level Chinese quota binds if the share of Chinese in a block exceeds 87% as shown in vertical red line. Red bars represent the blocks that are subject to the Chinese block-level binding quota. Panel B shows the distribution of the block-level shares of Malays. Block-level Malay quota binds if the share of Malay in a block exceeds 25% as shown in vertical red line. Red bars represent the blocks that are subject to the Malay block-level binding quota. Panel C shows the distribution of the block-level shares of Indians. Block-level Indian quota binds if the share of Indian in a block exceeds 13% (before March 2010) as shown in vertical red line. Red bars represent the blocks that are subject to the Indian block-level binding quota.

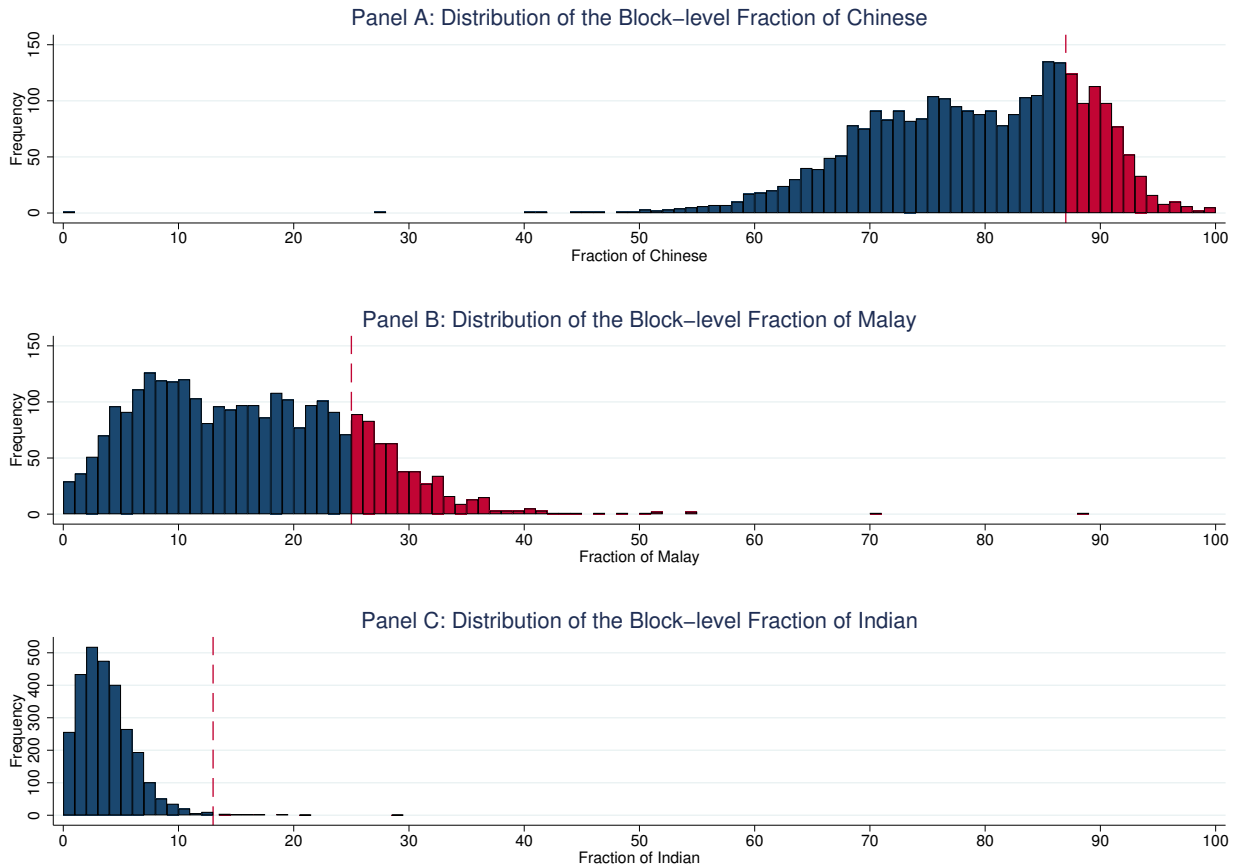


Figure 3: Time Series of Transaction Price, Appraisal Value, and COV

The figure reports the time-series of the average monthly transaction price, appraisal value, and COV from 2007 to 2012. Panel A reports the average monthly transaction price (psm) in the solid blue line and the average monthly appraisal value (psm) in the red dashed line. Panel B reports the average monthly COV (psm) by taking the difference between the average monthly transaction price (psm) and the average monthly appraisal value (psm), and we depict it with the blue solid line. The red dashed line represents the ratio of COV to total transaction price.

