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# Marriage-induced demand for homeownership as a driver of housing booms: Evidence from Hong Kong

**Abstract**

Buying a home for marriage is customary in many societies. Traditionally, therefore, young couples getting married is a key driver of demand for homeownership. Yet the idea of marriage-induced demand for homeownership is a relatively underexplored component of housing price change. We examine the role of marriage-induced demand for homeownership in Hong Kong, which is a relatively self-contained housing market with fewer options for migration than most large cities. We use an instrumental variable strategy to test the hypothesis that more unmarried individuals at the prime age for marriage increases housing prices. We find that an additional one thousand marriage-aged but unmarried individuals leads to a seven per cent increase in housing prices. These findings confirm the importance of demographic factors such as cohort size and marriage rates on housing price projections, housing needs assessments, and housing policy.

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## 1.    Introduction

The boom-bust cycle of the housing market is of immense importance for wealth distribution, housing affordability, local fiscal capacity, and economic development. Most analyses of housing price movements focus more on the financial and supply-side aspects, and overlook concurrent changes in demographics, especially the formation of new households (Clark et al., 1994; Malpezzi & Maclennan, 2001; Levin, Montagnoli, & Wright, 2009). Hong Kong is a notable case in point. While the city's housing prices are among the least affordable in the world, most discussion of the recent housing boom focuses on such factors as speculative investment from China (Yiu, Yu & Jin, 2013), negative real interest rates (Yiu, 2014), and insufficient land supply (Huang, Shen & Zheng, 2015).

Perhaps of equal importance for the city, however, are the transitions that its residents seek to homeownership (Mulder, 1998). Mulder & Lauster (2010) argue that housing researchers too infrequently recognize the explicit connections between housing and family. Notable exceptions acknowledge that marriage-induced demand for homeownership is one of the significant demographic drivers of housing booms (Clark et al., 1994, for the United States; Clark & Dieleman, 1996, for the United States and the Netherlands; Feijten & Mulder, 2002, for the Netherlands; Mulder & Wagner, 1998, for West Germany and the Netherlands). In this study, we use both Clark and colleagues' (1994) life-course perspective and Mulder's (1998, 2001) analytical frameworks to analyse homeownership demand induced by marriage. Our study aims to fill a gap in the literature by establishing causal evidence that home buying demands from marriage-ready couples contribute to housing price growth.

Two motivations underpin the desire for home purchase before or at the time of marriage. One is a cultural norm that is especially prevalent in Asia. Traditionally, young couples use the purchase of a home as an indication of their commitment to marriage (South & Spitze, 1986). The second motivation derives from Becker's (1974) theory of marriage, which posits that buying a home is regarded as part of a dowry, making a single man (or woman) more competitive on the marriage market. Occasionally, parents volunteer to assist their children by paying the relevant down-payments. Such behaviour not only boosts house prices but also gives rise to an inter-generational wealth transfer in the housing market (Hui et al., 2016).

The logic of marriage as a driver of demand to purchase a home, and hence of housing price booms, is straightforward. However, the literature offers contradictory positions on its precise effects. On the one hand, scholars posit that although young couples' preference for homeownerhsip may be delayed by high housing costs, the demand persists (Stebbing & Spies-Butcher, 2016). On the other hand, other scholars contend that many young adults simply respond to high housing prices with alternative living arrangements such as living with their parents, renting with friends, and remaining unmarried (Drew, 2015). In this scenario, the home buying demand induced by marriage is minimal.

A core issue in this relationship is that cultural change often occurs at a slower pace than changes in economic conditions. The way family norms change with economic conditions is reflected in the long-term stability of marriage rates in the United States in the face of often dramatic economic changes (Ruggles, 1997). Cohabitation has gradually become commonplace, as either a precursor or an alternative to marriage, and a growing proportion of births take place outside marriage. Indeed, compared with previous generations, millennials have a greater likelihood of remaining single, and typically defer marriage and parenthood (Xu et al., 2015). In the United States, scholars have gone even further, arguing that such weak family formation among youngsters is the primary cause for the slow recovery of the U.S. housing market after the subprime mortgage crisis (Bernanke, 2012; Furlong, 2016; Eyigungor, 2016).

Cultural differences provide additional nuances to the contrasting views about homeownership and family formation (Mulder, 2006). The extent to which people synchronise homeownership with marriage or first parenthood differs between countries and changes at different rates. Research suggests that couples in Britain postpone marriage or parenthood due to the unaffordability of housing (Murphy & Sullivan, 1985; Forrest et al., 1999), yet scholars studying West Germany and the Netherlands do not find any such accommodation to similar market adjsutments (Mulder & Wagner, 1993).

Mulder develops a theoretical argument that when the "necessity to be a homeowner before marriage" is strong in a society, people expect to become homeowners before having children. Furthermore, couples who feel obliged to buy a home may devote a significant amount of resources to homeownership, resources that might otherwise contribute to the cost of rearing children. Consistent with Mulder's argument, Lin et al.

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(2016) show that comparing with renters, homeowners in Taiwan have their first child at an older age, and families living with their parents or siblings become parents at a younger age.

A similar ideology around family and homeownership is prevalent in Asian societies (Ronald, 2006). In China, housing has traditionally been considered a prerequisite for marriage, with some individuals considering that the value of a house determines the attractiveness of a young man as a spouse (Wei & Zhang, 2011). Numerous media reports document how potential mothers-in-law oppose their daughter's marriage to a man without a house. This so-called "mother-in-law effect" puts pressure on couples to buy a house before marriage (Li, 2014). The existence of such a culture seems more likely in countries where homeownership is historically widespread (Mulder & Wagner, 2001).

The primary objective of this study, therefore, is to explore the causal relationship between marriage-induced homeownership and housing prices. A central challenge is the two-way causality between housing prices and household formation. High housing prices will tend to reduce household formation. This, in turn, will slow housing price growth. To disentangle this simultaneous causation requires a clean identification strategy, which is a novel contribution of this study. Distinctively from many related studies on the relationship between marital status and house-price changes that rely on cross-sectional data at the household level (Green & Hendershott, 1996; Farnham, 2011; Clark, 1994), we compare quarterly time series data on marriage with a quality-adjusted housing price index. This enables us to gauge the impact of marriage-induced homeownership on housing prices by taking into account macroeconomic factors. Our time-series estimation is an easy-to-replicate framework that can incorporate housing and financial data such as total housing supply, total population, and mortgage rates to control for exogenous shocks that may concurrently affect housing prices (DiPasquale & Wheaton, 1992).

Our empirical strategy begins with the linkage between never-married and ever-married[1] individuals. We use cohort analysis to empirically demonstrate how many of the never-married population eventually get married. In our cohort analysis more never-married individuals thereby trigger more marriages, implying a stable rate of marriage. Once

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[1] Ever-married individuals refers to those who are or have been married previously.

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potential couples are married, our cohort analysis shows they are prone to become owner-occupiers. Consistent with the proposition of Mulder & Wagner (2001), we call this transition from never-married renters to ever-married owner-occupiers *marriage-induced homeownership*. Given Hong Kong's relatively inelastic housing supply, the impact of marriage-induced demand on homeowership should be noticeable there.

While the focus of this study is on marriage-induced homeownership, we do not disregard other determinants of price movements such as housing supply, housing finance terms, and increasing incomes. Rather, our study supplements existing research with the demographic dimension of the housing market.

Our central finding is that holding other things being equal, every additional one thousand marriage-ready individuals in the city leads to a seven percent increase in housing prices. This serves as a reminder to policymakers that demographic changes are one of the critical factors contributing to housing market booms. The findings invite reflection on the goals of housing policy and planning, which are often framed by governments as providing sufficient housing to accommodate population growth. Because of this, the implications of this study are pertinent to other major cities (Cox, 2015) where governments face a similar situation of prolonged housing price growth.

The case of Hong Kong is useful for a number of reasons. Hong Kong's colonial history means that it has a unqiue rule of law as a Special Administrative Region of China. Importantly, there are immigration restrictions between the city and mainland China, so it has a relatively self-contained housing market. In addition, for economic and cultural reasons, fewer people in Hong Kong migrate to nearby Chinese cities. This contrasts with most metropolitan areas in the world, which are embedded in systems of cities. The net migration rate in Hong Kong has been stable, below two percent, over the past two decades (World Bank, 2012). This feature serves as a control for the potential impacts of immigration on new household formation. In addition, the belief in Hong Kong that owning a home is a prerequisite for marriage remains prevalent (Ting & Chiu, 2002). As Ting & Chiu argue (2002), leaving the parental home continues to be associated with marriage and with practical considerations such as housing, childcare needs, and the availability of elderly care. Hong Kong is also a good case because of its relatively inelastic supply of housing. The low supply elasticity means that changes on the demand

side – due to demographic factors such as marriage-induced homeownership – will feed more noticeably into changes in house prices[2].

The study contributes to the housing studies literature in two ways. First, our cohort analysis establishes the connection between never-married individuals and potential marriage. We show that more never-married individuals will lead to more marriage at the underlying marriage rate.[3] By further examining how married individuals shift from renting into owner-occupation across cohorts, we posit that more never-married individuals in a city will increase demand for homeownership and push up housing prices. To further contextualise the potential for marriage-induced homeownership, we use Brueckner's tenure choice model (1986, 2011).

Our paper will be structured as follows. In Secton 2, following, we will review the related literature on the role of homeownership in the context of marriage in the ensuing section. In Section 3 we will give the background of Hong Kong marriage trends and its housing market and justify the use of Hong Kong as an important case study. In Section 4 we will discuss the use of cohort analysis and instrumental variablean instrumental variable strategy to test our hypothesis that more unmarried individuals at the prime age for marriage increases housing prices. In Secton 5 we will present our data and empirical results. Finally, in the Conclusion, we will discuss the policy implications of highlighting the role of marriage in the demand for homeownership and its impact on housing prices.

