THE MISALLOCATION OF HOUSING UNDER SUBSIDIZED HOMEOWNERSHIP

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ABSTRACT

Subsidized homeownership is a key area of interest for many policymakers. Most studies tend to focus on its social benefits, with little regard to its social costs. This study aims to examine how the shared equity approach of subsidized homeownership distorts residential mobility through imposing resale restrictions on assisted homeowners. We develop a framework based on Glaeser and Luttmer's (2003) theory to examine the social costs arising from a shared equity approach in Hong Kong. Our empirical analysis reveals that misallocation losses, in the form of spatial mismatch, are created in addition to the welfare losses of supply. Compared to private homeowners, assisted ones are found to have a higher opportunity cost to move as if they were 'locked-in'. Moreover, our findings trigger us to re-think a fundamental policy question. Is subsidized homeownership: 1) an end to the promotion of homeownership per se (i.e., for which low mobility is intended) or 2) a means to enable lower income groups to move into private housing in the future (i.e., for which high mobility is intended)?

Keywords: subsidized homeownership, misallocation losses, lock-in effects, panel estimation, natural experiment

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1. INTRODUCTION

Most welfare analysis on government subsidies follows the standard economic inefficiency argument: when the social surplus falls short of the money used for paying and administering the subsidies, the so-called deadweight loss arises. Such analysis typically assumes that the allocation of subsidies is efficient on day one and remains so over time. This is however unrealistic when it comes to in-kind subsidies – recipients who obtained the subsidies a long time ago may no longer be those who value the subsidies most, while keeping the subsidies is still better than not. Based on the misallocation argument from Glaeser and Luttmer (1997; 2003), this paper suggests that subsidized homeownership, a common form of in-kind subsidies, will create misallocation losses on top of the traditional deadweight losses, and such losses could be accumulated over time. Ignoring such misallocation losses of subsidized homeownership may result in a too optimistic view of homeownership policy.

More importantly, this paper develops a new empirical strategy to assess the extent of misallocation by comparing the residential mobility (i.e., transaction turnover) of demographic subgroups in subsidized housing and free-market housing, based on the theoretical framework of Glaeser and Luttmer (2003).[2] One advantage of using the lack of residential mobility as a measure of misallocation in subsidized homeownership is that it captures not only the inefficiency arising from initial random allocation to eligible recipients (e.g. Gyourko and Linneman, 1989), but also any spatial mismatch that arises subsequently when the recipients get richer (Kain, 1968). The free market minimizes such misallocation through turnover. If the turnover rate of subsidized housing is lower than that of the quality-equivalent free-market housing, we can interpret this as evidence of misallocation. The free market is an ideal benchmark because it controls for many observed or unobserved determinants of turnover, except for subsidies.

With this strategy, we test whether there is a statistically significant misallocation of subsidized housing in Hong Kong as compared to the free market. We primarily focus on the subsidized housing sector, known as the Home Ownership Scheme (HOS), which had a much lower turnover rate than its private housing counterpart even after accounting for the initial resale restriction period. Our estimates show that subsidized homeowners tend to stay longer in their homes when the subsidy level (in the form of initial purchase discounts) is high, after controlling for different mismatch variables that might induce an omitted-variable bias. Our panel data methodology suggests that a 1% increase in the housing subsidy (as initial purchase discount) will reduce the transaction turnover by about 2%. To further test our misallocation hypothesis, we make use of the "privatized" subsidized housing units, a unique subsidized resale housing market in Hong

[2] The empirical methodology used by Glaeser and Luttmer (2003) for estimating the misallocation of housing under rent control in New York City is to compare the fraction of apartments demanded in the rent-controlled and free markets. The identifying assumption needed for their empirical analysis is that the overlap in latent housing demand between two groups is constant over space. Approximately, 20 percent of apartments are being misallocated in the city.

Kong, as counterfactual to see if misallocation still exists. We find some misallocation in these "privatized" subsidized housing, but substantially less than that in the subsidized market.

2. MISALLOCATION UNDER SUBSIDIZED HOMEOWNERSHIP

Glaeser and Luttmer (2003) argued that in case of price control, the welfare loss due to misallocation would exceed the welfare loss due to undersupply, as price can no longer guide the allocation of goods to consumers when demand exceeds supply. We borrow their framework (**Figure 1**) to examine the misallocation losses of in-kind housing subsidies, in the form of subsidized homeownership. Standard welfare analysis tells us that a price control (subsidy) of Δ will reduce the quantity relative to the free-market equilibrium. If subsidies are allocated randomly, the welfare loss will have two components: the area of classic deadweight loss triangle (ABC) plus the area of the misallocation loss trapezium (AEFG). The latter exists because the average person who is allocated a rent-controlled housing unit does not value it as much as those who can freely choose the units they want. Therefore, with randomly (not efficiently) allocated subsidies, the average consumer valuation would be reduced.

[Figure 1 Inserted]

The misallocation loss trapezium (AEFG) is most relevant to subsidized homeownership programs that are designed to randomly allocate the subsidised housing units to qualified households. In particular, such losses could increase over time – as the households living in subsidized housing (sub-optimally at the beginning) improve their socio-economic status, spatial mismatch arises. The losses under subsidized homeownership (in-kind subsidies) are arguably higher than those under price control (cash subsidies) if moving between subsidized units is prohibited.[3] Thus, the "Remaining Consumer Surplus" in **Figure 1** will eventually be dissipated. We refer to such welfare costs as the *misallocation losses due to mismatch*, in addition to the conventional welfare cost due to undersupply and random allocation. This argument sets the stage for our empirical work for testing such misallocation losses due to mismatch over time in the subsidised housing by studying the transaction turnover of subsidised homeownership in Hong Kong.

[3] The newly established resale market that allows subsidized homeowners to reallocate their flats to other higher-valued individuals may attempt to reduce these misallocation losses, but as you will see the "shared-equity" arrangement in many subsidized homeownership, almost all the capital gains are recouped back to the government. This incentivizes the existing subsidized homeowners to stay forever in the same home units and results in people being "lock-in" at the current flats even if their tastes and conditions changed. When the preferences of individuals change over time, the misallocation of housing across subsidized homeowners is expected to be escalate, even though the flat units were initially efficiently allocated.

3. BACKGROUND OF SUBSIDIZED HOMEOWNERSHIP

While affordable homeownership programs exist in many forms in different countries,[4] the term "shared equity homeownership"[5] has been increasingly used to describe such subsidized homeownership programs according to their nature of finance (Temkin, Theodos, and Price, 2013). Shared equity homeownership means the government offers cash or *in-kind* housing subsidies to eligible households to buy their properties at below-market rate. In exchange, the potential capital gain arising from the resale of the unit has to be shared with the government.

Hong Kong adopted the shared equity affordable homeownership policy since the 1970s; known as Home Ownership Scheme (HOS). The HOS program was first launched in 1976 to help low-income people own their homes because Hong Kong's robust and sustained economic growth at the time raised the aspirations of many of its citizens for better living conditions, which meant owning, rather than renting, a flat. Since its establishment, the HOS now boasts over 395,000 units which house about one-third of owner-occupiers in Hong Kong.

Under the HOS, the government sells newly-built flats to eligible public housing tenants and low-income residents at discounted prices, usually at 30-50 *per cent* below market rates for comparable units in the private sector, subject to resale restrictions. After the first three years of ownership, HOS owners could resell their flats to public housing tenants. From the sixth (instead of eleventh) year of residence, they could also choose to remove all the resale restrictions and sell their flats to any buyers by paying the government a premium proportionate to the original purchase price discount. In any circumstance, those owners who have disposed of their HOS flats will no longer be eligible for any other form of public housing. Therefore, replacing the current HOS flat with another HOS flat is not possible.

To show how the HOS resale market works, consider a typical case where the government sold a flat to a successful HOS applicant at a discounted price equal to $(1 - d\%) \times P_1$, where $d\%$ was the discount and P_1 was the prevailing market price. The applicant (*i.e.*, now owner) usually is not allowed to resell his flat within the first few years of occupancy. Upon the expiration of this restriction period, the owner can resell his subsidized flat, 1) to anybody at a market price (P_2) after paying the government a premium equivalent to $d\%$ of P_2; or 2) to public housing tenants at a negotiated price of about $(1 - d\%) \times P_2$.[6] Either way, the

[4] These programs include mortgage interest payments that are tax deductible, special treatment of capital gains from housing, tenant protection laws that negatively impact the value of investment properties, mass privatization, supply-side subsidies for state agencies and developers of housing for sale, mortgage interest subsidies, mandatory housing finance contributions, direct grants for housing purchase, property tax subsidies, planning laws, limitations on the supply of rental housing, *etc*.