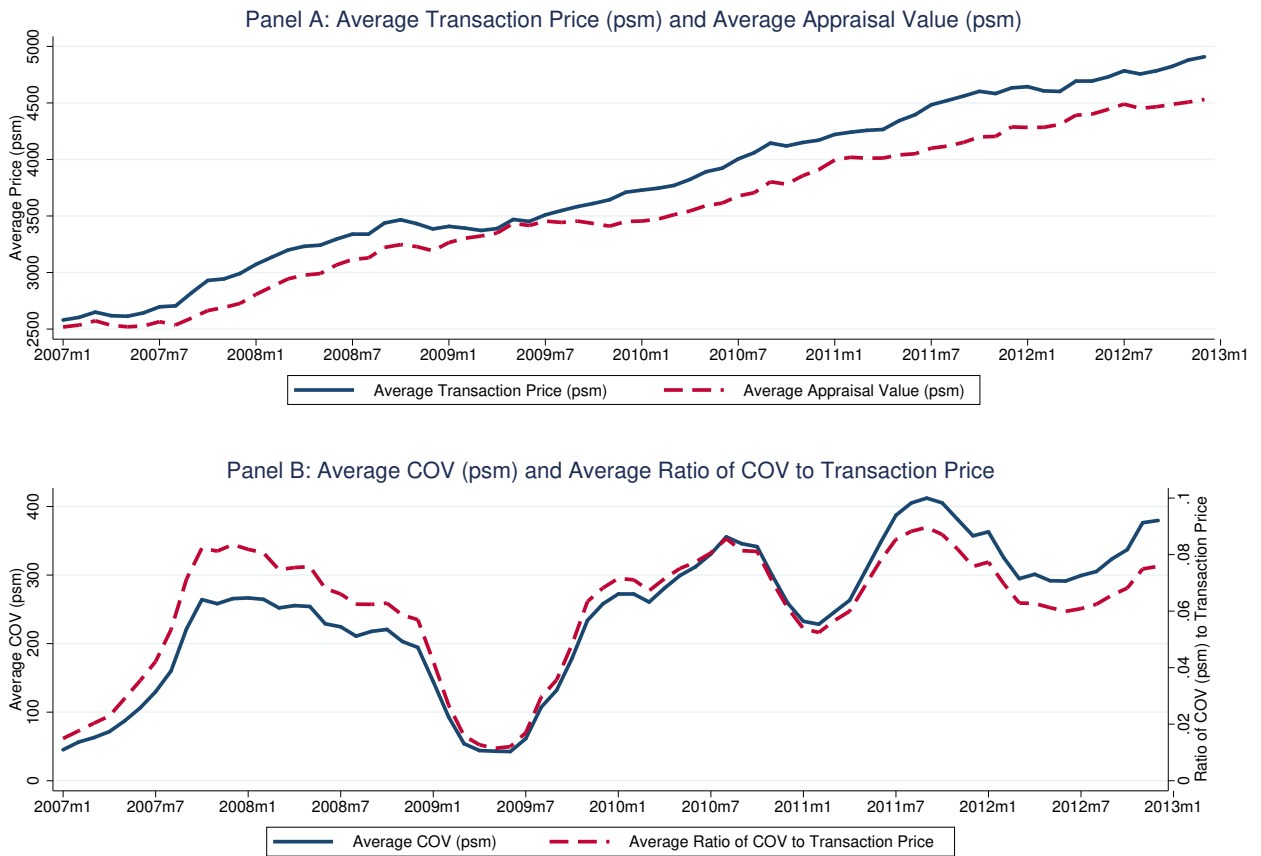


Figure 4: Distribution of COV (psm) in Full Sample

The figure reports the distribution of COV (psm) in full sample from 2007 to 2012. COV is the cash-over-valuation, which is the difference between the final agreed price (transaction price) and the appraisal value. COV (psm) is the COV per square meter. We report the average COV (psm) in vertical red line.

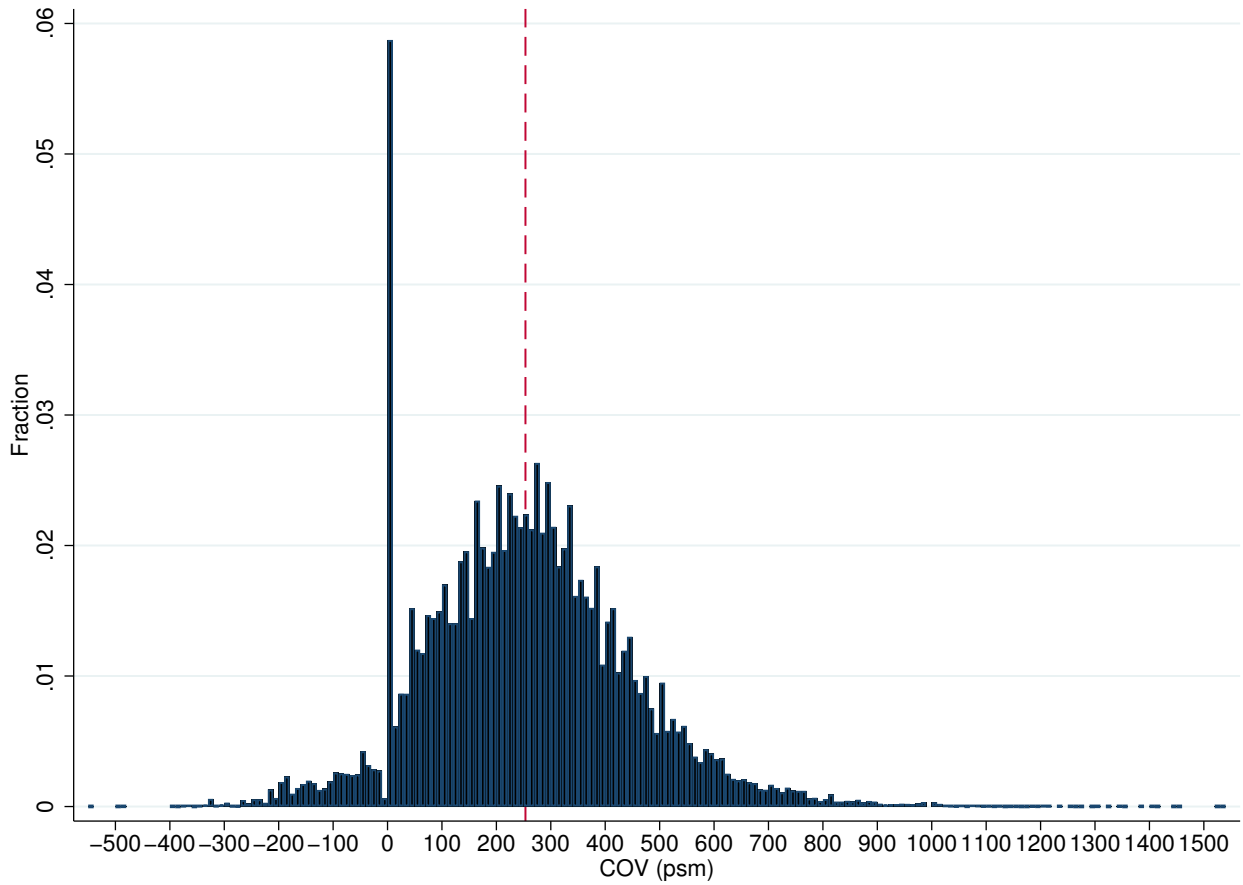


Figure 5: Distributions of COV (psm) in Repeat Sale Sample: Within- vs Cross-Ethnicity Transactions

