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**Working Paper**

## No flat, no child in Singapore: Cointegration analysis of housing, income, and fertility

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**ADB Working Paper Series**

**NO FLAT, NO CHILD IN SINGAPORE:  
COINTEGRATION ANALYSIS OF  
HOUSING, INCOME, AND FERTILITY**

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**Abstract**

A key feature of the demographic transition in prosperous East Asian and other developing Southeast Asian states is fertility decline. Various pro-natalist policy measures, including baby bonuses and universal child care, have been undertaken by governments in the region, often with disappointing results. Like other social institutions in modern societies, housing can play a vital role in shaping fertility decisions, but its effect on fertility has largely remained unexamined. The ambiguous effect of housing affordability found in existing literature constrains the ability of governments to truly tap in to its potential to curtail fertility decline. This paper seeks to address this gap by empirically examining this often-neglected relationship between house prices and fertility rates. It examines the relationship through the mechanism of housing wealth formation in Singapore, a country with one of the lowest replacement levels in the region but also with one of the largest public housing markets in the world. It uses the resale price of public flats to test whether this wealth formation can potentially increase the likelihood of having more children. By doing a cointegration analysis of housing, income, and fertility, the paper confirms the “no flat, no child” belief prevalent among young Singaporeans. It finds a negative long-run effect: a unit increase in the prices of resale flats reduces the total fertility rate (TFR) by 0.0036, statistically significant at 1%. Income is also found to negatively affect fertility. The variables included in the error correction model are also sensitive to disequilibrium. The resale prices also Granger cause the TFR both in the short and long run, and the effect is bidirectional. The paper emphasizes how imperative it is for policymakers to seriously consider this effect in crafting housing and population policies. Pro-natalist measures may prove inadequate if other aspects of family living in Singapore do not significantly change. Governments faced by a steady fertility decline need to consider how housing affordability can be used as an instrument to drive up fertility rates.

**Keywords:** fertility, house prices, Singapore

**JEL Classification:** J13, J11, C32

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## 1. BACKGROUND

Fertility decline forms a key component of the demographic transition in many countries all over the world. Various economies in East Asia, such as Singapore, Taipei, China; Hong Kong, China; the Republic of Korea; the People's Republic of China (PRC); and even Viet Nam, have a total fertility rate below replacement level. European countries such as Spain, Portugal, Italy, and Greece share a similar predicament. But the sheer scale and speed of fertility decline is a particularly remarkable feature in East Asia, with estimates revealing a rate of decline per decade ranging from 1.6 to 2.1 in these economies (Feeney 1994).

A few cultural and social institutions around work and education have been posited as important in suppressing childbearing. There is an uneasy relationship between the traditional gender roles in marriage, childbearing, and employment (Kim and Cheung 2015). The so-called "marriage package" often involves the postponement of childbearing, which increases its attendant costs as it entails an expectation of wives working less and becoming full-time homemakers (Bumpass et al. 2009). "Education fever," or the strong orientation towards high investment in child education among East Asian parents, also drives up the cost of rearing children (Anderson and Kohler 2013). For instance, spending on "shadow education" such as cram schools and home tutoring accounted for 0.19% and 1.72% of GDP in Japan and the Republic of Korea, respectively (Bray and Lykins 2012). These findings form part of what McDonald (2000) called the "marriage" and "direct-costs" factors that skew preferences for delayed family formation and a smaller family size.

As a result of these models of fertility decline, pro-natalist policies geared towards incentivizing larger family sizes began to emerge in the past 40 years. These family policies typically include financial incentives and support for parents to balance work-family tensions as well as broad social changes to support parenting and childbearing (McDonald 2000; Jones and Hamid 2015). Taipei, China recently introduced measures such as parental leave allowances, subsidized child care, tax deductions for preschool children, and even more flexible regulations for military enlistment of men for family reasons (Lee and Lin 2016). In the early 2000s, Singapore introduced a package of incentives to foster early marriage and larger families through cash benefits on the birth of children, a co-saving scheme for child development, a priority housing scheme for couples with children, parental leave, and matchmaking services for singles. Although it is hard to establish whether these policies worked, Jones and Hamid (2015) conjectured that without the policies, Singapore's TFR would be much lower, at similar levels to other cities like Seoul; Taipei, China; and Hong Kong, China.