## 2.    Literature review

Tenure change, especially the purchase of a home, is a major milestone in the lifecycle (Clark et al., 1994). Not only is it considered one of the key markers of adulthood (Brownstein, 2015), but it is also the largest purchase most households make. The impact of the housing market on family decisions is better understood than the reverse

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[2] For more details on the Hong Kong housing market see Monkkonen et al. (2012)

[3] The Hong Kong Census and Statistics Department (2016), retrieved from https://www.censtatd.gov.hk/hkstat/sub/sp160.jsp?productCode=FA100055 Table 4, also shows that the crude marriage rate is stable, which supports our arguments that most never-married individuals, but not all, will eventually become married couples.

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relationship. For example, scholars of demography and housing show how the relative costs of ownership versus renting, among other socio-economic factors, shape the opportunity costs of childrearing (Yen et al., 1989) and the timing of young adults to live independently (Goldscheider & Goldscheider, 1998; Murphy & Wang, 1998). Scholars have also studied the relationship between housing prices and fertility rates. For example, Yi and Zhang (2010) find that high housing prices have a significant negative impact on the fertility rate in Hong Kong.

The question of how the individual life cycle affects housing prices, however, is less well studied. In a special issue of *Housing Studies*, Mulder & Lauster (2010, p.433) state that "the function of housing is first and foremost to provide homes to families...surprisingly, only rarely do housing researchers explicitly address the connections between housing and family." That journal volume addressed three issues: the influence of the family of origin on housing characteristics and housing situations; the links between household events and housing events at the *micro* level of households; and homeownership as a context for parenthood at the *macro* level of countries.

To understand the role of homeownership in the context of marriage, we examined both the macro- and micro- factors influencing young couples' housing and marriage decisions using a life-cycle consumption model (Artle & Varaiya, 1978). Our review of the literature suggests that credit accessibility is the crucial macroeconomic factor shaping the demand for homeownership, whereas, at the household level, family decisions around marriage, divorce and childbearing drive demand for homeownership. While economists underscore the investment nature of homeownership, demographers emphasize the role of tenure change in household formation. The tenure change of marriage-ready adults encompasses both the spatial and the temporal dimensions of housing markets (Clark et al., 1994).

At the macro-level, financial constraints have a considerable impact on housing tenure changes. Notably, young people have to overcome imposed credit constraints to secure a mortgage, wealth constraints to save for a down-payment, and income constraints to meet the debt-to-income ratio limit (Barakova et al., 2003). The effect of housing wealth on household consumption will be limited when there are resale and refinancing constraints that prevent housing assets from being cashed out (Wong et al., 2018). Meanwhile, increasing housing prices may discourage young people from saving for a home and result

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in the overconsumption of non-housing goods. Scholars documented this phenomenon during the Japanese housing bubble (Yoshikawa & Ohtaka, 1989). Furthermore, at times of high unemployment and overall recession, young adults, rather than forming independent households, are more likely to live with their parents (Lee & Painter, 2013).

Stringent mortgage conditions also dampen young adults' incentive and ability to buy a house. A high down payment requirement will disproportionately impact young adults, who need a longer time to accumulate sufficient funds. Evidence from 14 OECD countries shows that homeownership rates for young cohorts are negatively correlated with down-payment requirements (Chiuri & Jappelli, 2003). This helps explain why even in the current prevailing low-interest environment in many countries, many young adults are still unable to afford to buy a home.

At the micro-level, scholars consider the move from renting to owning a house as a marker of adulthood. This major housing decision is associated with family events such as marriage, divorce, and childbearing (Mulder & Lauster, 2010; Rindfuss & Brauner-Otto, 2008). Clark and collaborators (1994) argue that there are two key moments in the family life course that are typical for becoming a homeowner: at marriage or during pregnancy. Also, Drew (2015) attributes the recent decline in homeownership among young adults in the United States to delays in marriage and to human capital-building activities, such as education and career development. Other scholars in the US estimate that the lower rate of marriage has contributed almost half of the drop in the homeownership rate (Fisher & Gervais, 2011).

Many first-time homeowners, therefore, are new families (Flowerdew & Al-Hamad, 2004; Holland, 2012). This reflects the preference of couples for having a more stable home environment, perhaps as an indication of their commitment to a long-term relationship (Grinstein-Weiss et al., 2011). Additionally, homeownership among young adults is dependent on the timing of parenthood after marriage. Clark et al. (1994) found that within two years of having children almost 40% of individuals had changed from being renters to being homeowners; and within three years 60% had. In a similar study, they identified family household formation in the United States as a key factor for homeownership (Clark, Deurloo, & Dieleman, 1994). Other studies point out that owning a home could reduce the propensity of divorce among young couples as their joint

investment creates a greater financial commitment to the marriage (Hendershott et al., 2009; Holland, 2012; Lauster, 2008).

## 3.    Marriage trends and Hong Kong's housing market

The linked exchange rate system between the United States and Hong Kong means that the low-interest rates and quantitative easing in the United States created a high level of liquidity in Hong Kong. This was the primary fuel of the housing price boom from the mid-1990s to the present, but especially since 2003 (Wong, 2015). Starting in 2009, the Hong Kong Government has introduced several measures to curb property speculation - notably from non-residents - as well as to prioritise the housing needs of local homebuyers (HKSAR, 2010). Nonetheless, housing prices rebounded quickly after the Global Financial Crisis, and rose by more than 50% between 2015 and 2018 (Hong Kong Rating and Valuation Department, 2018). For most people in Hong Kong, home purchase remains out of reach (Cox, 2018).

The anti-speculation measures included upward adjustments of the tax on both initial and short-term resales of residential property purchases as well as tighter mortgage lending[4]. To minimise the recurrence of negative mortgages and systemic risk, mortgage restrictions include a 40% down-payment requirement, stress tests, and maximum debt servicing requirements.

The Hong Kong Government also attempted to manage homeownership demand through various special stamp duties[5]. The resale market has, therefore, become subdued. This means that prospective buyers, especially young marriage-ready couples, have been nearly shut out of the market. Many young adults – especially among the so-called 'sandwich class', a common term for the lower middle class (Wah, 2000; Lam, 2006) – find it increasingly difficult to obtain financing. The Hong Kong Monetary Authority's continuous reduction of loan-to-value (LTV) ratio caps on home mortgages is particularly

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[4] For succinct summary of those measures, see the graphical illustration retrieved from http://www.colliers.com/en-gb/hongkong/about/media/2015-03-02-hk-property-market

[5] For details of various stamp duty, see Chapter 4 of the 2017 Hong Kong Economic Reports; Footnote (3) https://www.hkeconomy.gov.hk/en/pdf/er_17q4_ch4.pdf

unfavourable for young potential homebuyers with less ability to secure a sufficient down payment (HKMA, 2017)[6].

The sandwich class are sandwiched by their inability to purchase housing on the private market and being ineligible for public housing. Hong Kong has a large public housing system. Roughly one-third of the city lives in public rental housing and another fifth in subsidised ownership housing (Ronald & Doling, 2010; Yip, 2014). Thus, most of the recent government measures directed at homeownership have hit this group hard even though they are not the intended target.

Figure 1 compares the number of marriages (excluding non-local marriages) to the number of property transactions in Hong Kong. We note a substantial divergence between the two trends. One might argue that if marriage is indeed a driver of housing boom, the two variables in Figure 1 should be moving in tandem. This is not necessarily the case. In fact, new marriages may be delayed by high housing prices and stringent mortgage requirements, and these newly married couples can only save in the hope of buying at a later date. Pent-up demand for homeownership is cumulative until a certain age. Potential reverse causality between potential marriage and house prices motivates our use of instrumental variable estimation to identify the actual marriage-induced demand for homeownership.

**[Figure 1 here]**

Meanwhile, alternative living arrangements such as cohabitation and single-person households are also on the rise. In fact, the average individual leaves their parent's home in Hong Kong at a much older age than in most countries in the world (Li, 2014; Monkkonen, 2015). Scholars in other countries have cautioned that the potential mismatch between retiring baby boomers who wish to downsize their housing and young people who might not yet be ready to purchase those houses could result in another housing crisis (e.g., Myers & Ryu, 2008; Pendall et al., 2012). Others (Green & Hendershott, 1996; Green & Lee, 2016) have refuted this prediction, arguing that how

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[6] Loan-to-Value Ratio (LTV) caps and Debt Servicing Ratio (DSR) limits for property mortgage loans with effect on 19 May 2017 (2016). Retrieved from Hong Kong Monetary Authority, Web site: https://www.hkma.gov.hk/media/eng/doc/other-information/FAQ_J1_Table_Eng.pdf

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the demand for homeownership (in particular for families) relates to housing prices remains an under-researched question.

## 4.   Research methods

Family formation and homeownership are intertwined. Mulder & Wagner (1998, 2001) used life course surveys conducted in West Germany and the Netherlands in the 1980s and 1990s to investigate the interconnections between first marriage and first-time homeownership. They considered this temporal connection by conducting a survival analysis of the transition from marriage to homeownership. They found that the transition to first-time homeownership follows the family life cycle, though it also reflects the household's socio-economic status and housing market conditions.

In this study, we use a smiliar model in a cohort analysis to assess the rate at which the never-married population eventually gets married. We then assess how prone they are, once married,  to transitioning from renting to owner-occupation. This transition is the focus of our later reduced form model that estimates the impact of a larger never-married population on housing. To identify how an increase in unmarried population (aged between 25 and 34) generates marriage-induced demand for homeownership and leads to a rise in housing prices we used an instrumental variable approach.