[5] We used the term subsidized homeownership and shared-equity homeownership interchangeably in this study.

[6] The only difference is that the buyer in the first case will be exempt from having to pay a premium when he resells the flat, whereas the buyer in the second case will still be subject to the premium payment requirement when he resells.

owner will receive net sale proceeds of approximately $(1 - d\%) \times P_2$. Assuming no further transaction costs, the owner will make a profit if the housing price has gone up (*i.e.*, $P_2 > P_1$), but will incur a loss if the price has gone down (*i.e.*, $P_2 < P_1$). This outcome may also be affected by occasional changes made to the discount factor, resale restriction period, *etc*., as evident in the past. In general, given the prolonged uptrend of property prices in Hong Kong, many HOS flat owners should be able to make considerable profits if they resell their flats. Despite this, the data available so far indicate an extremely inactive HOS resale market. Only about 1% of total HOS stock has been sold to public housing tenants every year, which is way below the 9% recorded for private housing. Why have so many subsidized home units remained "frozen" and unsold to potential buyers on the market? That is what we want to find out by considering the initial purchase discount on HOS flats (*d%*) as primarily an *in-kind* rental subsidy for their owners. We will use panel data to show that the initial purchase discount is the primary factor behind the inverse relationship that exists between housing subsidies and residential mobility.

Recently, there was a sudden change to the HOS resale policy that enables us to conduct a natural experiment further. In 2013, the government implemented a *one-off* "premium waiver policy" in an attempt to encourage HOS owners to sell their flats to eligible buyers without paying a premium to the government.[7] The qualified buyers, having been selected by ballots (a quota of 5 000), could then go and find their favorable HOS flats within 12 months. Whether a sale would occur depends on the negotiation between the eligible buyers and HOS owners. This waiver policy gives us a golden opportunity to examine the effect of initial purchase discounts (the subsidy) directly. Would this waiver policy improve residential mobility, hence reducing the misallocation losses of subsidized homeownership? A natural experiment will be conducted to answer the question.

4. STRATEGIES FOR IDENTIFYING THE PRESENCE OF MISALLOCATION LOSSES

The idea behind our hypothesis of misallocation losses due to mismatch can be better understood using an intuitive case. Suppose a person lives in a subsidized flat far from his workplace. Frustrated by the long commute every day, he considers moving to a more convenient location. If his existing flat were privately-owned, he would be better off selling it and buying another one to save on the commute. However, since he is a subsidized flat owner, selling his flat would mean giving up the *in-kind* rental subsidy from the government. So long as the commuting cost does not exceed the *in-kind* rental subsidy, he will prefer to stay put and not move elsewhere. In this sense, a rental subsidy will constitute a disincentive for subsidized households to relocate, despite a mismatch between where one currently lives and where one wants to move

[7] The official name of the premium waiver policy is called "The interim scheme of extending the HOS secondary market to White Form buyers".

in the absence of a subsidy. Such a mismatch could arise from a commute being too long, a flat being too small, a district having insufficient schools, *etc*.

The illustration above is, in fact, related to the locational choice of households – a core subject in urban economics. A household's decision to relocate hinges on the discounted net return from relocation at a particular time; if the net gain is positive, the household will tend to move, and vice versa (Bartel, 1979). In the absence of government subsidies, the relocation decision (or the stay-or-move decision in the current case) involves a comparison between the imputed rental costs involved in the existing residence (R_u) and an alternative location (R_m). The costs are 'imputed,' to abstract from the tenure choice problem – the household is assumed to be an owner-occupant who leases back his premises.[8] If $R_u \geq R_m$, a mismatch arises, and the household will move; otherwise, the household will stay. In principle, there is no mismatch in the beginning, or else the household would not have lived there in the first place. However, as time goes by, a mismatch is likely to become more apparent due to changes in personal circumstances (e.g., a bigger flat is needed after marriage) or in the neighborhood (e.g., a waste disposal facility is built nearby). All these changes will induce a greater mismatch, thereby giving the household more incentive to move. As such, this leads to the first hypothesis:

Hypothesis 1 *Ceteris paribus, households in subsidized flats that face a greater mismatch are more likely to move (i.e., they are more mobile).*

The standard migration model similar to Bartel (1979) can be easily modified and extended to cover a stay-or-move decision under the influence of government subsidies. Suppose the government offers a household a rental subsidy, *S*, to stay. Whether or not the household will move is dependent on the size of $R_u + S$ relative to R_m. It is only when the rental cost of staying in the existing (alternative) place becomes too high (low) (i.e., $R_u + S \geq R_m$) that the household will decide to move. In other words, when a mismatch occurs, a larger subsidy provides a greater incentive for a household to stay, as if it were subsidized to tolerate the mismatch. In the subsidized housing case, the rental subsidy is directly related to the initial purchase discount (*d%*). This leads to the second hypothesis:

Hypothesis 2 *Ceteris paribus, the larger the price discount during the initial purchase, the smaller will be the effect of a mismatch on residential mobility.*

[8] HOS owners are not allowed to rent out their subsidized flats unless after payment of land premium to the government. So it is reasonable to assume they are owner-occupants.

More specifically, households facing a mismatch are spatially 'trapped' in their existing flats, thus giving rise to an illiquid subsidized housing market. Although the urban economics literature contains many studies on housing liquidity or residential mobility, little attention has been paid specifically to the institutional factors (such as housing subsidy programs, not to mention the rationales behind) and their relevance to low market liquidity. In the ensuing subsections, two strategies, namely panel data estimation and a natural experiment will be deliberated, as will the corresponding data and estimation results.

To test the two hypotheses developed above, two estimation strategies are considered to be viable, namely (1) panel data estimation and (2) natural experiment. The major advantage of these two strategies is that both can vastly mitigate the unobservable bias and well control the confounding factors affecting the likelihood of a household's decision to move or sell (Goodman, 1995; Haurin et al., 1996; Dietz and Haurin, 2003). To begin with, it is necessary to decide on how to measure and compare mobility in the resale market for subsidized housing. A number of measures have often been proposed to infer the degree of residential mobility; including the length of residence, likelihood of a household moving, the sellers' and buyers' time-on-market, as well as turnover of housing/dwellings (Kluger and Miller, 1990; Krainer, 2001; Genesove and Han, 2012; Sánchez and Andrews, 2011). For this study, the turnover of housing is used, which is often referred as "transaction liquidity" in the real estate literature, to capture residential mobility.[9]

4.1. ESTIMATION STRATEGY 1: PANEL DATA APPROACH

Transaction liquidity at building level is the best measure of residential mobility for the current study which directly reveals how the subsidy effect on average influences the households' relocation decision. Ideally, if there were a longitudinal dataset tracing the characteristics of each and every household in HOS, it would be a perfect data source to examine the residential mobility of HOS residents. However, such dataset cannot be obtained from the Census. Although the Census data does include a variable indicating whether a household relocates within the past five years, there is no information on the previous housing tenure (i.e., HOS/private housing). It is therefore impossible to identify which HOS households have sold their flats and made way into the private market.

Thus, as the second-best solution, the transaction liquidity of subsidized flats at estate-level is used as the measure of residential mobility. It is defined in terms of turnover rate, which is the percentage of flats traded over a certain period. The liquidity measure for building i at time t (L_{it}) is:

[9] In this study, residential mobility and transaction liquidity are used interchangeably.

$$L_{it} = \frac{VOL_{it}}{STOCK_{it}} \times 100\% \quad \textbf{(1)}$$

where VOL_{it} is the number of subsidized flats traded in building *i* at time *t*, and $STOCK_{it}$ is the number of subsidized flats (stock) available in building *i* at time *t*. For the subsidized housing case, some adjustments to the turnover rate are deemed necessary. First, flats subject to the resale restriction period have to be excluded. Second, flats that are free of the premium payment requirement should be excluded as well, as they no longer qualify as subsidized housing.