These policy responses are consistent with demographic transition theory, which posits societies as moving from high birth and high death rates to a low-birth and low-death scenario. Some calibration of the theory identified ideational, cultural, and sociological factors as important determinants of the demographic transition. However, Caldwell (1976) reformulated these theories as a function of change in the flows of wealth. With the decreasing role of extended families, modern societies value nuclear families and feature a flow in the wealth from parents to children, rather than children supporting the extended family. Given the increasing cost of living and westernized values for smaller families, households may see childlessness as a rational choice as they also begin to find utility in other social institutions, such as work and education, at the cost of marriage and family (Kirk 1996).

One crucial implication of this view of demographic transition as a flow of wealth is the role of housing as a source of wealth for the family. Along with education and work, it has been argued that housing is one of the three institutions that affect the tempo of fertility (Rindfuss and Brauner-Otto 2008). The adequacy in the supply of housing, the crowdedness of apartment living in dense areas, and the flexibility of the housing market, such as the existence of affordable rental apartments, are well-known constraints to family formation decisions (Chesnais 1996; Felson and Solaún 1975; Billari 2005). Expensive housing, particularly in densely urbanized cities, is believed to significantly increase the cost of childrearing, leading many couples to keep their family size small. It also makes marriage contingent on owning a house, as is the case throughout Central and Eastern Europe (Frejka and Sobotka 2008; Stropnik and Šircelj 2008; Tello 1995). Low fertility rates were found to be particularly acute among countries with high home ownership and low access to mortgages, factors that are seen as important in the transition to adulthood (Mulder and Billari 2010).

Despite the importance of housing in shaping fertility as shown by these studies in Europe, studies on how housing shapes fertility remain limited in the East Asian region. Some preliminary studies on the determinants of fertility in the region show that housing in urban areas disincentivizes large family sizes. For instance, 13% of respondents covered by a national fertility survey in Japan reported “house being too small” as a reason for not realizing the couple’s ideal family size (Gauthier 2016). Some studies also link the negative relationship between housing prices and fertility through time series analysis but often tend to be of limited value to policymakers because of the missing mechanisms that link the two variables (Yi and Zhang 2010; Hui, Zheng, and Hu 2012). These studies establish demographic factors such as infant mortality rates, maternal mortality rates, and social institutions like work and education as crucial determinants of female fertility. The mechanism found is largely through the perception of costs vis-à-vis income (Subramaniam, Loganathan, and Devadason 2018). Despite its saliency in the demographic transition, studies that examine housing as a policy lever for shaping fertility are limited, thereby leaving the potential effects of house prices on family decisions largely unexamined (McDonald 2000).

This paper serves to fill this gap by primarily examining the long-run relationship between fertility, housing, and income through the mechanism of wealth formation. Specifically, it tests the linkage between housing price, along with income, and fertility in the long run. It uses resale prices of public flats to model a household making interrelated decisions about maximizing on the capital gains from upgrading and forming a family, including deciding on the number of children. Using annual data at the aggregate level covering the period from 1990 to 2019 in Singapore, the paper finds a negative long-run effect: A unit increase in the HDB resale index reduces the total fertility rate by 0.0036, statistically significant at 1%. The impact of income, although very small in magnitude, is also negative. The variables in the error correction model are also sensitive to disequilibrium. The paper further provides robust evidence that housing prices Granger cause fertility in the short and long run. These findings suggest the coupling of housing and fertility decisions as implied by the “no flat, no child” belief popular among young Singaporeans.