### 4.1.   Cohort analysis

The data for our cohort analysis come from the Population Census conducted by the Census and Statistics Department of Hong Kong[7]. Specifically, we used the number of people in domestic households by age group, by marital status, and by housing tenure, over the six waves of the census years 1991, 1996, 2001, 2006, 2011 and 2016. Given the records for date of birth, the census data tracks the same age group (i.e., a cohort), their marital status, and the tenure of their housing.

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[7] Census and Statistics Department of Hong Kong (2018), data request reference: (L/M (26) in CENST/SCDEMO2/8-35/16-71/3)

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**[Figure 2 here]**

The cohort chart in Figure 2 shows that most never-married individuals will eventually become married couples. Each line represents a cohort (i.e., the population born in 1966/70, 1971/75, 1976/80, 1981/75, and 1986/90). The biggest change is between 25 and 30 years old. In some cohorts, nearly 40% of the group got married during those years. The decline in marriage rates in more recent cohorts is also evident, as well as the delay in marriage.

**[Table 1 here]**

Table 1 reports the percentage of couples owning a house and the transition to marital status. These couples become the homeowners around the time they are getting married. Evidently, a large proportion of married couples become owner-occupiers. Across the five cohorts within our purview, 55.6% of the population gets married and becomes a homeowner at their age of 25-29, 56.5% at age 30-34 and 50.5% at age 35-40. In the various cohorts over age 40, the proportion of marrying couples who become homeowners drops dramatically. This sudden drop is partly due to the fact that we cannot currently observe those born after 1981 becoming 40 as well as because those who marry late are simply less likely to become homeowners. Moreover, as the last column of Table 1 demonstrates, married couples across cohorts are more likely to be homeowners (54.2%) than are non-married couples (46.5%). It presents credible evidence that once potential couples are married, they are prone to become owner-occupiers. The cohort analysis here provides solid evidence in favor of using never-married individuals as a proxy for marriage-ready individuals because most will eventually get married. Further, we see that a significant and larger proportion of the married population than of those who remain unmarried will become owner-occupiers.

Before our empirical estimation, we articulate a theoretical framework connecting married couples to homeownership. To contextualise the benefits of homeownership for married couples and explain why married couples tend to become owner-occupiers, we rely on the housing tenure choice model developed by Brueckner (1986, 2011). The model postulates that if an individual's rental payment exceeds his or her mortgage instalment *plus* interest on a loan, an individual will buy provided s/he has accumulated sufficient savings for a down payment. The model also implies that when young people

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are under financial constraints, their subjective discount factor is high, and their wages and assets low, renting will be optimal for them.

Brueckner's (1986, 2011) theoretical framework provides us with a useful and straightforward exposition to identify determinants of young adults' housing decisions. One implication of this framework is that there is a cut-off owner-occupier's income tax rate ( $\hat{\tau}$ ) dividing renters from owners. More specifically, those individuals within an income tax bracket below $\hat{\tau}$ will be renters, while others with an income tax rate above $\hat{\tau}$ will be owners. Furthermore, the fact that the owner-occupier income tax rate $\tau$ tends to increase with income implies that low-income households are much more likely to be renters than high-income households.

We illustrate marriage-induced homeownership by using this housing tenure choice model. First, when people get married, they enjoy the standard benefits associated with homeownership (Dietz & Haurin, 2003). In the context of our housing tenure choice model, the desire for homeownership would appear as a negative cost (i.e., a homeowner's benefit), which would lead to a downward shift in the owner-occupier's user cost curve. This change would then reduce the cut-off tax rate, leading to an increase in the homeownership rate.

This notion of marriage-induced homeownership can be tested with a less trivial implication that, *ceteris paribus,* more potential "marriage-ready" individuals (in this case proxied by those who were born between the 1980s and the early 2000s but are never-married), will lead to higher demand for homeownership when they get married. This marriage-induced demand for homeownership will increase housing prices.

Our model so far considers only a comparison between the annualised costs of owning versus renting a house: it does not acknowledge the down-payment hurdle to homeownership. However, the introduction of the constraint should not alter the conclusion.[8] Since "marriage-ready" individuals are also perceived to be "owner-ready"

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[8] For a more formal analysis of the tenure-choice model with a down-payment scenario; see Brueckner (1986) and Artle & Varaiya (1978). Simply put, individuals with income-tax rates below the cut-off point $\hat{\tau}$ remain as renters. For those with tax rates above $\hat{\tau}$, it will depend on his/her patience (i.e., discount rate). Only the patient individuals (i.e., with a high discount rate) among this high tax group will be able to accumulate the required down-payment, while the impatient ones (those with a lower discount rate)

and will be more patient (i.e., with a higher discount rate) to save the down-payment for attaining the benefits associated with homeownership. The down-payment consideration further reinforces the idea that a greater stock of unmarried individuals will lead to more potential marriage and will increase the demand for ownership.

## 4.2. Instrumental variables models

To identify how the increase in a marriage-aged but unmarried population (aged between 25 and 34) would generate marriage-induced demand for homeownership, we specify the relationship in the reduced-form model as follows:

$$HP_t = \beta_0 + \sum_s \beta_{1,s} NM_{t,s} + \mathbf{X}'\boldsymbol{\beta} + e_{t,a} \tag{1}$$

*where* $HP_t$ represents housing prices at time *t,* and $NM_{t,s}$ the never-married population at time *t*. *s* is the upper bound of an age range, starting from 18 which is the legal age to get married, to age *s* which can be any number below 60, in Hong Kong. *α* and *βs* are coefficients to be estimated. $\mathbf{X}$ is a set of covariate controls including housing stock (Hsestock), mortgage rate (Mortage) and time trend effect (year), and *e* is the error term. It is noteworthy that the linear time trend (i.e., the variable *year* in Table 3) that consists of a sequence of year series {1, 2, 3, …} is added to essentially de-trend the model for ensuring that the time series is stationary in the setup[9].

Next, the total population of an age group ($POP_{t,a}$) is defined as the sum of married ($M_{t,a}$) and never-married people ($NM_{t,a}$) with age *a* at time *t* [10], that is,

$$POP_{t,a} \equiv M_{t,a} + NM_{t,a} \tag{2}$$

will not be able to do that, and will remain as renters, notwithstanding the advantage of homeownership based on annualized cost considerations.

[9] See Wooldridge (2012) for a discussion of the use of time trends (instead of time dummies) in the time series analysis.

[10] For simplicity, we ignore divorce and widowhood and a-18 refers to the legal age of marriage in Hong Kong.

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where $POP_{t,a}$ is the population with age $a$ at time $t$, and $M_{t,a}$ is the married population with the same age at time $t$. Hence, by definition, the never-married population is the difference between the total population ($POP_{t,a}$) and the married population ($\Delta M_{t-i,a-i}$) in the previous years, that is:

$$NM_{t,a} = POP_{t,a} - \sum_{i=0}^{a-18} \Delta M_{t-i,a-i} \tag{3}$$

We also note that the change in marriage rate is dependent upon housing prices, as higher housing prices are likely to dampen the home buying demand before marriage, i.e., $\Delta M_{t-i,a-i} = \alpha_0 + \alpha_1 HP_t + u_{t,a-i}$

$$NM_{t,a} = POP_{t,a} - \sum_{i=0}^{a-18} \alpha_0 + \alpha_1 HP_t + u_{t,a-i} \tag{4}$$

Manifestly, $HP_t$ is part of $NM_{t,a}$, which causes **simultaneity bias** in the estimation of equation (4) with OLS estimations.

To identify equation (4), a natural method is to use $POP_{t,a}$ as the instrument for $NM_{t,a}$, *after controlling the total population and macroeconomic trends*. Housing prices at period $t$ ($HP_t$) will not have any impact on the number of people aged between 25 and 34 at time $t$ because that number depends only on the birth rates and population size several decades earlier[11]. The use of a particular cohort (aged 25-34) as our instrumental variable allows us to exploit the demographic variation that has been predetermined 30 years earlier to identify the causal relationship between never-married population and house prices. This demographic variation influences housing prices only through the endogenous independent variable, given that we are controlling for total population (see Angrist & Krueger (2001) for more).

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[11] Suicide is assumed to be independent of housing prices.

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One consideration that we cannot completely exclude is the role of immigration by young people. However, we consider that the impact is minimal. The 2016 By-Census[12] (HKCSD, 2016, p.13) reports that only 4% of the young population (aged 25-34) are immigrants. Among these 4% immigrants, only one-fifth of them are never-married, as compared to 30% of permanent residents in Hong Kong. As our analysis focuses on the unmarried population, the impact of young immigrants should have a minimal impact on the results. Even if the migration effect matters, it will affect housing prices primarily through the channel of marriage[13].

Likewise, the population with age $a$ at time $t$ ($POP_{t,a}$) should not affect the housing prices ($HP_{t,a}$) after the total population and macroeconomic factors are controlled for (Harris, 1989). This identification strategy hinges on the exogenous change in the population affecting the never-married populations of different cohorts. Different cohorts may have different preferences for home buying, implying that the total population of a particular age can still directly affect housing prices. To address this concern, we further study the unmarried population of the different cohorts by specifying Equation (4) with a different value of $a$ for the age group's never-married population. We expect that the never-married population aged 25 to 34 will have the most significant effect on housing prices. Figure 4 is a schematic presentation of our instrumental variables approach.