The figure reports the distributions of COV (psm) in repeat sale sample for within-ethnicity and cross-ethnicity transactions. We construct repeat sale sample using the repeated transactions in a unit and identify the ethnicity of buyer and seller. Panel A reports the histogram of COV (psm) for within-ethnicity transactions. The average COV (psm) of 3,570 within-ethnicity transactions is SGD336.15 as shown in the vertical red line. Panel B reports the histogram of COV (psm) for cross-ethnicity transactions. The average COV (psm) of 289 cross-ethnicity transactions is SGD292.88 as shown in the vertical red line.

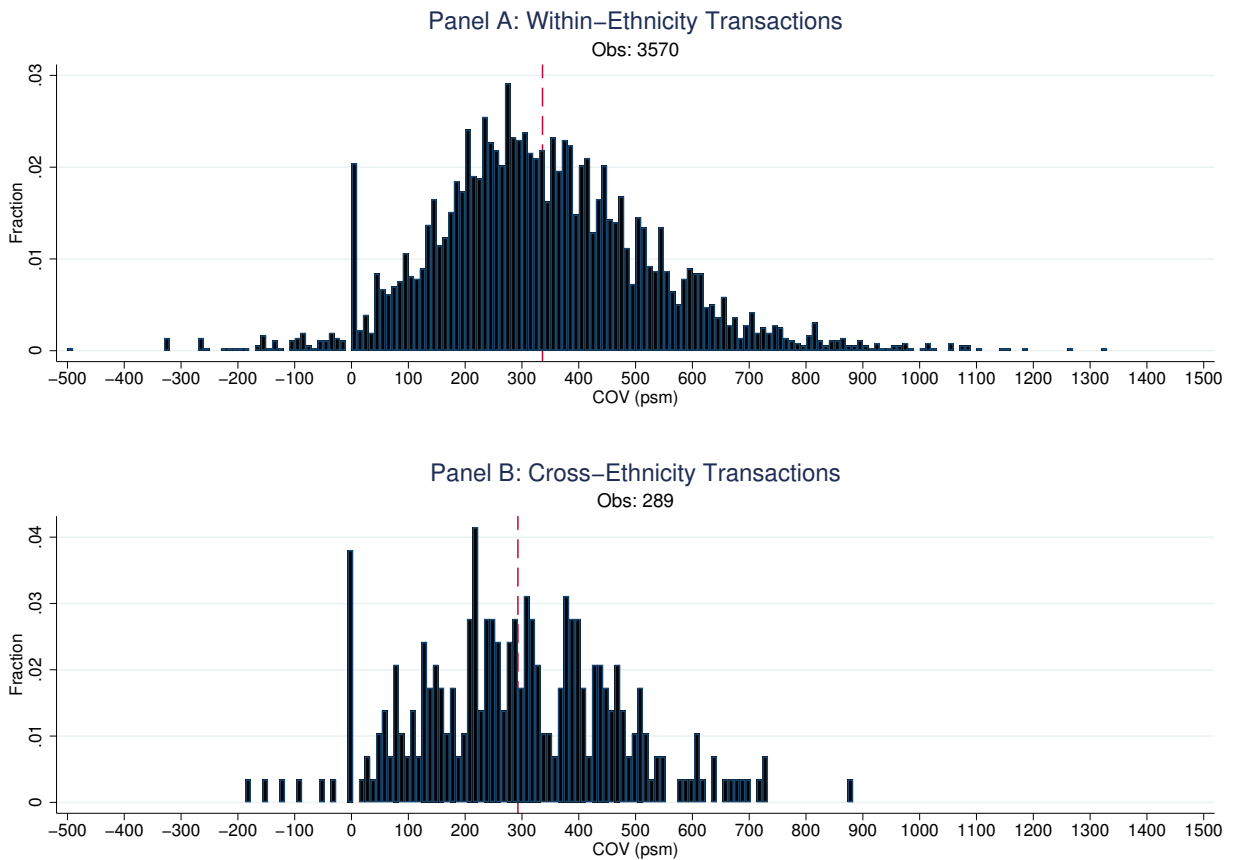


Figure 6: Within- vs Cross- Ethnicity Transactions: by Block Age

The figure shows the distributions of the within-ethnicity transactions (red vertical bars), the total transactions (blue vertical bars), and the fraction of the within-ethnicity transaction to the total transaction in blocks (darkened line) with respect to the age of the blocks.