The paper is organized as follows. The first section reviews the theoretical and empirical foundations of the relationship between housing and fertility. While it has long been acknowledged that housing negatively affects fertility, recent studies point to the potential positive relationship through wealth formation. The ambiguous effect found in the literature could be attributed to the diversity in housing markets as well as the stage of household formation. The second section situates the debate within Singapore, a country whose asset-based welfare system makes house ownership an important

source of wealth. Singapore is also one of the few countries in East Asia that has used housing as a policy instrument to shape fertility behavior, but little evidence exists on their relationship. The paper adopts a cointegration analysis, as will be elaborated upon in the Data and Methods section, to determine whether there is any short-term and long-term causality between housing and fertility in Singapore. The Results and Discussion sections present the main empirical findings of a negative relationship between housing and fertility, and generate implications for how the findings fit in to the theoretical propositions. Some remarks on future research and policy implications are made to conclude the paper.

## 2. HOUSING AND FERTILITY

Using the long-standing theoretical approaches from economics, housing can be expected to negatively affect fertility. Gary Becker's New Family Economics formulates the number of children as a function of opportunity costs of childbearing and rearing. Children can be viewed as durable goods that yield income (both material and psychological) to parents (Becker 1960). Households perform a cost-benefit analysis of bearing children and come up with an optimal number of children based on their net cost.<sup>1</sup> Sexual division of labor dictates that women should take on tasks where they hold comparative advantage like childbearing (Becker 1985). Thus, it is not surprising to see the recent growth in income, particularly among women, contributing to fertility decline (Becker, Murphy, and Tamura 1990). House price inflation would have a negative income effect on households as time away from the labor force means a lower income for consuming other goods.

The second theory is the relative income hypothesis developed by Richard Easterlin (1976). The decision to bear children is based on the process of managing the gap between aspirations and current level of resources. According to Easterlin (1976, 422), "the number of children [in someone's household] can 'afford' will depend on the outlook for multiplying his initial capital over the course of his lifetime," which indicates that the increasing cost of living would affect the optimal number of children per household (Easterlin 1980). Fertility decisions would be largely based on relative income to achieve material aspirations that are shaped by the standard of living in the parental home (Easterlin, Pollak, and Wachter 1980). The aspiration is largely determined by past consumption and family-size decisions the husband and wife experienced during their childhood. Housing prices can influence decisions to marry if the income is not rising sufficiently to maintain the same level of lifestyle afforded to them by their parents. The relative income hypothesis of a negative relationship between house prices and fertility is confirmed by empirical studies in developed countries like the United Kingdom (Ermisch 1988) and the United States (McNown 2003).

That housing prices negatively affect fertility rates has long been confirmed by studies that examined housing and fertility decisions as jointly made among young households. Öst (2012) used a cohort study in Sweden to demonstrate a strong statistical correlation between the simultaneity of decisions about homeownership and family formation. The study further found that the relationship was stronger among younger cohorts that experienced greater housing market uncertainty. Various studies have confirmed the existence of such a relationship through survey data in Italy (Vignoli,

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<sup>1</sup> This is computed as the present value of expected outlays plus the imputed value of parents' services minus the present value of the expected money return plus the imputed value of child services (Becker 1960).



Rinesi, and Mussino 2013), in the US (Clark 2012), and in Finland (Kulu and Steele 2013). These studies show that the perception of the housing market can affect the likelihood of having children in the next two to three years, suggesting a long-run relationship. It is concluded that fertility intentions shape residential mobility, particularly in contexts where there are opportunities to move to cheaper housing markets as in the case of Australia (Li 2019) and Britain (Ermisch and Steele 2016).

Given these considerations, it is important to situate the debate within East Asia where highly urbanized areas tend to have less diverse, expensive housing markets. High costs of living spaces would disincentivize larger family size and discourage early fertility timing. Using pooled data from the PRC, Clark, Yi, and Zhang (2020) reinforced the negative relationship between house prices and fertility in urban areas that Pan and Xu (2012) had found earlier. Their study established that a 1% increase in house prices among urban households causes a 0.94 decrease in the probability of having a child. Yi and Zhang (2010) utilized time series to provide evidence of a long-run cointegrating relationship between fertility and housing in Hong Kong, China. The authors find that a 1% increase in housing prices relates to a 0.45% decrease in total fertility rates. Hui, Zheng, and Hu (2012) also validated this negative relationship in Hong Kong, China where a 1% increase in house prices reduces birth rates by 0.52%. The findings of these studies point to a convergence in empirical expectations of a negative impact of housing prices on fertility decisions in restricted housing markets in the region.