**[Figure 3 here]**

## 5.   Data and empirical results

To test the hypothesis that more unmarried individuals will cause greater demand for homeownership, we used the quarterly marriage figures from the General Household

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[12] Hong Kong census and statistics department (HKCSD). (2016). Thematic Report—Persons from the Mainland Having Resided in Hong Kong for Less Than 7 Years. Retrieved from: https://www.bycensus2016.gov.hk/data/16bc-pmrs.pdf

[13] One potential concern is selection issues arising from never-married individuals aged 35-44, and the idea that some members of this group do not get married due to their low-income status. However, census statistics shows that the never-married population aged 35-44 has a median monthly income of HK\$16,000, which is 3% higher than the median monthly income of the overall married population in Hong Kong. Data request ref at Hong Kong Census Department is L/M (26) in CENST/SCDEMO2/8-35/16-71/3

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Survey (GHS) of the Census and Statistics Department (C&SD) in Hong Kong. This randomised sample survey covers about 99% of Hong Kong's resident population and provides a detailed demographic breakdown of that population. The data used in the current study cover 21 years, from the first quarter of 1995 to the fourth quarter of 2015. We compare these data with the housing price index compiled by the Rating and Valuation Department (R&VD) of Hong Kong. The R&VD's housing price index measures quality-adjusted housing price changes. It is based on a price factor divided by the rateable values of subject properties to account for not only the properties' floor area but also other quality differences. As the rateable value is legally binding, with considerable implications for the government rates [14], the quality-adjusted housing price index should accurately reflect housing price trends. Table 2 reports summary statistics.

**[Table 2 here]**

Figure 4(a) shows the relationship between Hong Kong's marriage trends and housing price movements. There is a strong positive correlation between changes in housing price index (HPI) and the number of never-married population aged 25-34. Other than the recession quarters (i.e., dots coloured in red) during the global financial crisis caused a slight interruption, the positive correlation is persistent.

**[Figure 4(a) and 4(b) here]**

We further subdivide the data in Figure 4(b) into two periods: before and after the global financial crisis of 2007. Doing this shows that the correlation increased after the crisis. This may have resulted from the strong rebound in housing prices in the wake of the crisis together with more stringent mortgage lending policies. Meanwhile, the build-up of the never-married population magnifies the impact of marriage-induced demand on prices.

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[14] Rates are a tax on property charged in accordance with the Rating Ordinance (Cap. 116) under the leasehold land system in Hong Kong. Properties in Hong Kong are charged 3% of their estimated annual open market rental value. The owner (i.e. the lessee of the leasehold land) is liable for government rent. If the person who pays government rent is not the owner, the government rent paid is a debt due to the person by the owner, unless there is an express agreement requiring otherwise.

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The proportion of the never-married population of Hong Kong increased between 1996 and 2015. In 2015, 33% of males and 38% of females (excluding foreign domestic helpers) had never been married. The median marriage age for men and women respectively increased from 31 and 28 in 2001 to 33 and 30 in 2014. The median age at first marriage for men has held stable since 2005 at 33, whereas for women it has continued to increase. While men continued to get married at older ages than women did, the gap narrowed from about three years in 1991 to about two years in 2013.

Table 3 presents both the ordinary least square (OLS) and instrumental variable (IV) estimates across different age groups of the never-married population, ranging from 25-34, 35-44, and 45 or the above. Columns (1) to (3) are the OLS results, and (4) to (6) are the instrumented estimates taking into account the endogeneity[15]. Year-fixed effects and quarterly dummies are both included in the equation as controls. All other control variables in our instrumented model, e.g. housing stock and mortgage rate, have the expected signs or are not significant. More housing stock has a negative impact on housing prices, whereas a higher mortgage rate slows price growth. We used a set of dummy variables for the timing of the global financial crisis (GFC) to control for outlier years, though the results without them did not change substantially.

**[Table 3 here]**

The significant positive coefficient of 6.97 for the never-married population aged 25-34 in column (5) means we cannot reject the hypothesis that, *ceteris paribus,* more unmarried individuals impacts housing prices. 1,000 more unmarried individuals lead to a 7% increase in the housing price index. As mentioned earlier, however, one might argue that the demand for homeownership is preference-specific, not necessarily marriage-induced.

To assess this concern, we applied the instrumented estimation for different age groups *a* to equation (4) and tested whether the size of the never-married population aged 35-44 and aged 45 or above had a different impact on housing prices. Interestingly, column (5) demonstrates that the never-married population aged 35-44 actually has a negative effect

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[15] First stage results are enclosed in the Appendix.

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on housing prices (with a coefficient of -2.8). We assume this is attributable to individuals in this age group preferring not to purchase homes: it further reinforces the idea that young unmarried individuals are the force behind marriage-induced demand for homeownership and the upward pressure on housing prices.

Meanwhile, the size of the never-married population aged 45+ has an insignificant, positive coefficient (of 9.63). This is reasonable because people in this older group are more likely to be settled in their living arrangements.

## 6.    Conclusions and policy implications

Since the 2000s, housing prices in cities across the world have increased dramatically. With notable exceptions, the field of housing studies has tended to focus on the financial sector and housing supply at the expense of studying demographic changes, such as the link between households' composition and age structure, cohort effects, and marriage-induced homeownership demand. This paper shows that demographic changes – specifically household formation – also impact housing prices. Our approach also extends a classic tenure choice model to marriage. Using data on demographic shifts from 1995Q1 to 2015Q4 together with a quality-adjusted housing prices index, our instrumented estimate suggests that every increase of 1,000 never-married individuals causes a seven per cent increase in housing prices.

Given that marriage-induced demand for homeownership may be an overlooked driver of house prices, we suggest that specific programs for marriage-and-home-ready young adults are a growing public-policy issue. Not only would these address asset-based welfare (McKee, 2012) and social justice considerations (Forrest, 2013), but they might also be a pragmatic means to cool off an overheated housing market. Indeed, to assist the marriage-and-home-ready young adults without invigorating the housing market, the Hong Kong government should consider expanding the Home Ownership Scheme (HOS) program targeting first-time married couples. The HOS program, a supply-side public housing program, houses roughly one-fifth of the city's population at present. The increase in publicly-built housing targeted to absorb marriage-induced demand for homeownership may also be conducive to reining in the overheated housing market.

More generally, this study is part of a literature that provides a more nuanced understanding of the dynamics of demographics and housing markets. By illustrating the role of marriage in the demand for homeownership and thus housing prices, we can improve the quality of projections of housing need. These projections and their role in public policy should always be considered within the broad parameters of national and international trends (Monkkonen, 2013), as well as those of cultural changes and subjective implicit choices about ideal household structures.

Although our study presents an important step in advancing the scholarly understanding of the relationship between marriage and housing prices, it has some limitations and would benefit from extension in future research. The main strength of our study is our time-series approach, which can be easily replicated for comparative studies across countries. However, a trade-off between parsimony and replicability on the one hand, is the lack of detail in our examination of the triggers in young couples' pre-marriage home purchases. To understand these decision betters, micro-data such as the Panel Study of Family Dynamics (PSFD) surveys in Taiwan (Lin et al., 2016), would be more appropriate. The time series approach also prevents us from considering the possible interaction between public housing policies and demographic characteristics for pre-marriage home purchases at household level. Nonetheless, the findings and implications of the study are pertinent to smaller economies where governments face similar overheated market conditions and where migration is difficult for most residents.

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## Appendix

**Table A1: The first-stage regression of the instrumental variable (IV) regression**

| NM age group | 1st Stage regression | | |
| --- | --- | --- | --- |
| | (1)<br>[25-34] | (2)<br>[35-44] | (3)<br>[45+] |
| Total population [25-34] | 0.164* | 0.153*** | -0.0391 |
| | (2.53) | (3.58) | (-0.84) |
| Total population | -0.0619** | -0.0531 | -0.0153 |
| | (-3.17) | (-1.98) | (-0.96) |
| 2.quarter | 6.043 | 3.546 | 2.877 |
| | (1.96) | (1.27) | (1.27) |
| 3.quarter | 10.79** | 6.058* | 6.780* |
| | (3.40) | (2.03) | (2.55) |
| 4.quarter | 10.48** | 6.810* | 10.19** |
| | (3.15) | (2.10) | (3.03) |
| year | 10.18*** | 6.469* | 18.48*** |
| | (10.21) | (2.18) | (4.83) |
| Hsestock | 0.0662 | 0.0983* | -0.150*** |
| ('000) | (1.58) | (2.12) | (-5.23) |
| Mortgage | 3.538*** | -2.083* | -0.994 |
| (%) | (3.91) | (-2.46) | (-1.46) |
| GFC | -0.0619** | -1.479 | 1.277 |
| | (-3.17) | (-0.37) | (0.41) |
| Constants | 463.5*** | 59.06 | 475.1*** |
| | (3.48) | (0.44) | (5.01) |
| Obs. | 76 | 76 | 76 |
| Adj. R-Sq | 0.911 | 0.948 | 0.987 |
| F-stats / $\chi^2$-stats | 96.69 | 151.4 | 640.8 |

*Notes*: The dependent variable is the never-married population aged 25-34.