To consider the effects of spatial mismatches and initial price discounts on liquidity and, by extension, residential mobility in this study, the model is specified as a linear functional form:

$$L_{it} = b_0 + b_1 MIS_{it} + b_2 MIS_{it} \times d\%_i + Z_{it} + \varepsilon_{it} \quad (2)$$

where L_{it} is the liquidity of a HOS building *i*; MIS_{it} is a vector of mismatch measures; $d\%_i$ is the initial purchase discount; Z_{it} is other determinants of liquidity; ε_{it} is a random error; and $b_{0,}$ $b_{1,}$ and b_2 are the coefficients to be estimated. It should be noted that the variable *d%* does not enter into Equation (2), as the variable is building-specific and will be eliminated when we first-differenced this panel equation into Equation (5) at the building level.

4.1.1. MISMATCH MEASURES

Regarding the mismatch measure (MIS_{it}), a direct observation is not possible. Based on the literature review on the spatial mismatch, three main types of measure are thus devised to proxy where a mismatch is likely to occur or accentuate.

The first measure is related to the spatial-induced mismatch. As discussed in our motivating example in section 4.2, the mismatch may arise from a long commute to work. Households working across district usually incur higher transportation and time costs. To capture such a spatial-induced mismatch, the proportion of working households who have to commute to another district for work (i.e., *WORKD*) is used as a direct measure[10]. The second measure is for an income-induced mismatch. Certainly, as households'

[10] One may have the concern that the variable *WORKD*, i.e., the proportion of workers commuting to another district to work ignores the actual travel time (and cost) in measuring the spatial mismatch. Nonetheless, the first-differenced panel estimation is measuring the incremental change of spatial mismatch. Given the mode of transportation to place of work in each building does not change drastically (which is true as revealed in the Census data), the change of variable *WORKD* is considered to be rather adequate in capturing the spatial-induced mismatch. In spite of this argument, I have further developed a measure of *ACCESS* as a further test in the later paper of this paper.

income increases, a household may want to sell the existing subsidized housing and upgrade to a private flat presumably of better quality. *Per capita* income of a household living in subsidized housing (INC_{it}) is used to proxy such a mismatch. The third is a neighborhood-induced measure, capturing the housing price gradient of private housing in the vicinity of a subsidized development (PPH_{it}). Homeowners of HOS flats in a certain district may want to stay in or dispose of their subsidized flats owing to the district amenities, e.g. good school network. These factors have been captured by the housing price gradient. The hedonic literature establishes that housing prices are capable of capitalizing amenities like better transportation and dis-amenities like poorer air quality (Alonso, 1964; Muth, 1969; Tse and Chan, 2003; Coulson and Engle, 1987). Lower housing prices in a neighborhood often mean a net deterioration in the quality of its surroundings, thereby producing a larger neighborhood-induced mismatch. The variable PPH_{it} is defined as the average private housing price in a district where an HOS building is located normalized by the average price of all private housing in Hong Kong during the same period. It is noteworthy that PPH > 1 means that the district has a better living quality than the Hong Kong average (that induces people to stay), while PPH < 1 refers to a worse quality than average (that triggers people to leave). The variable PPH is expected to carry a negative relationship with *L%*.

Apart from the three proxies listed above, a combined mismatch proxy is the length of time over which a household has lived in subsidized housing (LEN_{it}). In general, the longer the time, the more likely would a temporal mismatch arise due to changes in individual circumstances or neighborhood quality. For the HOS, since a household's decision to move is basically the same as its decision to sell, LEN_{it} can be defined as the period of holding subsidized flats in building *i* at time *t*. As to be seen later, such a temporal mismatch will be eliminated when it comes to the first-differenced panel estimation. Hence, the vector of mismatch measures refers to:

$$MIS_{it} = c_1 WORKD_{it} + c_2 INC_{it} + c_3 PPH_{it} + c_4 LEN_{it} \quad (3)$$

where c_1 to c_4 are estimated coefficients.[11] According to ***Hypothesis 1***, mismatches should increase subsidized housing's liquidity. Hence, b_1c_1, b_1c_2, b_1c_3 and b_1c_4 are all expected to be positive. On the other hand, according to ***Hypothesis 2***, a larger discount should reduce the mismatch effects or households are more tolerant of the mismatches. As a result, b_2c_1, b_2c_2, b_2c_3 and b_2c_4 are expected to be negative.

A more challenging task is to introduce controls for another determinant of liquidity, Z_{it}. From the literature, liquidity is known to vary with property price levels (Leung and Feng, 2005) and property quality (Wong et al., 2012). This means Z_{it} can be broken down into a time effect (Z_t) and a quality effect (Z_i):

[11] In Equation (2), c_3 is given a negative sign because *PPH* is negatively related to mismatches.

$$Z_{it} = Z_t + Z_i \qquad (4)$$

Z_t can be approximated by the liquidity of the private housing market. However, finding a measure for Z_i is much more difficult. The liquidity of nearby private housing is deemed unsuitable because there is a perceived quality difference between private and subsidized flats. Even among subsidized flats, quality may vary according to building age, location, developers, *etc*.[12] One solution proposed by earlier studies is to use these quantifiable development attributes as a proxy for Z_i, assuming away any unobserved quality difference. An alternative solution is to estimate the open market value of subsidized flats through a hedonic pricing model and take it as a quality measure, provided that there are sufficient resales of privatized HOS flats (with premium settled) for estimation. A still better solution, as this study proposes, is to use a first-differenced panel data approach to eliminate any cross-sectional variation in quality over time:

$$\Delta L_{it} = b_1 \Delta MIS_{it} + b_2 \Delta MIS_{it} \times d\%_i + (\Delta Z_t + a) + \Delta \varepsilon_{it} \qquad (5)$$

Equation (5) is the first-differenced of Equation (2), so all the time-dependent variables are prefixed by a time change operator, Δ. Z_i, including unobserved quality, are canceled out during the differencing process, except for building age, which increases with a constant unit of time. Since a difference of two consecutive periods is always equal to one, there is a constant term, *a*, left in the equation. A panel model can estimate equation (5), and the coefficients are expected to have the same sign as those of Equation (2).

4.1.2. THE PANEL DATA

Many previous studies seem to have focused on modeling binary household decisions to change homes by cross-sectional data (Wong and Liu, 1988; Lui, 2007; Lui and Suen, 2011). Conceptually, measuring mobility as the turnover of homeownership would be more intuitive because the frequency of property transactions would directly provide us with information on household movements. However, such transaction data, together with specific household characteristics, are not always readily available. To overcome this shortcoming, it is desirable to examine transaction liquidity by combining a comprehensive housing transaction database with the Population Census data. The dataset used in this study primarily comes from the Economic Property Research Centre (EPRC) and the Hong Kong Population Census. The former covers all property transactions filed by the Land Registry (the official property title registration system) in Hong Kong, including those for subsidized flats that have been "privatized" and resold in the open market. The data from the Hong Kong Population Census are available in several different formats. For this study,

[12] Some HOS flats have been built by private developers under the PSPS. Their sale and resale arrangements are the same as for other HOS flats. The PSPS flats are, however, often perceived to be of better quality.

the data used are based on the building block levels of HOS estates across the city. It is worth noting that the household samples of the Census are surveyed from the same building block, so while it represents panel data at the building level, it does not necessarily involve the same set of households for each Census. Such data refer to an average measurement. Nevertheless, suffice it to say that the Census contains all the essential data on household characteristics, including income and demographic attributes.

Some stylized facts about the Hong Kong subsidized sales housing market can be observed from the summary statistics of the variables in Panels (A) and (B) of **Table 1**. First, as Panel (A) shows, the trading volume (*VOL*) of the secondary HOS housing market, in which the flats are being transacted are still subject to the premium repayment (i.e., subsidized HOS), averaging 3.5 deals per year. The liquidity (*L%*; or trading volume as % of total stock) for the subsidized HOS units stays low at only 1.1%. Such a turnover is smaller than the 4% recorded for those HOS units with premiums being settled. These turnover figures are still well below that for private housing (*i.e.*, typically 9%). Without accounting for any difference in building quality and household characteristics, a simple *Welch t-test* result shown in the last column of **Table 1** indicates prima facie relatively inactive transactions in the subsidized HOS market.

As for Panel (B) of **Table** 1, the initial purchase discount (*d%, i.e.*, the housing subsidies) of HOS sales amounts to 36% on average, with some cases reaching a maximum of 50%. Generally speaking, the average household size (*HHSIZE*) within HOS buildings is larger than their private counterparts, which reveals the denser living conditions of HOS residents. Regarding the extent of "mismatch" among HOS owners, the severity of the problem can be inferred from the proportion of workers who have to commute to another district for work (*i.e., WORKD*). This is the spatial-induced mismatch. Roughly speaking, around 78% of HOS residents are found to have worked outside their home districts, exceeding the 70% for private housing residents. **Figure 2** graphically illustrates such a spatial mismatch. Each dot represents the location of an HOS building. Those dots in red indicate that almost 80% of residents need to work across districts. To a certain extent, the figures reveal that HOS households' transportation costs (around 6-8% of total household expenditure) are higher than those of private housing counterparts.