However, recent studies contend that many of these negative relationships could just be correlation, and in fact, the relationship could be positive. For homeowners, house price inflation can serve as an income shock and would increase the wealth of the household. If children are normal goods as asserted by Becker, then an increase in house prices would improve the outlook for the income of the household and would encourage larger family sizes. Using a panel study, Lovenheim and Mumford (2013) found that an increase by US\$100,000 in housing wealth would result in a 16%–18% increase in the probability of having a child among homeowners. Washbrook (2013) corroborated this finding but the relationship is only short term. The author found that a 10% increase in house prices leads to a 2.4% increase in fertility among homeowners in the following year. The analysis further showed that cumulative fertility rates normalize in the longer term. Similarly, Clark and Ferrer (2019) looked into the effect of house prices on “nonmover” homeowners and found a positive relationship in Canada. In one of the models, they established an 11% increase in the probability of giving birth from a \$10,000 increase in average house prices.

There is thus an ambiguous relationship between housing and fertility. What the existing literature suggests, however, is that the relationship could be contextual as the nature of the housing market can sharpen the effect of house price inflation on fertility. The relationship could also be differentiated according to the modeling of the type of household. One must consider the fertility decision being made (e.g., ordering of births, family formation) that is affected by decision on housing types and prices (e.g., cost of new house vs. renting, etc.). A negative relationship could be pronounced in contexts where there is greater concern over homeownership and first-order birth. These are households at the start of their formation when couples are deciding on getting a house and having children, where income flow would have a more pronounced effect. The evidence that shows a positive relationship, on the other hand, has been limited to existing homeowners and higher-order births where wealth formation is more possible. Thus, in order to rule out the wealth effect, subsequent research on the relationship between housing and fertility should examine how it relates to income.

### 3. SINGAPORE: NO FLAT, NO CHILD

Singapore is emblematic of the dilemmas posed by demographic transition in advanced East Asian economies. Since its independence, Singapore has experienced continuous economic growth, with its GDP per capita (at the current market price) growing exponentially from \$1,915 in 1970 to \$73,167 in 2016. Its economic development journey followed an export-oriented model and consistent economic restructuring, but it is also characterized as having exceptionally high savings and low inflation throughout its history (Huff 1995). But due to slow local population growth, Singapore's economic growth relied heavily on foreign workers to take on low-skilled service jobs (Fong and Lim 1982; Hui 1997). Such dependence on foreign workers, which accounted for 30% of the total resident population in 2016, is representative of the social transformation that had simultaneously occurred. Social indicators today show that Singapore is rapidly aging. Many young couples are marrying older with a median age at first marriage of 30 for males and 28 for females. Singaporeans are also marrying less with only under 50% of unmarried residents (15–49 y/o) getting married.

The issue of a continuous fertility decline lies at the core of these policy challenges. The fertility rate has been declining rapidly since the late 1960s owing in part to the vigorous anti-natalist policies of the government as part of its economic growth policies (Graham 1995). By the mid-1970s, the total fertility rate had reached below replacement levels. Since 1984, the Singaporean government has adopted a pro-natalist approach, introducing several policies and programs to encourage procreation and marriage (Yap 2003). These programs have been a mix of policies prioritized to certain demographics (like the Graduate Mother scheme), child-care subsidies, tax relief, and hospitalization coverage, among many others. The impact of these programs, particularly based on survey data, has so far been mixed (Drakakis-Smith et al. 1993; Graham 1995; Teo and Yeoh 1999). Aggregate trends show that the fertility decline is intractable with TFR currently standing at an alarming level of 1.2.