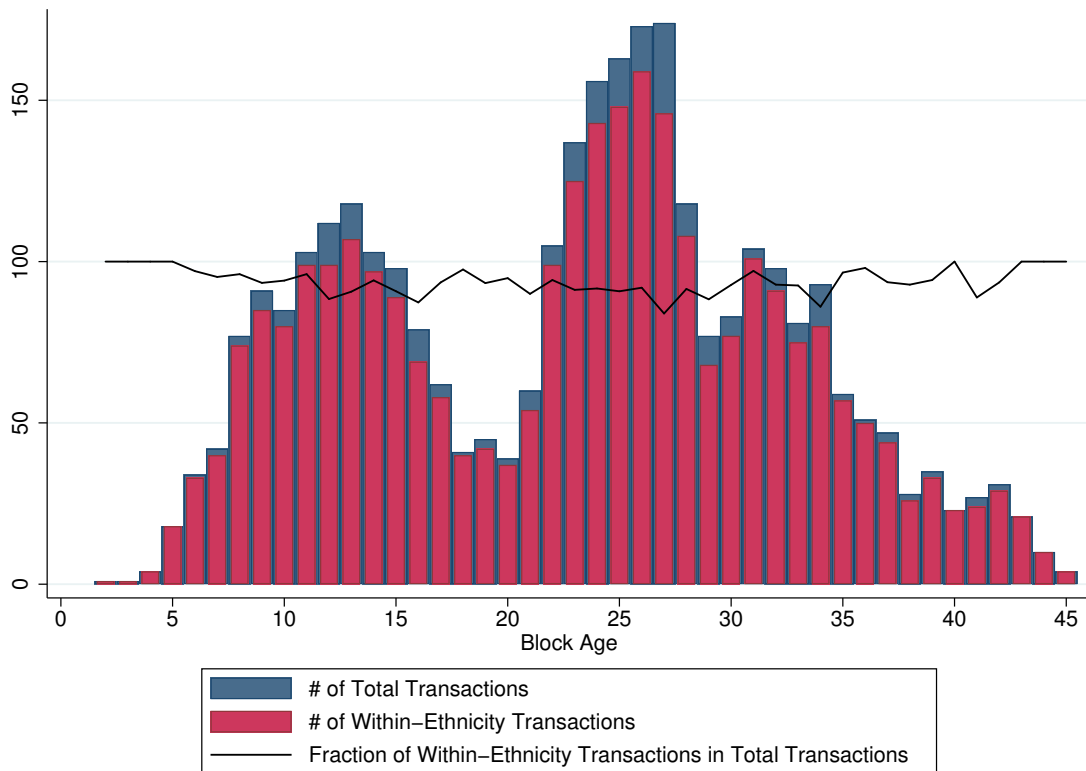


Figure 7: Matching Frequency by the Ethnicity of Buyers and Sellers

The figure reports the distributions of matching frequency by the ethnicity of buyer and seller. Panel A reports the fraction of buyers' ethnicity by sellers' ethnicity for different Chinese concentration blocks ("4/4", "3/4", "2/4" and "1/4" Chinese Blocks). For the blocks without ethnicity quotas, we sort them into 4 quartile groups of blocks by the fraction of Chinese residents in the blocks. Top-left panel reports the fraction of buyers' ethnicity by sellers' ethnicity in the top 4/4 Chinese Blocks. With reference to the sellers of different ethnic groups (horizontal axis), we report the fractions of transactions involving Chinese buyers, Malay buyers, and Indian buyers. Top-right panel reports the fraction of buyers' ethnicity by sellers' ethnicity in 3/4 Chinese Blocks, bottom-left panel reports the fraction of buyers' ethnicity by sellers' ethnicity in 2/4 Chinese Blocks, and bottom-right panel reports the fraction of buyers' ethnicity by sellers' ethnicity in the bottom 1/4 Chinese Blocks. Panel B reports the fraction of buyers' ethnicity by sellers' ethnicity for different Malay concentration blocks ("4/4", "3/4", "2/4" and "1/4" Malay Blocks). Panel C reports the fraction of buyers' ethnicity by sellers' ethnicity for different Indian concentration blocks ("4/4", "3/4", "2/4" and "1/4" Indian Blocks).

Panel A: By Chinese Concentration

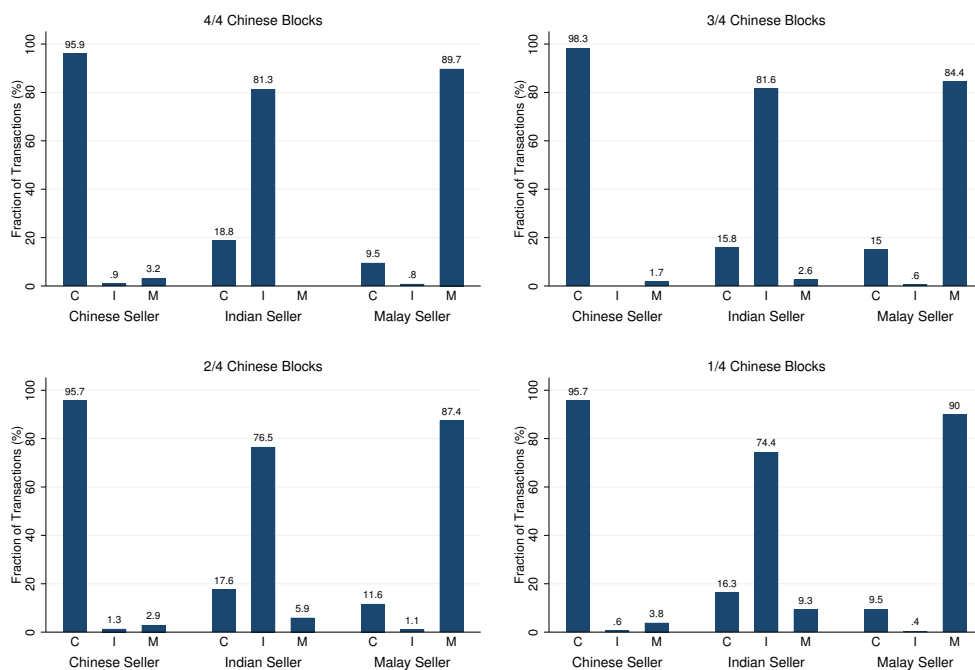
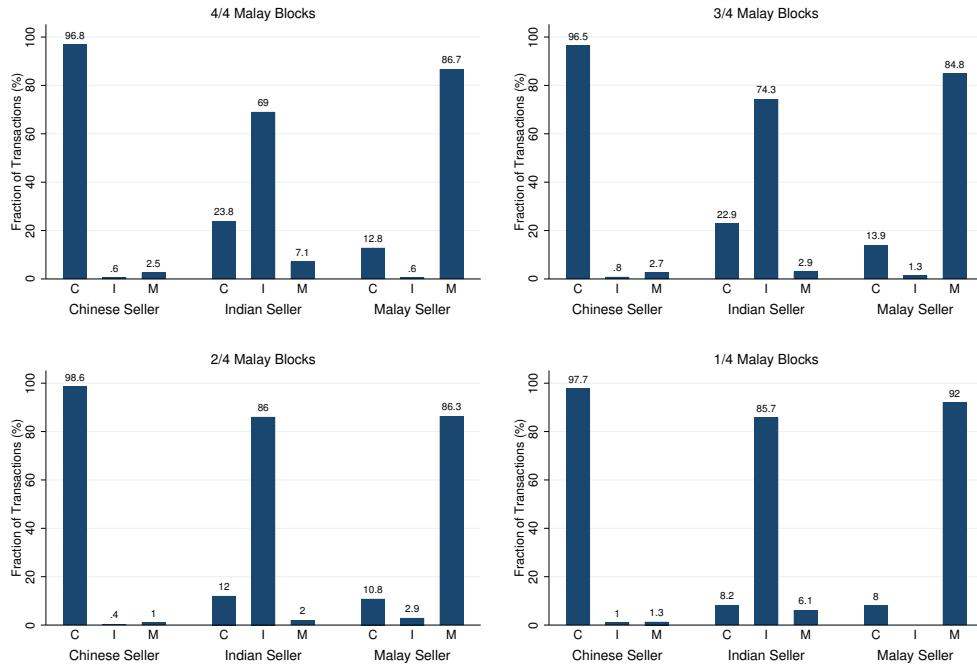