[Figure 2 Inserted]

As aforementioned, the mismatch can further be measured by the household income (*INC*) and housing price gradient (i.e., *PPH*). The income of households (*INC*) tends to capture any income-induced mismatch. Intuitively, when its income increases, a household has a greater incentive to trade-up the existing subsidized flat for a better private accommodation. The data indicate a median monthly household income (*INC*) for HOS buildings at around HK$23,900. Some HOS households actually have earned monthly incomes much higher than those living in private estates. Such HOS households can well afford private housing, yet, for some reasons (likely the subsidy impact), have decided not to upgrade their living conditions.

The housing price gradient (*PPH)* is used to capture the mismatch induced by neighborhood quality. It is defined as the average private housing price in a district where an HOS building is located divided by Hong

Kong's overall average housing price. The value $PPH > 1$ means the district possesses a better neighborhood quality than the overall average for Hong Kong, while $PPH < 1$ indicates otherwise. Hence the price gradient of 0.9 for the HOS estate suggests a lower-than-average neighborhood quality for the HOS buildings.

Last but not least, the liquidity of the comparable private housing (*PRIVATRADE*) is added to the estimation as another control. This variable *PRIVATRADE* is defined as the liquidity (*L%*) of private housing for which the consideration is less than HK$8 million and within the immediate 400-meter radius of an HOS building (as **Figure 3** shows). These selection criteria are based on the fact that covering the most expensive HOS units currently transacted at around HK$8 million in Hong Kong and buildings within a 400-meter radius of an HOS building would be a way to eliminate the variations caused by locational differences. Consistent with my hypothesis, the liquidity of these relevant private residences, which are free from the subsidy effect, is higher than their HOS counterparts (i.e., at around 5.5%).

[Table 1 Inserted]

4.2. RESULTS OF THE PANEL DATA ESTIMATION

4.2.1. BASELINE RESULTS

Columns (1) to (4) of **Table 2(a)** present the panel estimates on the transaction liquidity of subsidized HOS units. The mismatch (*MIS*) impacts are proxied by the variables $\Delta WORKD$, $\Delta HHINC$, and ΔPPH, while the subsidy effect is assessed from the interaction terms of *d%* and the mismatch proxies (*MIS*). It is worth noting that the first-differenced panel eliminates the variable LEN.

All mismatch proxies are lagged by one period to rule out any plausible endogeneity of income on transaction liquidity. The results of each specified mismatch measure are shown in Columns (1) to (3) respectively, whereas Column (4) indicates the results of all mismatch measures being used. Regardless of the model specification, all estimated coefficients for the lagged mismatch measures, i.e., $\Delta WORKD$, $\Delta HHINC$, and ΔPPH are statistically significant with expected positive signs. The results support ***Hypothesis 1***, which states that *households in subsidized flats that face a greater mismatch are more likely to move, holding other things constant.*

On the contrary, the interaction terms between the initial purchase discounts and mismatch variable measures ($d\% \times \Delta MIS$) in Columns (1) to (4) demonstrate an expected significantly negative result. In developing ***Hypothesis 2***, it is pointed out that while the mismatch leads to higher transaction liquidity, the *in-kind* housing subsidy, as manifested by the initial purchase discount, acts as an opposing force that could offset the mismatch effects and, hence, reduces transaction liquidity. The significantly negative coefficients of the interaction terms ($d\% \times \Delta MIS$) point to such offsetting effects in our sample.

Moreover, it is worth noting that the first-differenced panel has also eliminated the variable *d%* as the initial purchase discount is fixed for each HOS estate. Thus there is no need for *d%* in the model specification. To ensure the hidden factors, if any, that might still retain after differencing, the cross-sectional fixed effect is added to the models as a control.

[Table 2(a) Inserted]

4.2.2. ROBUSTNESS CHECKS WITH PRIVATIZED HOS TRANSACTIONS

To strengthen the arguments, we have further performed panel estimations by using the second-time and subsequent sales of HOS homeowners transactions (i.e., where premiums have been settled). Since the initial purchase discount is considered as a major force in counteracting the mismatch and thereby generates a significantly negative coefficient for all interaction terms $d\% \times \Delta MIS$, those HOS homeowners who have settled their premiums are expected to be unrelated or at least less sensitive to the initial purchase discount (*d%*). In this connection, a set of affirmative results is found in Columns (5) to (8) in **Table 2(a)**. All mismatch proxies in these columns are insignificant (with some even showing counter-intuitive signs). The interaction terms between the initial purchase discounts and mismatch variables ($d\% \times \Delta MIS$) likewise exhibit insignificant results. It is intuitive, as the initial purchase discount no longer applies to those HOS homeowners with their premium being settled (i.e. no housing subsidy effect at all).

On the other hand, the variable $\Delta PRIVATRADE$, which is used to capture the time element (ΔZ_t) in Equation (5), is positively significant for HOS markets. The coefficients of $\Delta PRIVATRADE$ for those HOS with premium paid in Columns (5) to (8) are larger than their subsidized counterparts in Columns (1) to (4), indicating that the liquidities of those HOS with premium paid are more sensitive to the liquidity changes in the private housing market. This is intuitively acceptable as premium-settled HOS units are tantamount to private housing. Their liquidity, therefore, tends to be more sensitive to private housing developments. The significance of $\Delta PRIVATRADE$ also indicates that the variable effectively captures the time effect (Z_t) in particular the potential supply and market trends at a period, because the private housing units are indeed the potential source of supply for subsidized homeowners.

4.2.3. A FURTHER CHECK WITH ANOTHER MEASURE OF SPATIAL MISMATCHES

To measure the spatial mismatch, the use of proportion of people working across districts (WORKD) may pose a concern that the variable may just consider a particular dimension of spatial mismatch, i.e., the frequency of commute across districts, while overlooking the time cost to commute. Nevertheless, since the census data in Hong Kong does not provide information on the place of work for residents, a direct measure of time cost is basically impossible. Instead, a district-level "accessibility index" is constructed to serve the

purpose. Appendix 2 describes how such an index is formulated. After the accessibility indices for 18 council districts are compiled, the index values are then multiplied by *WORKD* to replenish the deficiency of relying merely on the single variable *WORKD*.

Table 2(b) shows that both baseline and privatized HOS estimations remain intact while the variable *ACCESS* is used to substitute the variable *WORKD*. Prima facie, the crosscheck further strengthens our subsidy and mismatch hypotheses.

[Table 2(b) Inserted]

4.3. ESTIMATION STRATEGY 2: A NATURAL EXPERIMENT

The second estimation strategy is to make use of a *one-off* premium waiver policy[13] in 2013 as a unique randomized natural experiment to test the reactions of subsidized homeowners (for details, please refer to section 2.2.1). According to the hypotheses, it can be predicted that those HOS households who are facing the largest mismatches will immediately dispose of their properties and relocate elsewhere if they no longer have to be concerned about repaying housing subsidies. A higher HOS transaction liquidity can then be envisaged. In this experiment, the mismatches (*MIS*) are proxied by those HOS estates with their households (1) enjoying larger initial purchase discounts, *d%* or (2) living for a longer time, *AGE*. Such HOS units are expected to be more frequently traded under the waiver policy because households living in such estates are more likely to suffer severe mismatches and hence, more ready to move. The relevant regression model for analysis in this respect is presented below:

$$L_{it} = a + \gamma HOS_s + \lambda\, T_t + \delta(HOS_s \times T_t) + \beta\ (HOS_s \times T_t \times MIS_t) + \varepsilon_{ist} \qquad (6)$$

where L_{ist} is the monthly transaction liquidity at estate *i* in market *s (subsidized vs. private)*, which is defined in the same way as Equation (1) at time *t*. HOS_s is a dummy that equals 1 if the observation refers to the HOS estate transaction liquidity or 0 if otherwise; and T_t is a policy time dummy that equals 1 when the transaction occurs after 2013M6 (post-treatment) or 0 if otherwise. The measure of mismatches, MIS_t cover both initial purchase discounts (*d%*) and age of estates (*AGE*). Coefficient β is expected to carry a positive sign because HOS estates with larger discounts are more likely to face greater mismatches. As a result, their owners will have a greater incentive to sell flats and relocate elsewhere under the premium waiver policy.