Despite the recognition of the problem, little empirical evidence exists on the determinants of fertility decline. Much of the work in the studies on fertility in Singapore has largely been descriptive of the consequences of low fertility and the effectiveness of pro-natalist policies (Asher and Nandy 2008; Yap 2003; Graham 1995; Cheung 1990; Pyle 1997). Using survey data, Hashmi and Mok (2013) found that age at marriage, household income, and number of siblings' children affect fertility rates among Singaporean women. Those that have attempted to identify macro-level factors contributing to the decline have been limited. Using OLS of time series data, Park (2005) finds a small but positive effect of Qualified Child Relief (tax exemption for parents) where a 1% increase in the tax relief is associated with an increase in TFR of about 0.1%–0.2%. Lee and Ng (2012) reveal that infant mortality, total education expenditure, and female labor force participation are important determinants of fertility in Singapore. The authors also find long-run effects of these variables on fertility where infant mortality rate and total education expenditure take a negative sign while female labor participation is positive. More recently, Subramaniam, Loganathan, and Devadason (2018) found negative and cointegrating relationships between fertility rates, income, infant mortality rates, and female labor force participation across major ASEAN countries including Singapore.

Despite theoretical expectations, housing variables often do not make it into these studies examining the causes of fertility decline. In Singapore, the housing market can be subdivided into two segments: public housing, where 81% of the population lived in 2018, and private housing estates. The supply of public housing is regulated by the Housing and Development Board (HDB), which can be further divided into sold flats

and public rental flats. Only 3% of the population resides in these public rental flats but this figure has been growing over the past few years. Part of the reason why there is a significant public housing component in the market is the government's Home Ownership Scheme introduced in 1964. It linked home ownership with affordable housing unguided by principles of stability, affordability, financial security, and strong familial ties (Tan and Naidu 2014). The significant percentage of the population living in public housing marks an indirect pathway for the government to influence decisions on family formation.

In fact, housing has long been used to disincentivize and incentivize fertility in Singapore. In the 1970s, the government removed priorities given to large families in the allocation of public flats as part of a larger anti-natalist scheme (Palen 1986). But this was eventually reversed and larger, more educated families were favored. The government has been using housing policy to shape fertility decisions as the historical emphasis on house ownership made housing a basic good among Singaporean households (Chua 1991; Teo 2010; Teo and Lin 2011). Policies are configured to construct "normal families" as house-owning families (Teo and Yeoh 1999). The HDB allows young couples to rent flats before completion of their own flats to discourage delay in marriages and childbearing (Kong and Chan 2000). Young couples have more access to rental flats and the resale market, with some flexibility, than older couples (Wong and Yeoh 2003). They also actively discourage early-age singlehood – with only those aged 35 and above having access to subsidized housing under the Joint Single Scheme or Orphans Scheme. Social policies are essentially directed towards normal nuclear families.

As well as rental flats, there also exists a market for private condominiums and a resale market for public flats. Prices are often pegged to average-income households to make housing affordable to a large chunk of the population (Phang 2001). But there is a perception of social mobility if families move from HDB flats to private condominiums (Sing, Tsai, and Chen 2006). Savings through the Central Provident Fund (CPF) can be used to pay for HDB flats while the proceeds from their resale can finance the shift to private residences. However, there are some restrictions to selling HDB flats that are meant to constrain the ability of households to monetize the housing subsidies. These restrictions are essential to sustaining the principles of home ownership and ensuring that Singaporeans do not use "HDB units as investment vehicles" (Tan and Naidu 2014, 4). In order for households to sell their flats in the resale market, a minimum occupation period (MOP) ranging from two to seven years must be met depending on how the flat was sold and the number of rooms. Another restriction is imposed on non-Singaporean, non-Malaysian families whose flats cannot be sold if the ethnic quota or permanent resident quota has been reached. Lastly, a resale levy of between SG15,000 and SGD55,000 (depending on the type of flat) is imposed on households that received subsidies and wish to sell their flats.<sup>2</sup> Resale flats also became a source of political contention during the 2011 General Election and were further subjected to restrictions like higher stamp duties for second purchase of flats and total debt servicing ratio for borrowers (Tan and Naidu 2014).