Figure 7 Continues

Panel B: By Malay Concentration



Panel C: By Indian Concentration

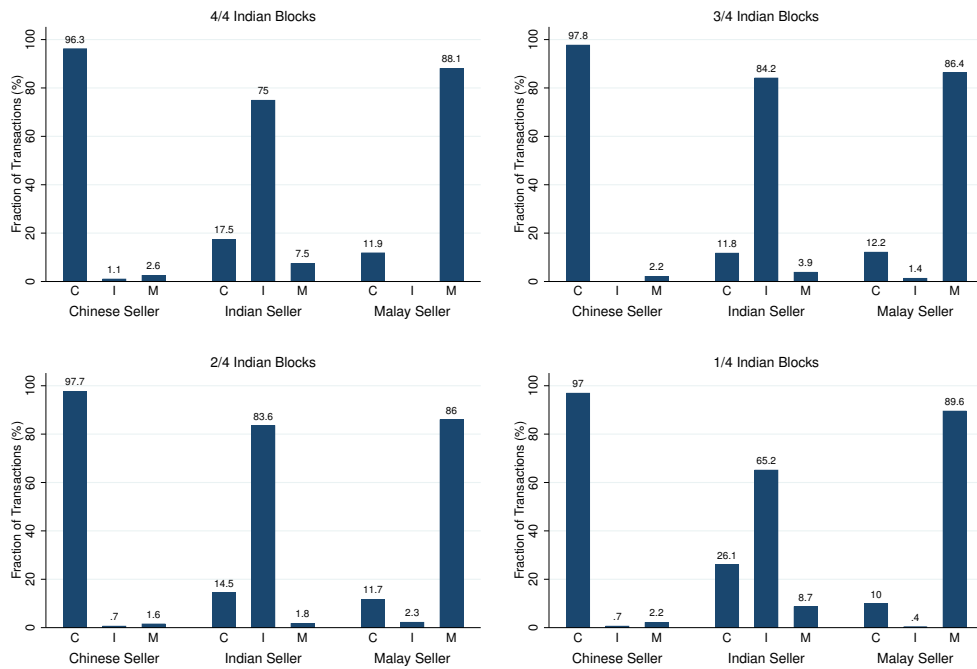


Figure 8: Fraction of Customers by Ethnic Group

The figure reports the distribution of the ethnic fraction of customers of real estate agents. Panel A shows the distributions of all real estate agents. Panel A shows the distributions of the shares of Chinese customers (left panel), Malay customers (middle panel), and Indian customers (right panel) for all the real estate agents. Conditional on agents having least one customer from an ethnic group, Panel B shows the compositions of customers by ethnicity in the agent listings.