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**Table A2: Marriage-induced home demand on housing prices (For Class A flats), instrumented evidence**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| NM age group | [25-34] | [35-44] | [45+] | [25-34] | [35-44] | [45+] |
| Never-married | -0.245 | -2.356*** | 3.332*** | 8.188** | -2.688*** | 14.44 |
| population | (-0.68) | (-8.45) | (8.59) | (2.72) | (-4.13) | (1.12) |
| Total | 0.112* | 0.170*** | 0.199*** | 0.577* | 0.176*** | 0.442 |
| population | (2.34) | (3.82) | (4.46) | (2.54) | (4.06) | (1.39) |
| 2.quarter | 1.463 | 4.272 | -7.550 | -49.37 | 4.875 | -32.68 |
| | (0.14) | (0.62) | (-1.11) | (-1.68) | (0.75) | (-0.88) |
| 3.quarter | 0.194 | 4.380 | -20.82** | -89.62* | 5.336 | -82.20 |
| | (0.02) | (0.62) | (-2.85) | (-2.17) | (0.77) | (-1.10) |
| 4.quarter | -1.271 | 1.026 | -30.68*** | -82.32 | 1.680 | -120.9 |
| | (-0.12) | (0.14) | (-3.88) | (-1.96) | (0.24) | (-1.13) |
| year | 23.18*** | 12.05*** | -30.39*** | -63.97* | 10.84*** | -200.5 |
| | (4.50) | (4.89) | (-4.79) | (-2.12) | (3.41) | (-1.02) |
| Hsestock | -0.711*** | -0.181 | -0.261** | -0.730* | -0.106 | 1.240 |
| ('000) | (-6.30) | (-1.86) | (-2.89) | (-2.52) | (-0.65) | (0.71) |
| Mortgage | 3.420 | -3.829 | 5.159* | -29.79* | -4.713 | 14.17 |
| (%) | (1.03) | (-1.75) | (2.50) | (-2.20) | (-1.81) | (1.13) |
| GFC | -2.601 | -3.071 | -6.929 | 0.781 | -3.150 | -21.68 |
| | (-0.22) | (-0.31) | (-0.70) | (0.01) | (-0.34) | (-0.57) |
| Constants | -0.245 | -21.56 | -613.1* | -5169.6* | -132.0 | -5204.0 |
| | (-0.68) | (-0.10) | (-2.47) | (-2.38) | (-0.47) | (-0.97) |
| Obs. | 76 | 76 | 76 | 76 | 76 | 76 |
| Adj. R-Sq | 0.705 | 0.849 | 0.851 | - | - | - |
| F / $\chi^2$-stats | 15.23 | 47.88 | 48.61 | 28.25 | 395.1 | 65.31 |
| Instrumented? | No | No | No | Yes | Yes | Yes |

*Notes*: The dependent variable HPI is the quality-adjusted overall housing price index (Class A) compiled by the R&VD of Hong Kong. The *t-statistics* are shown in parentheses. NM age group refers to the never-married population with age indicated in square brackets, 25-34 represents the age group of 25 to 34, 35-44 refers to the age group of 35 to 44, and 45+ indicates the age 45 or above. The variable "year" is the linear time trend which is defined as a series {1, 2, 3, …}. Including time trend (i.e., years) is essentially a form of de-trending that ensures the time series is stationary in this setup (Wooldridge, 2012; Ch10). GFC refers to the time dummies for the global financial crisis. The household survey data covers the period between 1995Q1 and 2015Q4. *, **, and *** represent the significance levels at 5%; 1 % and 0.1% respectively.

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**Figure 1: Divergence between housing transaction and number of registered marriages**
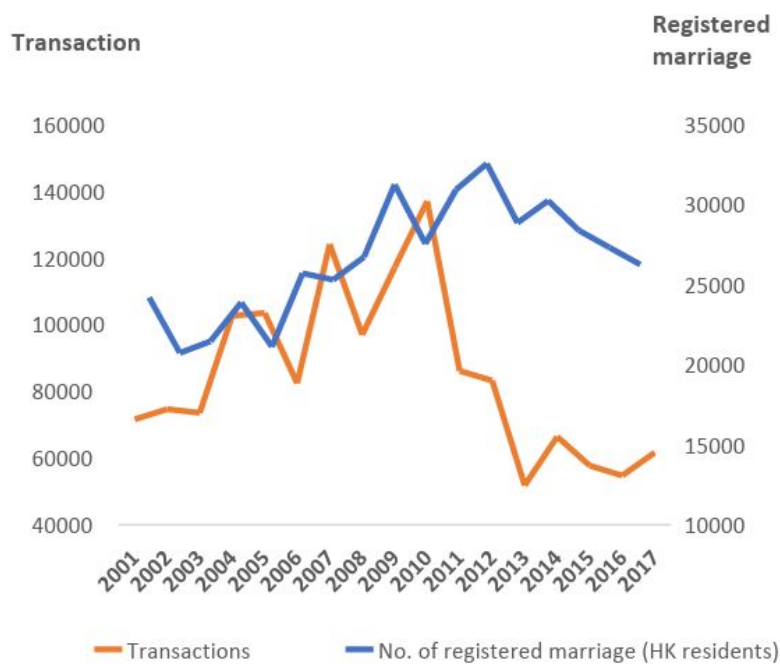


Sources: Census and Statistics Department, Rating and Valuation Department.

Notes: Hong Kong Monthly Digest of Statistics 2018, Table 6; Number of marriages registered in Hong Kong with both bridegrooms and brides being Hong Kong residents, registered marriage figure for 2017 is an estimate.

**Figure 2: Share of married population over age of various cohorts**
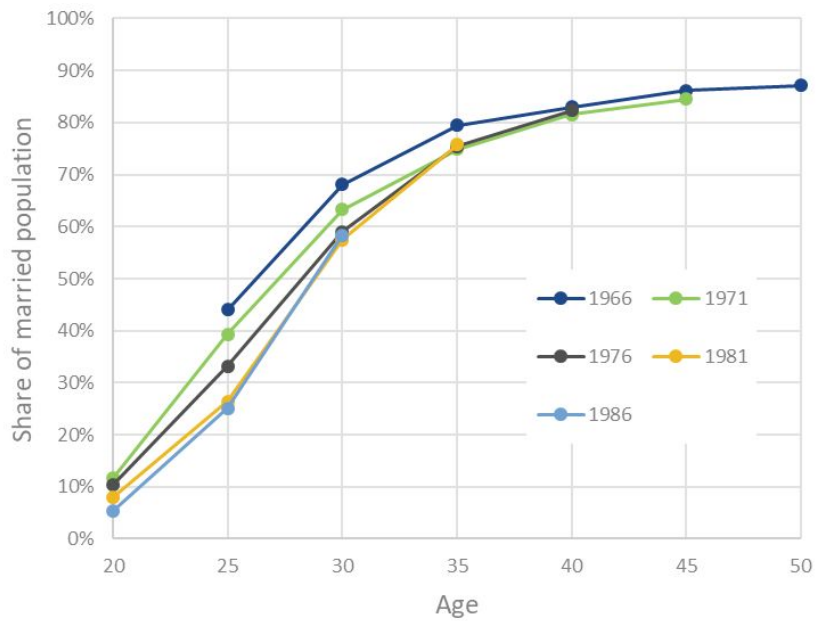


Source: Authors compiled based on Census data.
Note: Each line indicates the respective cohorts with the dates of birth of 1966-70, 1971-75, 1976-80, 1981-75, and 1986-90.

**Figure 3: Schematic presentation of the instrumental variables**
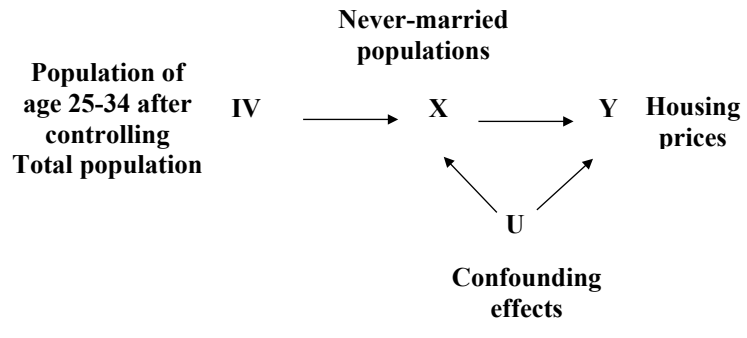
**Figure 4 (a): The change in housing prices versus the never-married population (excluding the financial crisis period)**
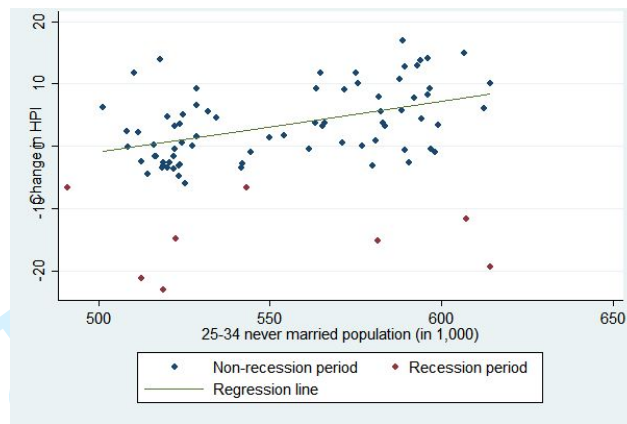


**Figure 4(b): The change in housing prices versus never-married population before and after the global financial crisis in 2007**

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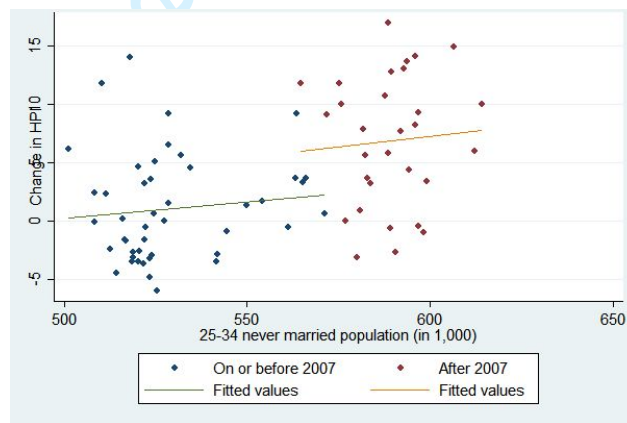
**Table 1: Percentage of couple owning a house as a result of the transition of marital status**

| Age | Date of birth (Cohort) | | | | | Average | |
|---|---|---|---|---|---|---|---|
| | 1966 | 1971 | 1976 | 1981 | 1986 | | |
| 25 | | 52.8% | 60.4% | 56.1% | 53.2% | 55.6% | |
| 30 | 55.3% | 68.1% | 56.9% | 55.4% | 47.1% | 56.5% | [45.1%]* |
| 35 | 78.3% | 42.2% | 43.4% | 38.0% | | 50.5% | [47.9%]* |
| 40 | 9.3% | 11.2% | 6.3% | | | | |
| Average | 47.6% | 43.6% | 41.8% | 49.8% | 50.1% | 54.2% | [46.5%] |

Source: Census and Statistics Department of Hong Kong (2018)
Notes: (*) The percentage shown in square bracket refers to the average non-married couples who are the homeowners.