[13] The premium waiver policy is officially called as "The Interim Scheme to Extend the Home Ownership Scheme Secondary Market to White Form Buyers".

4.3.1. THE EXPERIMENTAL DATA

For assessing the effects of the premium waiver policy on the monthly transactions liquidity (*L%*) of HOS estates, the transaction data for 170 subsidized housing estates with trading activities from July 2011 to March 2015 together with those comparable private housing units within 400 meters of HOS estate have been used. The monthly transactions recorded for nearby private sector flats provide a relevant control group (i.e. counterfactual) for benchmarking the impact of the premium waiver on HOS trading activities. The study period has been carefully chosen for good reasons. As 5,000 premium waivers by ballot were issued from June 2013 to March 2014 and the selected households were allowed to search for their flats within 12 months, all granted premium waivers should have expired by March 2015. The study period is thus set to commence from July 2011 in order to balance the time frame before and after the waiver policy.

Several features of the selected samples over the designated study period are considered to be favorable for the estimation. First, the premium waiver policy occurred amidst several rounds of property-market cooling measures. These measures included various special stamp duties (a stamp duty is a property tax in Hong Kong that also applies to HOS transactions in the open market), which significantly raised the transaction costs of purchasing property in the market. Upon implementation of such measures, any increase in the number of HOS transactions over the period could be primarily attributed to the growth in genuine demand, rather than property speculation.

Second, private housing within the immediate 400-meter radius of an HOS estate tends to be closely linked to that estate. This should form a good basis for comparison with the monthly transaction liquidity for the relevant sites. The variations in the initial purchase discounts (*d%*) and the age of HOS flats (*AGE*) should allow us to further test the varying subsidy effects on residential mobility. Moreover, the seasonal pattern of transaction liquidity, if any, should be similar for both HOS and nearby private housing estates. The difference-in-differences (DID) methodology (Card and Krueger, 1994) is expected to effectively "difference out" most unobservable confounding impacts on the monthly HOS transaction liquidity.

[Figure 3 Inserted]

Table 3 shows the means of the variables in the dataset. The means for variables in the HOS and private housing estates before and after the waiver policy are presented in Columns (1) to (4). After the implementation of the waiver policy, the number of monthly HOS transactions averaged 6.19, which slightly exceeded the transaction volume (i.e., 6.07) before the 5,000 waivers were introduced. Nevertheless, such an increase should not be regarded as trivial when compared to the figures for the private housing market. As mentioned earlier, owing to the implementation of various tightening measures,[14] trading activities in the

[14] The tightening measures apply to the resales of HOS units with premium settled.

property market remained slack over the study period. In fact, the number of transactions for private units adjacent to HOS estates, on average, dropped from 15 to 11 cases per month. This somehow reinforces my argument that the introduction of premium waivers has boosted the number of transactions in the HOS resale market. An initial assessment of the waiver program[15] also indicates that the average annual transaction in the HOS market increased to 2,810, more than the annual average of 2,100 in the past decade. The waiver boosted most of the transactions during the period. More importantly, as the government pledged to roll out another batch of waivers, those HOS households who had planned to buy their HOS units without getting the waiver were expected to have a strong incentive to wait for the impending round of waiver. That further helps ensure the validity of my comparison between subsidized homeowners and private homeowners in the natural experiment. Furthermore, the main attributes of housing transactions before and after the waiver program, including estate age (*AGE*), floor level (*FLR*), and flat size (*SIZE*), are likewise found to be similar for the HOS and private estates. Thus, buyers' housing preferences should not have changed much after the waiver policy.

[Table 3 Inserted]

4.3.2. RESULTS OF THE NATURAL EXPERIMENT

The results shown in **Table 4** are in line with my prediction of the subsidy effect on residential mobility. In Columns (1) and (2) of the table, the policy time dummy T (i.e., $T = 1$ when the transaction occurred after 2013M6 or 0 if otherwise) carries a significantly negative sign that coincides with the tightening impact of the property cooling measures. Meanwhile, the main deterrent effect of housing subsidies on transaction volume is represented by the negative coefficient of the standalone variable of the initial purchase discount *d%*.

The premium waiver appears to have reduced the transaction liquidity for HOS flats in the market. The relevant impact is captured by the interaction term $T \times HOS$. The dwindling transaction liquidity in general may be attributable to people holding up their sales amid expectations of a further round of premium waiver. Indeed some anecdotes indicate that many HOS residents were expecting the waiver program to continue. Anyhow, the sign of this interaction term is not our main concern. Of particular note is the DID effect of subsidies on transaction liquidity, which is captured by the significantly positive coefficients for the interaction terms $T \times HOS \times d\%$ (i.e., 0.0106 and 0.0104) in Columns (1) and (2). The estimated coefficient remains intact when the fixed effects of HOS estates are added. (i.e., Column 2 of **Table 4**). As mentioned

[15] An initial assessment of the waiver policy (i.e., Interim Scheme) can be available at http://www.legco.gov.hk/yr14-15/english/panels/hg/papers/hg20150105cb1-384-4-e.pdf

earlier, β is expected to be positive because those HOS estates with more heavy discounts tend to suffer more severe mismatches and their owners are more likely to relocate elsewhere upon implementation of the premium waiver policy. The results in various specifications further confirm the proposed hypotheses.

As mentioned earlier, the age of HOS (i.e., *AGE* in Columns (3) and (4)) flats is employed as an alternative measure of mismatches (*MIS*). The DID effect of estate age on transaction liquidity, which is captured by the significantly positive coefficients of the interaction terms $T \times HOS \times AGE$ (i.e., 0.0157 and 0.0049) in Columns (3) and (4), are consistent with the prediction regarding the mismatch hypotheses.

[Table 4 Inserted]

4.4. EMPIRICAL RESULTS IN TERM OF ELASTICITIES

Notably both the panel data estimation and natural experiment in this study display broadly similar results in respect of the marginal effects of initial purchase subsidy on transaction turnover. For the panel data results, it is observed that the marginal effect of the initial price discount on the transaction turnover is about -0.07 (i.e., the sum of coefficients for the interaction terms with d%,). As to the natural experiment, the marginal effect of the initial price discount on the transaction turnover is indicated by the interaction terms T × HOS × d%, which is 0.01. In fact, the estimation results can be expressed in terms of elasticities, i.e. the responsiveness of the change in transaction turnover with respect to the change of initial purchase discount. Based on the average transaction turnover (i.e., 1.09%) and initial price discount (i.e., 36%), the arc elasticity of transaction turnover with respect to initial purchase discount is estimated at around 2.4%16 This implies that a 1% increase in the initial purchase discount will reduce the transaction turnover by about 2%.

If residential immobility does matter, what should be done in order to resolve such a problem? We believe a long-term solution to the residential immobility problem is to unbundle the "property rights" of in-kind subsidies – to break the deadlock between the rights to live in an HOS flat and the rights to enjoy a housing subsidy. That is, an existing HOS owner is allowed to sell his unit and keep the subsidy for buying another flat in the private market. In the future, if he wants to sell the private flat, he may either sell it to another eligible HOS buyer at a discount or to anyone at the market price after repaying the subsidy. The final section will focus on discussing various solutions as a concluding remark of this study.

[16] Based on the panel data estimates, the arc elasticities of transaction turnovers with respect to subsidies are estimated as follows:

$$\bar{\epsilon} = \frac{0.36 + (0.36 + 0.01)}{1.09 + (1.09 - 0.07)} \times \frac{0.07}{0.01} = 2.4$$

5. CONCLUSION: MINIMIZING THE MISALLOCATION OF HOUSING BY MOBILIZING TRANSACTIONS

In this study, we extend Glaeser and Luttmer's (2003) misallocation losses argument to empirically examine the misallocation losses due to mismatch under subsidized homeownership. Our empirical analysis confirms that subsidized homeownership creates misallocation loss in addition to the welfare losses of supply. In theory, ignoring such misallocation losses of subsidized homeownership may result in a too optimistic view of this housing policy especially when the subsidized homeownership usually "lock-in" the subsidy recipients by increasing their opportunity cost to move.