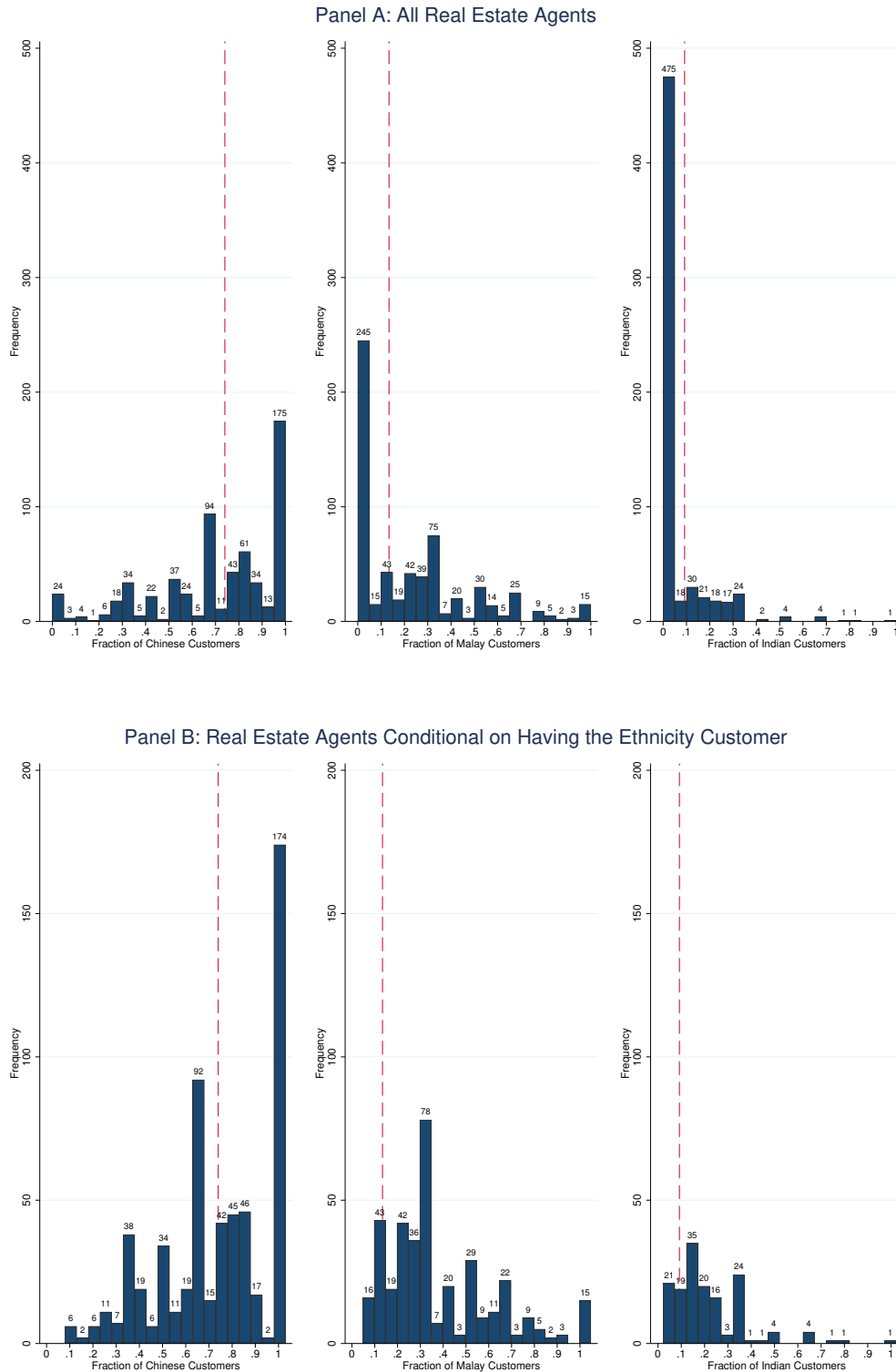
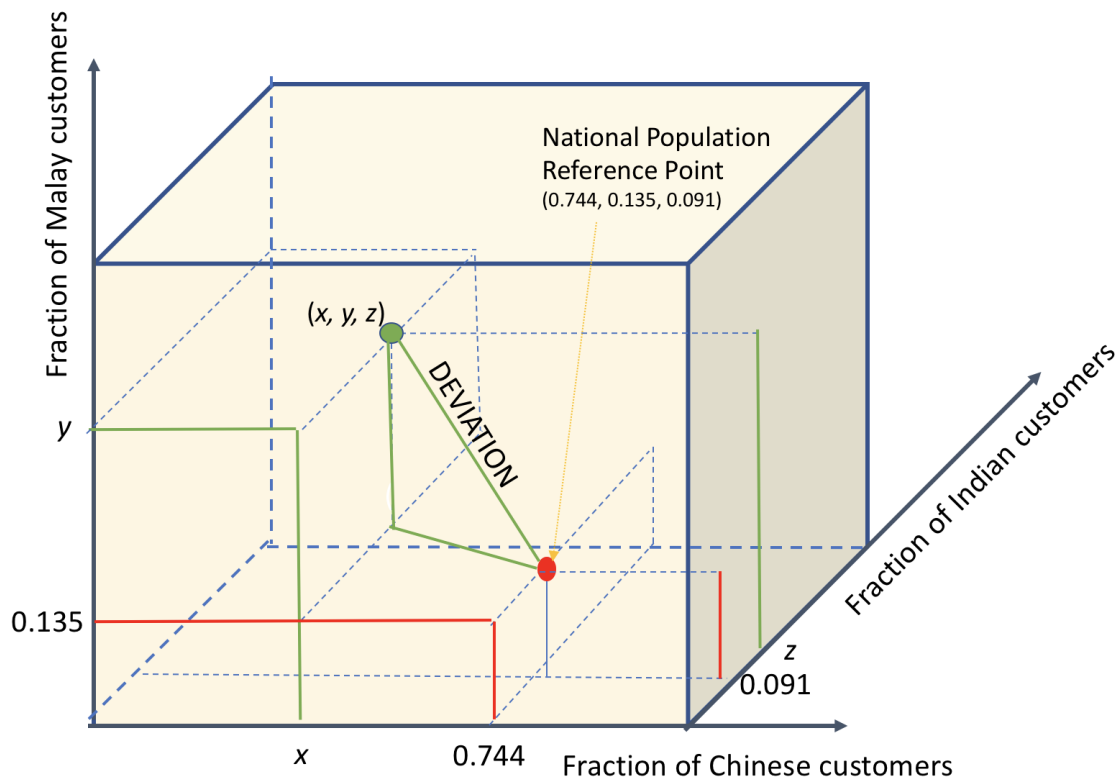


Figure 9: Customer Ethnic Composition in a 3-D Cartesian coordinate

We define the customer ethnic composition in the agent listings as a three-dimensional Cartesian coordinate, i.e., $(x, y, z) = (\text{Fraction of Chinese Customers}, \text{Fraction of Malay Customers}, \text{Fraction of Indian Customers})$, where $x + y + z \leq 1$. By setting the ethnic composition of the country's residents as a reference point, $(74.4\%, 13.5\%, 9.1\%)$, we measure the distance between the agents' customer ethnic composition and the reference point using the distance metric: $\text{DEVIATION} = \{(\text{frac_Chinese Customers} - 0.744)^2 + (\text{frac_Malay Customers} - 0.135)^2 + (\text{frac_Indian Customers} - 0.091)^2\}^{1/2}$.