**Table 2 Descriptive Statistics**

| Variables | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| HPI (overall) | 137.22 | 66.38 | 59.30 | 305.20 |
| Total population [25-34] | 993.37 | 57.73 | 940.90 | 1125.90 |
| Never-married population [25-34] | 551.83 | 34.67 | 491.10 | 614.30 |
| Total population [35-44] | 1161.56 | 97.81 | 1021.80 | 1304.80 |
| Never-married population [35-44] | 212.62 | 35.33 | 129.50 | 252.80 |
| Total population [45+] | 2555.03 | 500.55 | 1676.30 | 3361.20 |
| Never-married population [45+] | 151.44 | 66.04 | 58.60 | 278.90 |
| Total population | 5573.72 | 370.09 | 4650.40 | 6122.50 |
| year | 10.13 | 6.17 | 0.00 | 21.00 |
| Total Housing Stock | 2155783 | 178567 | 1796772 | 2381734 |
| Mortgage rate (%) | 4.94 | 3.05 | 2.19 | 11.04 |
| GFC | 0.09 | 0.29 | 0.00 | 1.00 |

*Notes*: HPI is the quality-adjusted housing price index compiled by the R&VD of Hong Kong. Population is in thousands. Age group of the population are indicated in square brackets, 25-34 represents the age group of 25 to 34, 35-44 refers to the age group of 35 to 44, and 45+ indicates the age 45 or above. The variable "year" is the linear time trend which is defined as a series {1, 2, 3, …}. Including time trend (i.e., years) is essentially a form of de-trending that ensures the time series is stationary in this setup (Wooldridge, 2012; Ch10). GFC refers to the time dummies for the global financial crisis. Class A flats refers to the unit with a saleable area less than 40 m$^2$.

**Table 3: Marriage-induced home demand on housing prices, instrumented evidence**

|  | OLS | | | IV | | |
|---|---|---|---|---|---|---|
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| NM age group | [25-34] | [35-44] | [45+] | [25-34] | [35-44] | [45+] |
| Never-married population | -0.171 | -2.004*** | 2.831*** | 6.968** | -2.729*** | 9.626 |
|  | (-0.54) | (-7.98) | (8.08) | (2.72) | (-4.43) | (1.17) |
| Total population | 0.118* | 0.165*** | 0.190*** | 0.512** | 0.178*** | 0.338 |
|  | (2.51) | (4.12) | (4.71) | (2.64) | (4.35) | (1.66) |
| 2.quarter | 0.788 | 3.402 | -6.646 | -42.24 | 4.722 | -22.01 |
|  | (0.09) | (0.55) | (-1.08) | (-1.70) | (0.76) | (-0.93) |
| 3.quarter | -1.249 | 2.708 | -18.71** | -77.27* | 4.800 | -56.25 |
|  | (-0.12) | (0.42) | (-2.84) | (-2.21) | (0.74) | (-1.18) |
| 4.quarter | -2.879 | -0.568 | -27.51*** | -71.49* | 0.864 | -82.69 |
|  | (-0.30) | (-0.09) | (-3.86) | (-2.00) | (0.13) | (-1.21) |
| year | 20.03*** | 10.95*** | -25.10*** | -53.75* | 8.307** | -129.2 |
|  | (4.45) | (4.94) | (-4.38) | (-2.09) | (2.76) | (-1.03) |
| Hsestock ('000) | -0.652*** | -0.201* | -0.269** | -0.668** | -0.0372 | 0.651 |
|  | (-6.43) | (-2.30) | (-3.30) | (-2.68) | (-0.24) | (0.58) |
| Mortgage (%) | 3.169 | -2.848 | 4.793* | -24.94* | -4.783 | 10.30 |
|  | (1.09) | (-1.45) | (2.57) | (-2.16) | (-1.94) | (1.29) |
| GFC | -3.624 | -4.038 | -7.316 | -0.761 | -4.213 | -16.34 |
|  | (-0.32) | (-0.45) | (-0.82) | (-0.02) | (-0.48) | (-0.68) |
| Constants | 771.5* | -20.43 | -522.5* | -4401.5* | -262.3 | -3330.3 |
|  | (2.48) | (-0.11) | (-2.33) | (-2.38) | (-0.98) | (-0.97) |
| Obs. | 76 | 76 | 76 | 76 | 76 | 76 |
| Adj. R-Sq | 0.705 | 0.849 | 0.851 | - | - | - |
| F-stats / $\chi^2$-stats | 15.23 | 47.88 | 48.61 | 28.25 | 395.1 | 65.31 |
| Instrumented? | No | No | No | Yes | Yes | Yes |

*Notes*: The dependent variable HPI is the quality-adjusted overall housing price index (all classes) compiled by the R&VD of Hong Kong. The *t-statistics* are shown in parentheses. NM age group refers to the never-married population with age indicated in square brackets, 25-34 represents the age group of 25 to 34, 35-44 refers to the age group of 35 to 44, and 45+ indicates the age 45 or above. The variable "year" is the linear time trend which is defined as a series {1,2,3,…}. Including time trend (i.e., years) is essentially a form of de-trending that ensures the time series is stationary in this setup (Wooldridge, 2012; Ch10). GFC refers to the time dummies for the global financial crisis. The quality-adjusted housing prices index for Class A flats (with a saleable area less than 40 $m^2$) is also used as the dependent variable as the robustness check for our model setup. The results remain intact as shown in the Appendix Table A2. The first-stage of IV regression is also enclosed in the Appendix Table A1. The household survey data covers the period between 1995Q1 and 2015Q4. *, **, and *** represent the significance levels at 5%; 1 % and 0.1% respectively.

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Responses to reviewers for Manuscript ID CHOS-2019-0006

Thank you for the constructive feedback, which was helpful in revising the manuscript. Please find our responses below.

**Responses to referee 3:**

|   |   | Comments | Responses |
|---|---|----------|-----------|
| 1 |   | The first comment concerns the validity of instrumental variable. A valid instrumental variable requires that (1) it is exogenous and (2) it is correlated with the explanatory variable. In the paper, the authors use population aged between 25 and 34 at time t as instrument for the endogenous independent variable. | Angrist and Krueger (1991, 2001) explain the exogeneity condition of using the date of birth as an IV. The size of a particular cohort, in this case people aged 25-34, is predetermined 30 years prior. If the size of this cohort influences housing prices, it has to be through the endogenous independent variable given that we control for the total population size. |
|   | • | The assumption of exclusion restriction is violated if the IV is endogenous: the population of aged 25-34 would be affected by factors including economic growth, income growth and employment rate. | • Agreed, which is why in our estimation we have used mortgage rates to control the macroeconomic factors, and added additional references and explanation in the text. |
|   | • | The low net migration rate specified in the introduction section could not completely exclude the possibility of high immigration of young population (aged 25-34) into the city, given that the net migration rate is the total difference between the number of immigrants (people coming into an area) and the number of emigrants, regardless of age group. | • Good point. Indeed, we do not completely exclude the possibility of high immigration rates of young people driving the results. However, we consider that the impact is minimal. First, as of 2016 By-Census, only 4% of the young population (aged 25-34) are immigrants (i.e. have resided in Hong Kong < 7 years). Second, only 21% of these 4% (0.8%) of immigrants are never married as compared to 30% permanent residents in Hong Kong. As our analysis focuses on the unmarried population, the impact of young immigrants should have a minimal impact on the results. |
|   | • | In addition, the IV could affect the dependent variable directly, not only via the channel of the endogenous explanatory variable. The way the authors explored (employing instrumented estimation for different age groups) is less convincing and would not be able to address this concern thoroughly. In particular, the authors claim that the negative relationship between housing price and never-married | • Thanks for pointing this out. We have checked with the Census Department that the monthly median income of the never-married population of aged 35-44 (HK$16,000) is 3% higher than that |

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| | | population aged 35-44 reinforces the idea that only young unmarried individuals create marriage-induced homeownership demand that pushes up property price. There could be selection issues by examining never-married individuals aged 35-44, given that one of the reasons of them being single could be due to their lower-income status, and hence the inability to own a house. | of the total married population (HK$15,500). This rules out the alternative explanation suggested by the referee that never-married individuals are single owing to their lower-income status. Although we are not able to verify whether the difference in income (HK$500) is statistically significant, it should be relatively unimportant in the context of an average housing price of HK$8 million. We have added a footnote to account for this fact.