One of the most common factors restraining transaction activities in many share-equity homeownership arrangement is the statutory requirement to repay the relevant housing subsidy upon resale of the property. That is, the subsidy in the form of unpaid land premium has to be returned to the government at the time of resale. It makes very costly for residents in such subsidized homes to trade their flats on the open market. Even worse, the unpaid land premium is pegged with the growth of private housing prices. As a result, the possibility of settling the relevant premium by subsidized homeowners has become increasingly remote over time. Typically once an subsidized flat is allotted to a household, such a unit will seldom become available to the others on the open market even if the subsidized occupant has little intention to stay in the flat. The lack of residential mobility has therefore become a major source of inefficiency and inequity in the public housing sector. This has provoked heated debate and stimulated reflection in society on how to revive the residential mobility. Several approaches are discussed as a concluding remark for this study.

One approach is to waive the repayment of premium upon the resale of subsidized homes (Wong, 2015). The advocate argues that if the HOS homeowners are granted a full title to their flats and allow them to sell it on the open market without having to settle the unpaid land premium, the residential immobility problem will be solved satisfactorily. This approach has been disclosed for quite some time, yet incapable to gain wide support from the stakeholders. Many people have raised opposition on the grounds of "unfairness" in the relevant distribution of interests. In particular, it is hard to convince the middle class in the society why they need to use their tax money to subsidize the moderate-income people to become homeowners, whereas they have to struggle hard for many years hopefully just to get a small private flat. Moreover, the waiver approach is *de facto* a privatization of HOS flats. In such a case, the Government becomes a "developer" competing with private firms. Understandably the private developers as a primary stakeholder of the market have also voiced strong opposition to such an idea. So the approach soon got stuck as it is increasingly treated as a political rather than an economic issue. Even though this proposed approach may seem a possible way out regarding tackling the HOS residential immobility, the substantial political economic pressures have been keeping it virtually inside the ivory tower.

Another suggested approach to mobilize the HOS residents is to constrain the inherent property rights of inheritance (Chau, Wong, and Yiu, 2012). As pointed out earlier, the housing subsidy is the main culprit of low HOS mobility. In exploring the question of "What if such subsidy will be expired?" Chau et al. (2012) proposed that if the newly completed HOS units are sold with a terminable leasehold contract, the price of such HOS units will be reduced significantly. Assuming such new HOS units have, say only 50-year leasehold period (i.e. 50-year rights to occupy, rights to transfer and rights to derive income), the value of such units will certainly be priced at a discount since the owners do not have the option (rights without obligation) to inherit when opportunity arises in the longer-term future. At the end of the leasehold contract, the HOS residents can only sell back to the Government at a fairly assessed price.

Under the leasehold arrangement proposed by Chau et al. (2012), the HOS market will become more sustainable but inheritable. The 50-year terminable period guarantees that the units will be forfeited to the Government which in turn will be re-allocated to the people in need. In essence, the expiry leasehold contract facilitates the development of a housing ladder. Since the leasehold HOS can be freely traded in the market, the homeowners can enjoy a "full homeownership" (except after expiry date of the lease). Homeowners can exercise their "full" rights by reselling the flats, using them as collateral for refinancing, and subletting if necessary by the varying needs of their life cycles. More importantly, as the value of such leasehold, HOS is significantly reduced, less financial subsidy is required from the government.

Apparently, the premium waiver and leasehold HOS proposals represent two extreme approaches to deal with the residential immobility problem. Simply put, the premium waiver approach provides an opportunity for a windfall gain to HOS residents so as to allure them away from the relevant housing program, whereas the leasehold HOS approach directly makes use of government regulation to restrict the length of stay of HOS residents under the program. Admittedly both approaches have their own merits, but they might fail to provide a market solution that directly addresses the core problem encountered by the HOS homeowners: once a choice is made to resell their flats (i.e., to forgo the rights to occupy), the HOS homeowners are at the same time giving up their rights to enjoy the housing subsidies.

We believe a long-term solution is to unbundle the "property rights" of *in-kind* subsidies – to break the deadlock between the rights to live in an HOS flat and the rights to enjoy a housing subsidy (Cheung, 2017). An existing HOS owner can choose to sell his unit and keep the subsidy for purchasing another flat in the private market. In the future, if he wants to sell the private flat, he may sell it to another eligible HOS buyer at a discount or to anybody at the market price after repayment of the subsidy[17].

[17] This property right solution is a modified solution from a so-called "imminent HOS plan" proposed by Wong (2011). Please vide at http://news.stheadline.com/dailynews/headline_news_detail_columnist.asp?id=155189&section_name=wtt&kw=232; the main gist of this proposal is to transform some private housings into HOS. The Government can use the proceeds obtained from any land auction to purchase back some private housing units and resell them as HOS.

This property rights arrangement will increase the flexibility of *in-kind* subsidies. Its spirit is in line with the notion of *housing vouchers*, which has been hotly debated in recent housing literature and studies – whether a *cash equivalent* housing subsidy enables public housing residents to enjoy greater mobility and, thereby, leads to a substantial improvement in their well-being (Eriksen and Ross, 2015). Regrettably, most public housing policy debates so far, whether in Hong Kong or many other economies, have mainly concentrated on the provision of adequate affordable housing by the government, with little regard to the role of housing subsidies in the society. Thus, additional research and policy attention are warranted to help policymakers to better understand the differences between *in-kind* and cash-equivalent housing subsidies and their effects on residents' behavior so that policymakers can devise suitable housing policies that take into account their overall effects on society, as well as on various stakeholder groups.

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APPENDIX

Accessibility Index of 18 District Council Districts in Hong Kong

Locational accessibility is an important aspect when considering tenure choices. This is particularly so in Hong Kong, where significant housing price differentials are observed just a mile away from the Mass Railway Transit. In order to measure the influence of time cost for proxying the spatial mismatch, an accessibility index for 18 District Council Districts in Hong Kong is constructed. Specifically, this accessibility index is a weighted index taking into account the travel time factor and the working population within a corresponding district.

The travel time involved is compiled by using the Google map Distance Matrix API through the function "gmapsdistance" in R[18] (i.e., an open source programming language developed by GNU project). Both the origin and the destination are the respective centroid of the Council Districts. If the centroid of a DC is located at sea, an approximated centroid within land is selected. Using "Mass Transit" as the mode of transportation and setting the departure time as Monday, 8:00 a.m. in the morning, a travel time matrix can be developed. For instance, the centroid of Wan Chai district is located near the Hong Kong Sanatorium & Hospital, the "gmapdistance" in R will map out all travel times between this point and the remaining 17 DCs.

Travel time is not the only consideration in examining the accessibility of a district. The working population is also relevant in particular when a spaital mismatch is a key concern. Therefore, the working population in each district at a particular year is used as a measure to weigh against the travel time aggregated. Based on the working population of each DC and travel times between districts, an accessibility index for 18 districts in Hong Kong is constructed.

[18] For details of "gmapsdistance" function in R, please vide: https://cran.r-project.org/web/packages/gmapsdistance/README.html

Figure 1 The Welfare Losses from Rent Control when Apartment are Randomly Allocated across Consumers (Adopted and Redrawn from Glaeser and Luttmer, AER 2003, p. 1029)