Appendix Table 1: COV and the Fraction of Ethnic Concentration in Full Sample

We report the panel regressions of buyer's ethnicity and the presence of ethnicity groups in a block on COV (psm) in our full sample. The dependent variable is COV (psm). Panel A reports the results with block fixed effects. Columns (1)-(3) use a dummy variable for Chinese buyer (Buyer Ethnicity). In column (1), we interact Chinese buyer dummy with Chinese share in a block. Independent variables include Size (sqm) and Unit Floor. We also include year fixed effects, month fixed effects, block fixed effects, and property-type fixed effects. In column (2), we interact Chinese buyer dummy with Malay share in a block. In column (3), we interact Chinese buyer dummy with Indian share in a block. Columns (4)-(6) use Malay buyer dummy and Columns (7)-(9) use Indian buyer dummy. Panel B reports the results without block fixed effects. Specifications are similar to Panel A except the block fixed effects and additional independent variables such as Distance to Nearest MRT, Primary School Quality within 1 km, Primary School Quality within 1-2 km. For brevity, we do not report the estimates for other controls in the Table. The table reports point estimates with t-statistics in parentheses. All standard errors are clustered at the block-level. ***, **, * denotes 1%, 5%, and 10% statistical significance.

Panel A: With Block Fixed Effects									
Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: COV (psm)									
Buyer Ethnicity	51.69*** (34.87)	51.45*** (34.58)	47.37*** (33.80)	-55.53*** (-33.51)	-55.99*** (-33.24)	-48.25*** (-32.27)	-25.24*** (-9.54)	-22.68*** (-8.78)	-24.60*** (-8.64)
Buyer Ethnicity × Fraction of Chinese	2.09*** (14.10)			-2.14*** (-13.19)			-2.49*** (-8.99)		
Buyer Ethnicity × Fraction of Malay		-2.05*** (-13.33)			2.20*** (12.83)			2.68*** (9.25)	
Buyer Ethnicity × Fraction of Indian			-1.91*** (-3.64)			1.70*** (2.97)			0.59 (0.60)
Observations	73,107	73,107	73,107	73,107	73,107	73,107	73,107	73,107	73,107
R-squared	0.486	0.486	0.485	0.485	0.485	0.484	0.477	0.477	0.476
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Year, Month, Block, and Property Type								
Panel B: Without Block Fixed Effects									
Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: COV (psm)									
Buyer Ethnicity	54.02*** (36.82)	53.94*** (36.58)	54.90*** (39.66)	-57.79*** (-35.62)	-58.28*** (-35.47)	-57.16*** (-38.97)	-27.56*** (-10.52)	-27.38*** (-10.66)	-28.23*** (-10.11)
Buyer Ethnicity × Fraction of Chinese	2.26*** (16.04)			-2.35*** (-15.42)			-2.40*** (-8.72)		
Buyer Ethnicity × Fraction of Malay		-2.29*** (-15.73)			2.53*** (15.90)			2.30*** (8.03)	
Buyer Ethnicity × Fraction of Indian			-0.76 (-1.39)			-0.71 (-1.24)			2.41** (2.34)
Fraction of Chinese	-0.04 (-0.36)			2.05*** (25.58)			2.12*** (29.69)		
Fraction of Malay		0.03 (0.24)			-2.07*** (-25.28)			-2.17*** (-29.59)	
Fraction of Indian			-0.10 (-0.22)			-1.07*** (-3.52)			-0.78*** (-2.84)
Observations	70,197	70,197	70,197	70,197	70,197	70,197	70,197	70,197	70,197
R-squared	0.355	0.355	0.348	0.353	0.353	0.347	0.343	0.343	0.334
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Year, Month, and Property Type								

Appendix Table 2: Robustness of Table 5

We report additional panel regression results for the robustness of Table 5. Panel A uses randomized buyer ethnicity and Panel B additionally include Appraisal Value (psm) as a control. Other regression specifications are same as in Table 5.