Although restrictions exist, the creation of the HDB resale market has created a permanent source of wealth for public house owners (Bardhan et al. 2003). The public resale market was earlier estimated to be five times larger than the private housing market (Tu and Wong 2002). Resale applications grew to 23,714 in 2019 from just over 17,000 in 2014, a sign of recovery from a slump in the market in 2013. In fact, the

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<sup>2</sup> More information can be found here: <https://www.hdb.gov.sg/cs/infoweb/residential/selling-a-flat/financing/computing-your-estimated-sale-proceeds/selling-a-flat---resale-levy>

resale volume has gone up even during the pandemic along with a rise in resale prices, reflecting optimism on the part of buyers and sellers in the market (Ng 2020). In a market that exhibits a “property ladder” between highly subsidized public flats and new private residential properties, the housing wealth effect essentially makes the upward mobility in the ladder contingent upon house prices (Sing, Tsai, and Chen 2006). This suggests that household mobility decisions, as found in advanced economies, are affected by price fluctuations in public flats. In fact, consumption spending is found to react more to changes in HDB resale prices than private flats and this relationship has sharpened post-Asian financial crisis (Edelstein and Lum 2004).

Thus, the resale market in Singapore presents an opportunity to examine the ambiguous relationship between housing and fertility through the so-called “wealth effect.” Resale prices, given their sensitivity to market forces, can be used to signal the widening in the gap of actual and desired income since the baseline cost of producing “quality children” has also increased. In other words, price fluctuation in the secondary housing market could indicate diminishing levels of wealth, owing to market constraints, leading households to decide on a smaller family size. We could thus expect a negative relationship between HDB resale prices and fertility. On the other hand, if the argument of the effect of HDB flats on wealth formation is true, such wealth effects could actually encourage bigger family sizes. Thus, it could also mean that HDB resale prices will have a positive association with aggregate fertility rates.

#### 4. DATA AND METHODS

The paper employs a multiple time series analysis to tease out the relationship between housing prices, income, and fertility. Similarly to Lee and Ng (2012), the paper uses cointegration analysis, which enables the analysis of at least two nonstationary time series. Unlike earlier studies, the paper conducts a unit root test to establish stationarity at first differences, an important condition for cointegration analysis. Without the unit root test and checking cointegration relations, the apparent co-movement of the time series may be spurious and no meaningful interpretation can exist. Park (2005) uses the original model specified by Whittington, Alm, and Peters (1990), which is thought to be a classic case of spurious regression (Crump, Goda, and Mumford 2011).

This study will also use a vector error correction model specified as follows:

$$\Delta X_T = a + \sum_{j=1}^p \Gamma_j \Delta X_{t-j} + \delta \beta' X_{t-1} + e_t$$

where  $X_t$  is a 3 x 1 vector including a measure of fertility rate, income, and housing price, and  $e_t$  is the vector of error terms and is assumed to be serially uncorrelated after the appropriate selection of the lag length  $p$ .  $\beta$  is the cointegrating vector representing the long-run relationship between the two variables.  $\delta$  is the adjustment parameter vector representing the speed of convergence to the equilibrium path. Short-run and long-run Granger causality effects are also tested using the Wald test.

The series used in this paper are taken from publicly available sources in Singapore via the Ministry of Finance/Government Technology Agency (<https://data.gov.sg/>) and Department of Statistics Singapore (<http://www.singstat.gov.sg/statistics>) (see Table 1 for summary statistics and definition of variables). The measure of the fertility rate used in the analysis is the total fertility rate (TFR), which refers to the average number of live

births each resident female would have during her reproductive years if she were subject to the prevailing age-specific fertility rates in the population in the given year. Using the TFR meets the requirement of the time series being  $I(1)$ .

**Table 1: Summary Statistics of TFR and HDB Resale Index**

Variable	Definition	N	Mean	SD	Minimum	Maximum
TFR	Total fertility rate	30	1.39	0.22	1.14	1.83
Index	HDB resale index	30	92.17	36.87	24.7	146.7
Income	Gross national income per capita	30	50,223.33	17,712.68	22,901	80,778

Source: Ministry of Finance, Department of Statistics Singapore.