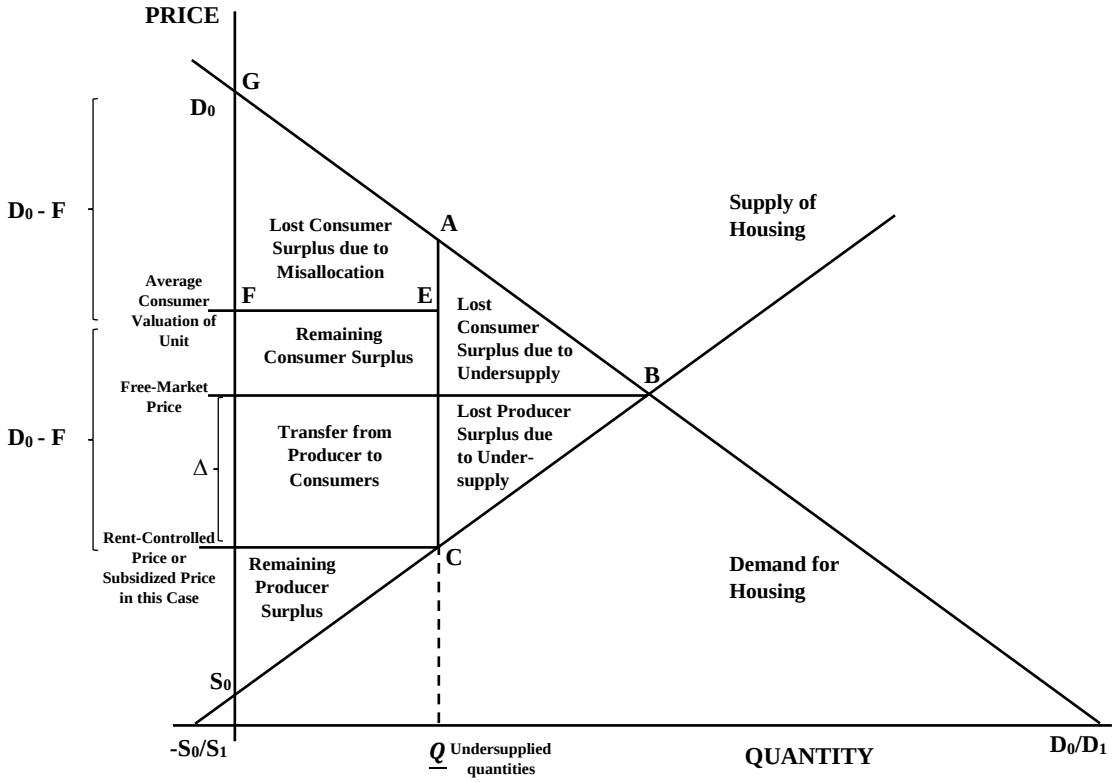
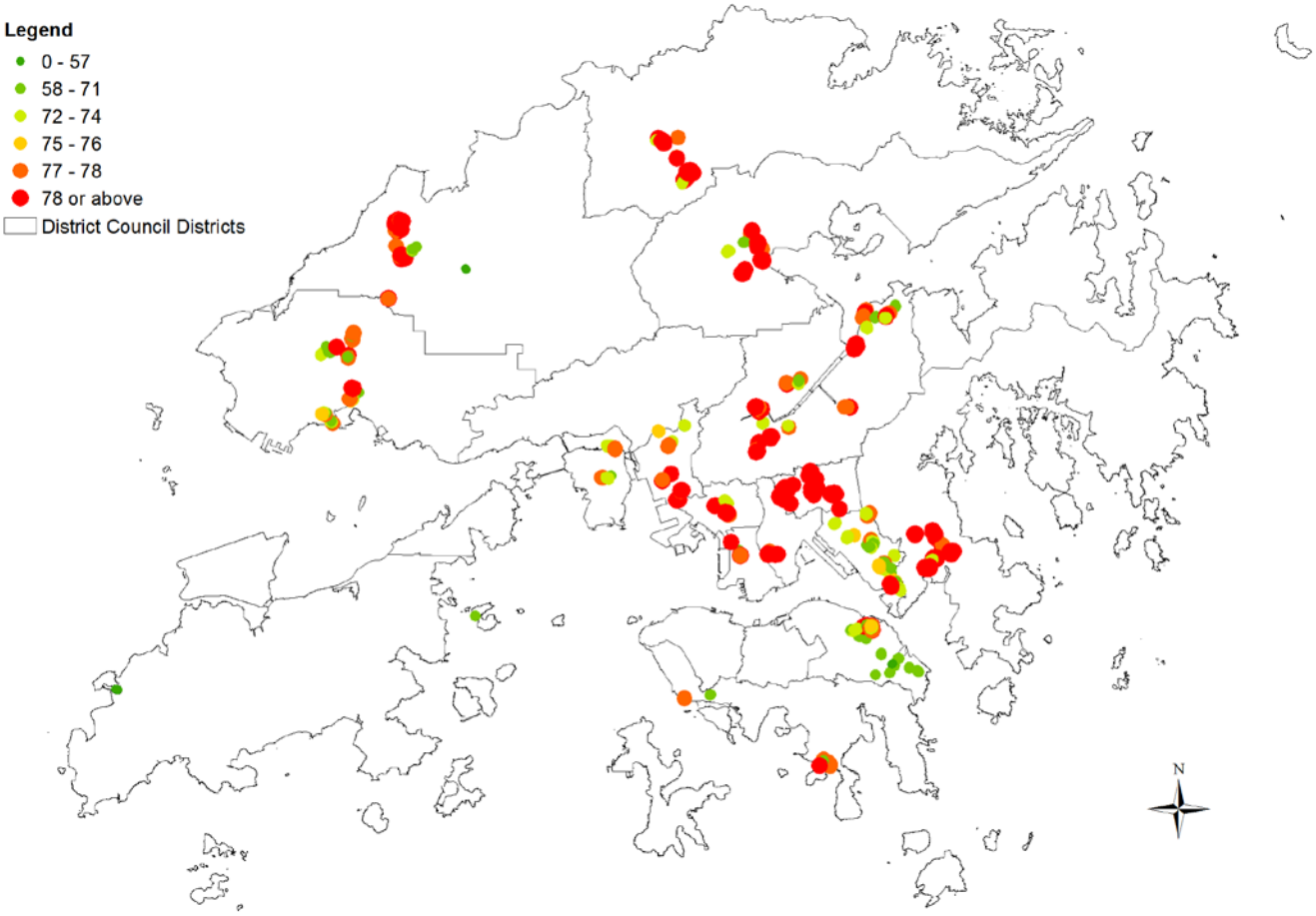


Figure 2 Locations of HOS Estates and % of Residents Working in Other Districts



Notes: Authors' compilation based on 2001, 2006, and 2011 Hong Kong Population Census

Figure 3 Private Housing Estates near one HOS Estate

Notes: Affluence Garden consists of five blocks. The 400-meter radius is centered near Block 3 (the orange dot) and encompasses six estates (26 buildings) and 16 single building blocks.

Table 1 Definition of Variables and Their Descriptive Statistics

Panel (A) - Liquidity Measure

		Subsidized (1)		Premium settled (2)		Diff. (2) - (1)
Variable	**Description**	**Mean**	**S.D.**	**Mean**	**S.D.**	**t-test**
L%	Liquidity (i.e., transactions per annum as % of relevant stock)	1.09	1.12	4.53	5.57	-73.2**
VOL	Transactions for each building per annum	3.49	3.90	1.06	2.25	-66.3**
STOCK	Total relevant stock of each building	306	156	22	37	-218.7**

Panel (B) - Mismatch Measure and Controls

		Subsidized and premium settled HOS (1)				Private (2)
Variable	**Description**	**Mean**	**S.D.**	**Min.**	**Max.**	**Mean**
d%	Initial purchase discount (%)	36.19	9.94	13.25	50.00	-
HHSIZE	Domestic household size	3.19	0.33	1.58	4.95	3.06
WORKD	Proportion of workers who commute to another district for work (%)	77.7	10.3	33.2	99.3	70.4
INC	Median monthly household income (HK$)	23 865	9 081	5 758	211 954	27090
PPH	Housing price gradient (i.e., avg. private housing price in the district with an HOS building divided by overall HK avg.)	0.90	0.37	0.39	3.90	-
PRIVATRADE	Liquidity (%) of private housing (<HK$8M; <400m radius of an HOS estate)	-	-	-	-	5.46
No. of Observations		15 156	15 156	15 156	15 156	-

Notes: Sample period is from 1997 to 2014; 842 HOS buildings are covered in the sample. Hence, the sample includes 15,156 observations (i.e., 842 × 18). The liquidity measure in Panel (A) is calculated according to the data from the Land Registry, and Economic Property Research Center (EPRC), while the mismatch measures in Panel (B) are based on 2001, 2006, and 2011 Census. The data for years in between are obtained by linear extrapolation. All HOS variables indicate the average of a building *i* for each year. Subsidized HOS refers to purchases made without settling the premium. "**" means the coefficient is significant at the 1% level.