Panel A: Randomized Ethnicity									
Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: COV (psm)									
Buyer Ethnicity	8.49 (1.03)	8.65 (1.05)	8.33 (1.03)	-10.57 (-1.10)	-10.84 (-1.13)	-10.15 (-1.07)	-11.71 (-0.69)	-11.66 (-0.70)	-11.35 (-0.67)
Buyer Ethnicity × Fraction of Chinese	0.13 (0.15)			-0.49 (-0.50)			-0.07 (-0.04)		
Buyer Ethnicity × Fraction of Malay		-0.25 (-0.26)			0.76 (0.69)			-0.01 (-0.01)	
Buyer Ethnicity × Fraction of Indian			0.30 (0.09)			-0.61 (-0.17)			-0.35 (-0.05)
Fraction of Chinese	-0.07 (-0.08)			0.13 (0.21)			0.01 (0.02)		
Fraction of Malay		0.33 (0.33)			-0.003 (-0.004)			0.15 (0.23)	
Fraction of Indian			-1.30 (-0.44)			-0.96 (-0.47)			-1.07 (-0.56)
Bankrupted Seller	-71.88*** (-2.65)	-71.73*** (-2.64)	-72.55*** (-2.68)	-72.17*** (-2.66)	-72.11*** (-2.65)	-72.89*** (-2.69)	-70.56*** (-2.61)	-70.39*** (-2.60)	-71.21*** (-2.64)
Size (sqm)	-1.36 (-1.40)	-1.36 (-1.40)	-1.34 (-1.38)	-1.36 (-1.40)	-1.36 (-1.40)	-1.33 (-1.37)	-1.35 (-1.39)	-1.35 (-1.39)	-1.33 (-1.37)
Unit Floor	4.29 (1.12)	4.35 (1.13)	4.30 (1.12)	4.08 (1.06)	4.14 (1.08)	4.15 (1.08)	4.36 (1.13)	4.41 (1.15)	4.36 (1.14)
Distance to Nearest MRT	-23.33 (-0.94)	-23.56 (-0.95)	-22.84 (-0.92)	-23.31 (-0.94)	-23.60 (-0.95)	-22.91 (-0.92)	-22.97 (-0.92)	-23.33 (-0.94)	-22.38 (-0.90)
Primary School Quality within 1 km	-13.97 (-0.99)	-13.86 (-0.98)	-14.02 (-0.99)	-13.78 (-0.98)	-13.71 (-0.97)	-13.87 (-0.98)	-13.68 (-0.97)	-13.61 (-0.97)	-13.71 (-0.97)
Primary School Quality within 1-2 km	-8.41 (-0.46)	-8.48 (-0.47)	-8.57 (-0.47)	-8.60 (-0.47)	-8.82 (-0.48)	-8.82 (-0.48)	-7.70 (-0.42)	-7.74 (-0.43)	-7.81 (-0.43)
Age of the Block (20 - 40 years)	17.80 (1.21)	17.76 (1.21)	17.80 (1.21)	17.87 (1.22)	17.87 (1.22)	17.57 (1.19)	17.65 (1.21)	17.53 (1.20)	17.80 (1.22)
Age of the Block (above 40 years)	5.12 (0.41)	5.36 (0.43)	4.38 (0.35)	4.86 (0.39)	5.12 (0.41)	4.06 (0.33)	5.00 (0.40)	5.23 (0.42)	4.25 (0.34)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677	0.677
Fixed Effects	Month, Property Type, Town×Year×LFloor, Town×Year×LSize, Town×Year×LMRT								

Appendix Table 2 Continues

Panel B: Controlling for Appraisal Value (psm)									
Variables	Chinese Buyer			Malay Buyer			Indian Buyer		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable: COV (psm)									
Buyer Ethnicity	39.67*** (4.91)	40.27*** (5.02)	31.81*** (3.95)	-41.08*** (-4.48)	-42.69*** (-4.69)	-30.79*** (-3.46)	-25.04* (-1.69)	-21.94 (-1.50)	-21.28 (-1.36)
Buyer Ethnicity × Fraction of Chinese	3.64*** (4.72)			-3.36*** (-4.17)			-2.72* (-1.81)		
Buyer Ethnicity × Fraction of Malay		-4.17*** (-4.89)			3.97*** (4.41)			3.43** (1.99)	
Buyer Ethnicity × Fraction of Indian			0.70 (0.22)			-1.05 (-0.32)			-1.16 (-0.19)
Fraction of Chinese	-2.19*** (-2.83)			1.15 (1.64)			0.31 (0.48)		
Fraction of Malay		2.68*** (3.14)			-1.12 (-1.49)			-0.17 (-0.25)	
Fraction of Indian			-1.10 (-0.41)			-0.91 (-0.41)			-0.81 (-0.44)
Bankrupted Seller	-69.08** (-2.56)	-68.08** (-2.54)	-68.50** (-2.55)	-69.01** (-2.55)	-67.11** (-2.48)	-71.51*** (-2.68)	-71.84*** (-2.69)	-72.32*** (-2.72)	-70.13*** (-2.61)
Size (sqm)	-1.60 (-1.64)	-1.58 (-1.61)	-1.74* (-1.75)	-1.61* (-1.66)	-1.58 (-1.63)	-1.66* (-1.69)	-1.57 (-1.61)	-1.56 (-1.60)	-1.61 (-1.64)
Unit Floor	3.89 (1.00)	3.82 (0.99)	4.62 (1.20)	4.42 (1.14)	4.42 (1.15)	4.85 (1.26)	4.68 (1.22)	4.66 (1.21)	4.81 (1.25)
Distance to Nearest MRT	-24.30 (-0.95)	-23.94 (-0.94)	-27.34 (-1.07)	-28.28 (-1.13)	-28.54 (-1.15)	-29.94 (-1.19)	-28.23 (-1.10)	-28.29 (-1.10)	-28.59 (-1.11)
Primary School Quality within 1 km	-14.77 (-1.06)	-14.65 (-1.06)	-12.58 (-0.90)	-14.50 (-1.03)	-14.32 (-1.02)	-12.77 (-0.91)	-11.89 (-0.85)	-12.00 (-0.86)	-11.96 (-0.85)
Primary School Quality within 1-2 km	-5.54 (-0.31)	-5.64 (-0.32)	-7.37 (-0.41)	-3.63 (-0.20)	-3.27 (-0.18)	-6.98 (-0.38)	-10.24 (-0.56)	-10.44 (-0.57)	-9.67 (-0.53)
Age of the Block (20 - 40 years)	12.81 (0.85)	13.12 (0.88)	13.41 (0.89)	12.96 (0.86)	13.45 (0.89)	14.22 (0.94)	13.69 (0.91)	13.57 (0.90)	13.48 (0.90)
Age of the Block (above 40 years)	8.81 (0.68)	8.80 (0.68)	6.28 (0.48)	6.97 (0.54)	7.48 (0.58)	5.67 (0.44)	7.42 (0.58)	7.38 (0.58)	6.24 (0.48)
Appraisal Value (psm)	-0.02 (-1.12)	-0.02 (-1.10)	-0.02 (-1.25)	-0.02 (-1.13)	-0.02 (-1.11)	-0.02 (-1.23)	-0.02 (-1.11)	-0.02 (-1.05)	-0.02 (-1.15)
Observations	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922	2,922
R-squared	0.685	0.686	0.681	0.683	0.684	0.680	0.679	0.679	0.678
Fixed Effects	Month, Property Type, Town×Year×IFloor, Town×Year×ISize, Town×Year×LMRT								