*Data request ref: L/M (26) in CENST/SCDEMO2/8-35/16-71/3 |
| | 2 | The main assumption of this paper is that unmarried individuals will eventually be married given an underlying marriage rate, and so more "never-married" individuals would create a higher potential for marriage-induced housing demand.

          In the paper, the underlying marriage rate is based on the historical marriage rate obtained from the cohort analysis. Following the modernization and globalization trend as well as the rapid change in demographic and lifestyle, it is not sufficient to use historical marriage rate of older cohorts as the base to infer the expected marriage rate of younger cohorts.

          Furthermore, it is also inconclusive to claim that marriage induce demand for housing just by looking at the higher rate of homeowners in married couples (54.2%) relative to non-married couples (46.5%). It could be highly possible that homeownership is induced by the presence of children or childbearing plans upon marriage. In this case, the effect of interest is children-induced housing demand, rather than marriage-induced | First, we do not intend to predict the marriage rate of the younger cohort. Instead, we use the change in the demographics of older cohorts as the exogenous variation to project the marriage rate of the same cohort, given their demographics and marriage rate are observable.

Moreover, if the impact of globalisation on demographics really matters, the effect should be revealing in the past decades. Having said that, the crude marriage rate provided by HK Census over the years (Table 4) remains fairly stable; and we do not presume any dramatic changes without hard evidence.

It's not our goal to understand why people want to get married. Instead, we want to investigate the impact of marriage on housing prices.

While the need for young married couples to leave home and build their new "nest" is quite obvious, childbearing is less so, as many couples nowadays opt to not have children. Even the suggested reference (Lin et al., 2016; p.3544) points out that 'buying houses in the housing boom periods could have no |

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| | housing demand as claimed in the paper. | impact on families' fertility decisions". The direct linkage between fertility and housing prices may not be straightforward. Subject to editors and referees' view, we seek to maintain the focus on the concept of marriage-induced housing demand. | |
| | Besides, Table 1 also shows low homeownership rate in married couples aged 40. Alternative explanation to this is that these couples have already adopted the rental lifestyle, having been renters for a long period. Also, it could be possible that those marrying at an older age could be people with low-income, and hence their inability to sustain homeownership.

Having said that, the paper should provide a clearer description on Table 1. Does the rate indicate the homeownership rate among married couples, or the percentage of couples owning a house as a result of the transition of marital status? Do they become homeowner after they get married, or before? How did the authors account for couples with age differences? How did the authors account for cases when married couples decided to own a house years after marriage? | As previously mentioned, the statistics rendered from Hong Kong Census Department (Ref: L/M (26) in CENST/SCDEMO2/8-35/16-71/3) shows that the monthly median income for never-married population of aged 35-44 (HK\$16,000) is 3% higher than that of the total married population (HK\$15,500) in Hong Kong. It is therefore hard to argue that those marrying at an older age are people with low-incomes, and an inability to sustain homeownership.

Table 1 indicates the percentage of couples owning a house as a result of the transition of marital status. People become homeowners before or after 2.5 years of getting married due to the definition of our 5-year cohorts. Our analysis is based on individuals rather than couples; so the age differences of couples are not our concern. Married couples can always choose to own a house before or after marriage subject to their planning, and this question is somewhat beyond the scope of our study. | |
| 3 | The authors should perhaps restructure the sentences, or provide clear details and information on the following sentences: | Thanks for the reviewer's suggestion. We have revised the sentences accordingly. | |

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| • Page 3, line 45 "more and more young couples prefer never to marry…" | • We have referenced Xu et al. (2015) in regards to deferment of marriage and parenthood. |
| • Page 5, line 46 "Its status as a Special Administrative Region in China means the city has a relatively self-contained housing market, with fewer people migrate to nearby cities compared to many metropolitan areas." Similarly, Page 6, line 31 "Hong Kong is disconnected from a national system of cities…" More information on the institutional background could be provided so that readers could better understand the background of the story. | • We have revised the sentences to give more details regarding the implications of the British colonisation of Hong Kong. |
| • Page 6, line 12 "most Hong Kong people across birth cohorts will not let high housing prices discourage them…" | • Revised - read as "Homeownership remains a top aspiration for most Hong Kong people across birth cohorts…" |
| • Page 6, line 24 "net immigrants" should be changed to "net migration rate." | • Corrected. |
| • Page 7, line 41 "one of the most of important events…" | • Revised. |
| • Page 13, line 40 "We next examine the percentage of the population with their marital status changing from never-married to ever-married who transitions from…" | • Revised. Now it reads as "Individuals who get married and choose to be owner-occupiers across cohorts are presented in Table 1." |
| • Page 13, line 48 "We see a large proportion of married couples are opting to be owner-occupiers" | • Revised. |
| • Page 14, line32 "ever-married" is not explained in the paper. | • We have footnoted the explanation for "ever-married". |
| • Page 19, line 43 "The use of a particular cohort as our instrumental variable will also allow us to free from the migration effect…" | • We have revised this as per the comments in point 1. |

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| 4 | Other related literature, the authors may have omitted the following recent studies on demographic and housing prices:<br><br>• Lin, Pei-Syuan, Chang, Chin-Oh, Sing, Tien Foo, (2016) "Do Housing Options Affect Child Birth Decisions? Evidence from Taiwan" Urban Studies, Vol. 53(16) 3527–3546.<br><br>• Yen, E.C., Yen, G. and Liu, B. (1989) Cultural and family effects on fertility decisions in Taiwan R.O.C.: Traditional values and family structure are as relevant as income measures, American Journal of Economics and Sociology, 48(4), pp. 415-426.<br><br>• Yi, J. and Zhang, J. (2010) The effect of house price on fertility: evidence from Hong Kong, Economic Inquiry, 48(3), pp. 635-650. | Many thanks for the suggested literature.<br><br>They are useful in contextualising our study and we have added them into the manuscript as appropriate. |

**Responses to referee 1:**

| | Comments | Responses |
|---|---|---|
| 1 | Figure 1 shows that there is small or no relationship between housing transaction and number of registered marriages. If the conclusion that marriage is a driver of housing boom is true, shouldn't the two variables in Figure 1 be positively correlated? | Figure 1 indeed articulates the merit of an IV approach to teasing out the impact of marriage-induced housing demand from the reverse causality of Equation (1). It is always convenient to argue that high house prices could restrain the concurrent potential demand and create an illusion that marriage no longer matters. That motivates the use of IV to identify whether marriage-induced demand for homeownership exists. We elaborate this point further when we discuss Figure 1. |
| 2 | Since most people know they will eventually get married, they will buy houses no matter they get married or not. Does it mean it is actually not marriage that induce higher house price, it is the increase in total population/increase in demand vs limited housing supply in the Hong Kong market that push the price up. | Point taken. Total population is one possible factor that triggers housing demand. That's the reason why when we specify our Equation (1), it is essential to control for the total population. Our IV estimates reveal that potential marriages significantly affect house prices even with this control. We further elaborate on this point when we discuss the specification of Equation (1). |
| 3 | In line with comment 2, I need some explanation or proof to show the increase in house price is not caused by changes in macroeconomic conditions, influx of hot money, etc. | Point taken. In our reduced form of IV estimates, we have attempted to capture the macroeconomic conditions with the use of mortgage rate and a set of GFC dummies. We have added references to support the use of mortgage rate as a good proxy for taking into account macroeconomic conditions and influx of hot money, etc. |
| 4 | Figure 4 is directly from Brueckner (1986). It could be removed and be replaced with language explanation. | We have removed Figure 4 and provide only a written explanation. |
| 5 | Equation (3) is odd. i is from *0* to *18-a*. Does it mean age *a* cannot be over 18? | Thanks for pointing out the error. The superscript should be read as "a-18". The value "a" should not be over 18 as it represents the legal |

| | | age of marriage in Hong Kong. Footnote is added for clarifying the specification. |
|---|---|---|
| 6 | In the main model shown in equation (1), X is a set of controls including time trend effect. However, in Table 2 the time trend was illustrated as a variable year. It is very unusual to directly include a year variable in the model. The general solution would be including yearly dummies which can control yearly fixed effects. I expect the model result will be dramatically changed with adding of yearly dummies. | We have added clarification. The variable "year" is the linear time trend which is defined as a series {1, 2, 3, …}. Including a time trend (i.e., years) is essentially a form of de-trending that ensures the time series is stationary in this setup. To support our argument we have added the reference to Wooldridge (2012) Ch10.<br><br>It is noteworthy that it is time series analysis and not a cross-sectional analysis. Adding year dummies in a time series estimation is impossible. The year dummies approach is appropriate when one suspects that there are specific effects *to a year*, e.g. GFC, which we applied already. In our model, there is no specific year effect for marriage. Also, year dummies would eliminate the variation in marriage cohorts. |
| 7 | The dependent variable used in the main model is the quality-adjusted housing prices index for Class A flats. I would like to see some robustness checks of using different definition of house price index. | As footnoted, the dependent variable used in the main model is the quality-adjusted housing prices index. That is the **overall market index**, while the index of class A flats has been used as a robustness check. Results are similar and are attached for referee's reference.<br><br>We have provided the results with the use of Class A housing prices indices in our Appendix – Table A2. |
| 8 | Table 1 shows the percentage of marrying couple becoming a home owner. I am interested in seeing a similar table using total population instead of marrying people. If total population has the similar numbers, it means marriage is not related to the increase in housing demand. | Even if the total population is similar, it doesn't mean marriage is not related to an increase in housing demand. When we estimate Equation (1), the total population is included as a control. The IV estimates, after holding total population constant, still show that the never-married population affects house prices, which supports |