The main dependent variable is housing prices measured as HDB resale index. Currently, prices at acquisition are hard to generate and teasing out the subsidies would be difficult. The HDB resale index is computed by the Housing Development Board (HDB) and captures the overall price movements of HDB resale flats calculated using resale transactions registered across towns, flat types, and models. The index in the fourth quarter is used with observations from 1990 to 2019. HDB resale prices are much more indicative of market demand and supply since public homeowners are allowed to sell their heavily subsidized public housing units in the public resale housing market at market price (Yuen et al. 2006).

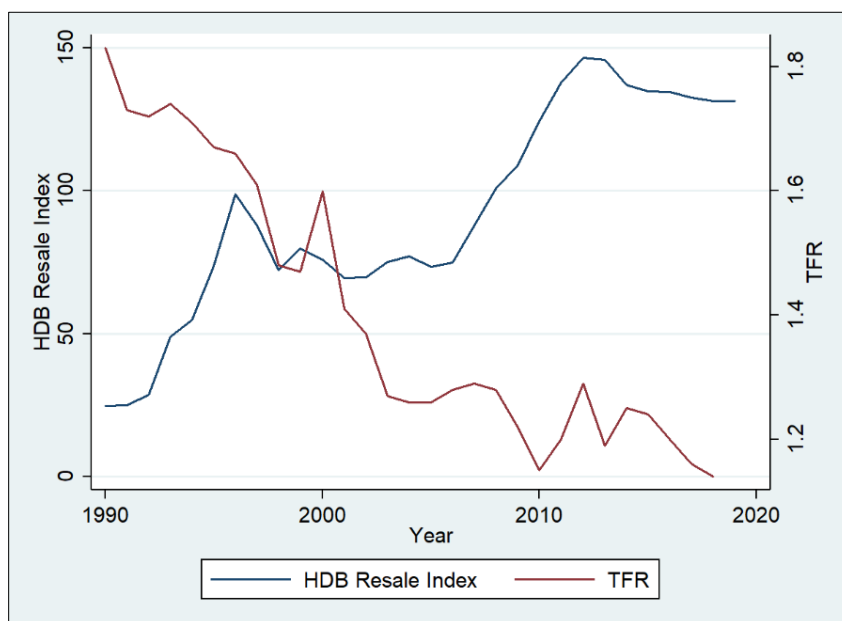
To control for other potential sources of wealth, a measure of income is included in the model. GNI per capita at current prices is used as a proxy for the average income of Singaporeans. GNI per capita is measured as the dollar value of a country's final income in a year, divided by its population. We can expect a negative relationship between income and fertility as it increases the opportunity cost of bearing children.

## 5. RESULTS

By looking at the data, a co-movement between the three time series can be observed. Figure 1 illustrates the decrease in TFR while the HDB resale index increased for the same period. The TFR has been decreasing by 1.5% on average since 1990. There were only seven years (1993, 2000, 2006, 2007, 2011, 2012, and 2014) in which the TFR posted a positive growth. The trend (in terms of peaks and dips) is consistent with other measures of fertility like the gross reproduction rate. On the other hand, the HDB resale index and GNI per capita grew an average of 7% and 4.6% for the same period, respectively.

The co-movement of the time series may lead one to conclude that there is a cause-effect relationship, but it is important to establish first if the time series has unit roots. A Perron unit root test was conducted using one lag for the first difference of the TFR, two lags for GNI, and four lags for the first difference of the HDB resale index. The unit root test results show time series to be nonstationary at levels but stationary at first difference (see Table 2). This indicates that fertility behavior follows a random walk process in which it might not be able to return to its former levels. This supports the use of the Johansen test for cointegration to derive long-run relationships between the time series.

**Figure 1: TFR and HDB Resale Index (1990–2019)**



At this point, a cointegration test is appropriate to determine the number of cointegrating equations. The trace test suggests that only one cointegrating vector exists (see Table 3). The null hypothesis of no cointegration is rejected as the trace statistic is higher than the 5% critical value. This means there is at least one cointegrating vector. Having a cointegrating vector at rank two is rejected since the critical value (25.32) is higher than the trace statistic (17.778). An alternative test based on the residuals using Engle-Granger test (not reported) reveals similar results.