Table 2 (a) Results of the panel data estimations

	Δ (Subsidized HOS transaction liquidity in %)				Δ (Premium settled HOS transaction liquidity in %)			
Δpanel eq. variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mismatch effect								
Δ*WORKD(-1)*	0.037**	-	-	0.047**	-0.077	-	-	-0.095
	(0.007)	-	-	(0.007)	(0.047)	-	-	(0.048)
Δ*ln(HHINC(-1))*	-	0.995**	-	1.519**	-	0.258	-	-2.971
	-	(0.214)	-	(0.244)	-	(2.007)	-	(2.216)
Δ*PPH(-1)*	-	-	0.544**	0.607**	-	-	-2.377	-1.865
	-	-	(0.138)	(0.153)	-	-	(2.097)	(2.060)
Subsidy effect								
d% × Δ*WORKD(-1)*	-0.001**	-	-	-0.002**	0.003**	-	-	0.003**
	(0.000)	-	-	(0.000)	(0.001)	-	-	(0.001)
d% × Δ*ln(HHINC(-1))*	-	-0.036**	-	-0.053**	-	-0.223**	-	-0.097
	-	(0.007)	-	(0.008)	-	(0.068)	-	(0.080)
d% × Δ*PPH(-1)*	-	-	-0.016	-0.018**	-	-	0.103	0.078
	-	-	(0.005)**	(0.005)	-	-	(0.057)	(0.054)
Δ*PRIVATRADE*	0.018**	0.018**	0.019**	0.019**	0.521**	0.514**	0.433**	0.531**
	(0.002)	(0.002)	(0.001)	(0.002)	(0.032)	(0.031)	(0.030)	(0.032)
Constant	-0.047**	-0.074**	-0.072**	-0.069**	-0.020	0.007	0.387**	0.119
	(0.009)	(0.009)	(0.009)	(0.010)	(0.067)	(0.070)	(0.061)	(0.081)
Fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations:	13360	13360	13360	13360	7133	7133	7133	7133
Adjusted R^2	0.011	0.009	0.009	0.014	0.054	0.054	0.056	0.058

Notes: The dependent variable is the change in transaction liquidity for **subsidized and premium settled HOS homeowners at the building level respectively**. ** means the coefficients are at 1% significance level. Standard errors presented in the parentheses. Δ*(variable(-1))* represents the difference-lag operator, such as $\Delta X(-1) = X_{t-1} - X_{t-2}$. The variable *d%* refers to the initial purchase discount (i.e., the *in-kind* subsidy referred to in this study). *WORKD* is the proportion of workers who commute to another district for work (%). It measures the job location-induced mismatch. HHINC represents the per capita monthly household income which captures the income-induced mismatch. PPH is the housing price gradient that proxies the neighborhood-induced mismatch. PPH > 1 means that the district is of a better quality than the Hong Kong average, while PPH < 1 refers to the opposite. The variable ΔPRIVATRADE in % represents a change of transaction liquidity in private housing, of which the consideration was less than HK$8 million and within the **immediate 400-meter radius** of an HOS building.

Table 2 (b) Results of the panel data estimations (con't)

	Δ (Subsidized HOS transaction liquidity in %)		Δ (Premium settled HOS transaction liquidity in %)	
Δpanel eq. variable:	(1")	(4")	(5")	(8")
Mismatch effect				
Δ*ACCESS(-1)*	0.049**	0.063**	-0.034	-0.080
	(0.009)	(0.009)	-0.066	(0.0672)
Δ*ln(HHINC(-1))*	-	1.518**	-	-2.419
	-	(0.239)	-	(2.135)
Δ*PPH(-1)*	-	0.604**	-	-1.784
	-	(0.152)	-	(2.060)
Subsidy effect				
d% × Δ*ACCESS(-1)*	-0.001**	-0.002**	0.003**	0.003**
	(0.000)	(0.000)	(0.001)	(0.001)
d% × Δ*ln(HHINC(-1))*	-	-0.053**	-	-0.097
	-	(0.008)	-	(0.080)
d% × Δ*PPH(-1)*	-	-0.018**	-	0.078
	-	(0.005)	-	(0.054)
Δ*PRIVATRADE*	0.018**	0.019**	0.521**	0.531**
	(0.002)	(0.002)	(0.032)	(0.032)
Constant	-0.047**	-0.069**	-0.020	0.119
	(0.009)	(0.010)	(0.067)	(0.081)
Fixed effects?	Yes	Yes	Yes	Yes
Observations:	13360	13360	7133	7133
Adjusted R^2	0.011	0.014	0.054	0.058

Notes: This table shows the extended results of **Table 2(a)** in respect of Columns (1), (4), (5) and (8), except that the variable *WORKD* is replaced by *ACCESS*. The dependent variable is the change in transaction liquidity for **subsidized and premium settled HOS homeowners at the building level respectively**. ** means the coefficients are at 1% significance level. Standard errors are presented in the parentheses. Δ*(variable(-1))* represents the difference-lag operator, such as $\Delta X(-1) = X_{t-1}-X_{t-2.}$ The variable *d%* refers to the initial purchase discount (i.e., the *in-kind* subsidy referred to in this study). *WORKD* is the proportion of workers who commute to another district for work (%). It measures the job location-induced mismatch. HHINC represents per capita monthly household income which captures the income-induced mismatch. PPH is the housing price gradient that proxies the neighborhood-induced mismatch. PPH > 1 means that the district is of a better quality than the Hong Kong average, while PPH < 1 refers to the opposite. The variable ΔPRIVATRADE in % represents a change of transaction liquidity in private housing, of which the consideration was less than HK$8 million and within the **immediate 400-meter radius** of an HOS building.

Table 3 Descriptive statistics of variables

Variable	Description	*Before the waiver: Jul 2011 – May 2013*		*After the waiver: Jun 2013 – Mar 2015*	
		(1)	***(2)***	***(3)***	***(4)***
		HOS	***Private***	***HOS***	***Private***
MVOL	No. of monthly transactions	6.07	15.01	6.19	11.47
		(0.09)	(0.59)	(0.08)	(0.26)
d%	Initial purchase discount (%)	36.0	-	36.0	-
		(0.17)	-	(0.17)	-
AGE	Avg. age of estate being transacted	20.31	20.21	22.07	22.13
		(0.13)	(0.16)	(0.13)	(0.16)
FLR	Avg. floor level being transacted	16.43	91.74	16.45	20.58
		(0.12)	(34.83)	(0.11)	(2.32)
SIZE	Avg. flat size being transacted (in sq. ft.)	615.07	701.01	618.57	676.77
		(1.65)	(5.65)	(1.55)	(4.73)
STOCK	No. of total stock of estates	2130.24	2617.39	2141.85	2624.13
		(22.70)	(64.17)	(22.24)	(64.18)
UPRICE	Unit prices (HK$ per sq. ft.)	4325.00	6098.10	5405.03	7118.94
		(21.80)	(46.29)	(22.81)	(35.16)

Notes: Standard errors are given in parentheses. Private housing transactions with unit prices above HK$8,000 per sq. ft. are excluded to give like-with-like comparisons with HOS transactions.

Table 4 Results of the natural experiment (DID estimates)

Estate Level	*Dependent Variable: No. of Monthly transactions liquidity (L%) within a 400m radius of an HOS estate*			
Variable	*(1)*	*(2)*	*(3)*	*(4)*
T	-0.1633**	-0.1647**	-0.1438**	-0.1453**
	(0.0222)	(0.0208)	(0.0170)	(0.0151)
HOS	0.9827**	0.9631**	0.228**	0.2100**
	(0.0654)	(0.0761)	(0.0165)	(0.0150)
d%	-0.0228**	-0.0229**	-	-
	(0.0017)	(0.0021)		
AGE			0.0131**	0.0132**
			(0.0009)	(0.0011)
T × HOS	-0.2439**	-0.2391**	-0.2676**	-0.0274
	(0.0935)	(0.0876)	(0.0534)	(0.0511)
T × HOS × d%	0.0106**	0.0104**	-	-
	(0.0025)	(0.0023)		
T × HOS × AGE			0.0157**	0.0049*
			(0.0021)	(0.0021)
C	0.6112**	0.3569**	0.3052**	0.0882**
	(0.0155)	(0.0921)	(0.0219)	(0.0683)
Fixed effect?	*No*	*Yes*	*No*	*Yes*
Observations	15300	15300	15300	15300
Adjusted R^2	0.0381	0.1686	0.0743	0.2872

Notes: The dependent variable is the **monthly transactions liquidity *(L%)* of 170 HOS estates versus those of private estates within a 400m radius** of the former during the period 2011M7 to 2015M3. The total number of observations is 15 300 (i.e., 170 × 45 × 2). ** means the coefficient is at the 1% significance level. Standard errors are presented in parentheses. *T* is a policy dummy that equals 1 when the transaction occurred after 2013M6 or 0 if otherwise. HOS equals 1 when the transaction liquidity refers to an HOS estate and 0 for its private counterparts. The variable *d%* refers to the initial purchase discount, which is an *in-kind* subsidy in this study. Fixed effect is a set of HOS dummies to capture, if any, estate-specific impact on transaction liquidity.