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| | | the marriage-induced homeownership demand argument. |
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| 9 | The paper needs a thorough editorial review. Some of the errors are listed here: a. "per cent" should be "percent" throughout the paper.<br><br>b. Page 18, line 48: "α and β…" should be "βs…"<br><br>c. Table 1 was typed as Table 2 in the table section. | Thanks - point taken.<br><br>a. In British English, percent is usually written as two words (per cent). Percent is not absent from other varieties of English, but most publications still prefer the two-word per cent. We will leave this to the discretion of the editors.<br><br>b. Corrected.<br><br>c. Corrected. |

**Responses to referee 2:**

| | Comments | Responses |
|---|---|---|
| | The manuscript suggests the effect of unmarried people on house prices in Hong Kong. The study is interesting. The Hong Kong case is appropriate. A cohort analysis in line with tenure choice method is meaningful. However, the manuscript needs major revisions before it can be accepted for publication in *Housing Studies*. | Thanks for your comments. Our revision based on the comments are tabulated as follows. |
| 1 | The manuscript argues that the primary objective is to examine the causal relation between unmarried people as defined in this research, and house prices, page 5, line 34. However, it seems that the manuscript has mostly examined the effect of unmarried people on house prices in Hong Kong. | The Hong Kong case is used to test the causal relationship between unmarried people and house prices. It has some unique features (migration restrictions especially) that conditions the generalizability of the findings. In the introdution we have added further discussion of why we use Hong Kong as our case. |
| 2 | Please definitely define the house price in Sections of Introduction, Data, Discussions. State the house price in Conclusion. Keep the | Point taken. We have added the definition of house price to the introduction. |

| | | |
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| | definition consistent throughout the text. | |
| 3 | I suggest that in the Introduction, the authors use a separate paragraph, placed in front of this section, to definitely and perfectly define 'marriage-induced homeownership demand'. The author's definition and description of this concept is a little fragmented throughout the text, which would seriously affect the reader's understanding of such concept. | Thanks for your suggestion.<br><br>We have modified the second paragraph to define marriage-induced homeownership demand. |
| 4 | Unreasonable. I recommend that the authors use the following sections: Introduction, Literature review, Methods, Data, Empirical results, Discussion, and Conclusions. You should break the method and data into separate sections. Put Discussion in a single section.<br>In Introduction, you needs to insert an independent paragraph at the end of the Section to illustrate what you will do in the following Sections. | Noted. Subject to the view of referees and editors, we would like to keep section 3 to contextualise the Hong Kong case to benefit readers who may not be familiar with it.<br><br>The cohort analysis is now combined with our IV estimation as Research Design section. Section 5 discusses Data and empirical results. And Section 6 concludes. |
| 5 | You need more explanations about why Cohort analysis can identify causal relationships.<br><br>The most common method for causal analysis between time series variables is Granger causality analysis which is widely used in natural sciences and humanities and social sciences I suggest that you briefly describe this method, and indicate in the literature review whether there is relevant research and provide relevant references. You actually estimated a semi-logarithmic model. In Methodology, please present the sources of these equations and provide enough citations. I do not find any citations in Section 5.2. State which variables in the models are in logarithmic form, and which are not. | We have added more explanation is added to clarify that we use cohort analysis to justify the use of the unmarried population in our reduced form model, while we use IV estimation to identify causality.<br><br>Point taken. There is an extensive econometric literature concerning the methods for inferring causality with Granger-causality test (Maziarz, 2015). The gold standard of causal inferences has to be 1) randomised experiment, 2) natural experiment (treatment effect), and 3) Instrumental variable approach. Inferring Granger causality as a causal inference could be tempting, but also be dangerous which our study is trying to avoid.<br><br>Maziarz, M. (2015). A review of the Granger-causality fallacy. *The journal of philosophical economics:* |

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| 6 | Merge the tenure choice technique you applied into Methodology. Clearly explain how to use this technique in Methodology. | Point taken. We have restructured as point 4 suggested. |
| 7 | You should use a separate Data section, which would clearly state the source of the data. Insert a Statistical Description table of the data. The table should clearly describe the sample period, observations, maximum value, minimum value, average value, median value, normality, logarithmic value, and so on.<br><br>In Data, you need to clearly define a complete set of variables and list them all in the table. | Section 5 now reports on the Data and Empirical Results.<br><br>We have added a table of descriptive statistics. |
| 8 | You should use a separate Empirical Results Section to report the results. The footnotes below the OLS regression table should report model specification test indicators as many as possible so that the reader can readily judge the quality of regression results. For example, Adj. R-squared=?, DW=?, F=? … in Table 2.<br><br>When reporting empirical results in the text, t-statistics or probability values should be reported simultaneously with the results. The significant levels in Table 2 should be 10%, 5%, 1% rather than 5%, 1%, 0.1%. | Section 5 is now reporting the Data and Empirical Results.<br><br>Adj. R-squared, F-statistics, and observation etc. are added in Table 2.<br><br>The *t-statistics* have been already reported in parentheses in Table 2 with the corresponding asterisks indicating the significance level of the p-value.<br><br>In this study we have adopted more stringent level of significance to ensure more convincing results. (See "Stringent statistics make better science [URL]") |
| 9 | You actually estimated a semi-logarithmic model where the price is in logarithmic form and the population number does not use logarithmic transformation. Therefore, the most important conclusion you suggest is: For every more 1,000 unmarried population, | Usually, the impact of population change is considered in the level term to infer its effect. Indeed, if the percentage term is required, readers can always make a ballpark estimate by inferring the mean of the never-married population. For example, an extra 1,000 unmarried |

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| | the house price increases by 7%. I consider that it is easy for this result to be misunderstanding in practice and thus has limited meaning.<br><br>A better empirical result may be the elasticity of house price relative to unmarried population, that is, a 1% increase in the number of people waiting for marriage would 'cause' the ?% growth of house price. But this requires the use of a double logarithmic (log-log) model, with demographic variables using quarterly growth rates rather than number of population you used. | population aged 25-44 (i.e., 0.18% of 552,000) leads to 7% increase in house price, holding the housing stocks, mortgage rates, and total population equal.<br><br>More importantly, the exogenoity condition of our proposed IV is grounded on the level of the population rather than the growth in population. The demographics of a cohort was pre-determined by a group of people with the same year of birth decades earlier. |
| 10 | English needs to be professionally edited. Elsevier or Taylor & Francis usually provides such English editing services.<br><br>You should use a concise and straightforward language.<br><br>The author uses too many parentheses to explain or emphasize a concept, which seriously undermines sentence integrity and reduces readability, For example,<br><br>Page 2: In this study, we subscribe to both Clark et al.'s (1994) life-course perspective and Mulder's analytical frameworks (1998, 2001) to analyze the (first-time) homeownership induced by marriage. What does the 'first-time' mean?<br><br>Page 5: The more never-married individuals thereby trigger more marriages to occur (i.e., a stable rate of marriage in our cohort analysis). Suggest: The more never-married individuals would thereby trigger more marriages to occur, which implies a stable rate of marriage in the cohort analysis. | We have used this opportunity to have a colleague who is an experienced English language author to read our manuscript and check its language. Some additional changes include a reorganisation of the manuscript, updated references, and general editing of the language. We also cleaned up some minor typographical errors throughout.<br><br>We have revised this. It now reads as "more potential "marriage-ready" individuals which are proxied by those who were born between the 1980s and the early 2000s but never-married, will lead to higher demand for homeownership when they eventually get married."<br><br>We have revised this accordingly. |

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| | Page 7: Previous research on demography and housing focuses especially on how housing costs, among other socio-economic factors, affect the temporal aspects (i.e., timing in a family lifecycle) of young adults to live independently. Suggest: Previous research on demography and housing focuses especially on how housing costs, among others, socio-economic factors, affect the temporal aspects of young adults to live independently. The temporal aspect is referred to be as the timing in a family lifecycle. | We have revised this in line with the comments by another referee. It now reads as "Previous research on demography and housing focuses especially on how housing costs of owners versus renters, among other socio-economic factors, affect the opportunity costs in childrearing (Yen et al., 1989) and the timing of young adults to live independently (Goldscheider & Goldscheider, 1998; Murphy & Wang, 1998)." |
| | Page 18: indicates the upper bound of an age range, starting from 18 (i.e., the legal age to get married in Hong Kong) to age s (which can be any number below 60). α and β are coefficients to be estimated. | Revised. |
| | Page 5, line 27: While the focus of this study is on marriage-induced homeownership; we do not…. Note that semicolon should be comma. Revise similar errors. | Corrected. |
| | Page 14, line 53 and page 15, line 3-4: We rely on the housing tenure choice model developed by Brueckner to contextualize the benefits of homeownership for married couples; and explain…. Note that semicolon should be comma. Revise similar errors. | Revised. |
| 11 | Limitations of this study? Please state in Conclusion. | In the Conclusion we have added limitations of the study. |
| 12 | The manuscript has repeatedly emphasized that research fills a gap, which is not necessary. Delete or rewrite them. | Point taken – we have made the revision accordingly. |
| 13 | This policy has just been promulgated for about three years. You argue that it has caused house prices to rise. However, there is no any empirical evidence for such an | We have revised the sentence. |

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| | argument. I suggest that you delete or rewrite those words. | |
| 14 | Page 18, Equation (1), βX, not Xβ. | It has to be Xβ; which is an ordering rule of matrix algebra. **X** is a [m×n] matrix which needs to be prior to the [n × 1] vector β. |
| 15 | Page 21, the never-married population aged 35-44 and 45+ have : 45+ is not academic. '45 and above' is better. | Noted. For the sake of presentation, we have added a note to indicate the meaning of "45+". |