**Table 2: Unit Root Test**

Variable	Perron-Stat	Unit Root Decision
TFR	-6.522***	I(1)
INDEX	-3.544**	I(1)
INCOME	-5.459***	I(1)

Note: \*\*\* Significant at 1% level. \*\* Significant at 5% level. \* Significant at 10% level.

**Table 3: Results of Johansen Test for Cointegration**

H <sub>0</sub>	H <sub>1</sub>	TFR, INDEX, INCOME	
		Trace Statistics	5% Critical Value
$r = 0$	$r = 1$	47.874	42.44
$r = 1$	$r = 2$	17.778*	25.32

Note: Lag length selection criterion is Akaike information criterion (AIC). Includes a restricted trend in model. \* Statistically significant at 5%. An alternative test (Engle-Granger) reveals similar results of cointegration.

Using one cointegrating vector, the coefficient of TFR is normalized to 1 using the error correction model with four lags. The estimated error correction term is reported in Table 4. The signs confirm a negative relationship between HDB resale price and fertility. A unit increase in the HDB resale index will result in a decrease in the total reproduction rate of 0.0036, statistically significant at 1%. Similarly, a unit increase in

income leads to a decrease in fertility of about  $-0.00002$ , significant at 5%. All variables are sensitive to disequilibrium, and the variables have a tendency to come back together to the mean. But the speed of adjustment is slow as evidenced by a coefficient closer to 0 than  $|1|$ .

When short-run Granger causality is investigated, a feedback effect is only found between fertility rates and the HDB resale index where resale housing prices Granger cause fertility rates. The error correction term is also statistically significant, suggesting that multiple time series have long-run effects on fertility. The HDB resale index does not have a short-run impact on TFR or GNI per capita but it has a long-run Granger causality on the error correction term. On the other hand, income does not seem to have a short-run and long-run Granger causal effect on fertility. The p-value is more than the critical value of 0.5 that allows us to reject the null hypothesis of nonzero lagged values.

**Table 4: Estimates of Cointegration Equation and Adjustment Parameters for TFR**

TFR	INDEX	INCOME
Cointegrating Equation		
1.00	$-0.0036 (0.0012)^{***}$	$-0.00002 (0.000)^{**}$
Adjustment Parameters		
$-0.5061 (0.2322)^{**}$	$85.2869 (35.4433)^{**}$	$17,432.15 (12,397.27)$

Note: Values given are coefficients (SE). Includes a restricted trend in the model. Lag length selection criterion is Akaike information criterion (AIC). \*\*\* Significant at 1% level. \*\* Significant at 5% level. \* Significant at 10% level.

**Table 5: Short-Run and Long-Run Granger Causality**

Variables	Short-Run		Long-Run	
	TFR	INDEX	INCOME	ECT <sub>t-1</sub>
TFR	—	$9.07 (0.028)^{**}$	$1.95 (0.582)$	$4.10 (0.042)^{**}$
INDEX	$1.47 (0.688)$	—	$4.44 (0.218)$	$6.74 (0.009)^*$
INCOME	$1.03 (0.793)$	$2.13 (0.546)$	—	$2.07 (0.150)$

Note: Values given are  $\chi^2$  (SE). Includes a restricted trend in the model. Lag length selection criterion is Akaike information criterion (AIC). \*\*\* Significant at 1% level. \*\* Significant at 5% level. \* Significant at 10% level.

Cointegration analysis assumes that the error terms are independent and are normally distributed,  $\epsilon_t = N(0, \Sigma)$ . Thus, there is a need to check the autocorrelation and normality of distribution of the residuals. As robustness checks, the residuals of the error correction regression are analyzed using the Jacque-Bera test for autocorrelation and the Lagrange multiplier test for normality. Table 5 presents the test statistics for autocorrelation with a null hypothesis of no autocorrelation at lag order 1. We do not reject the null hypothesis of no autocorrelation. It also displays the test statistics for all equations jointly against the null hypothesis that there is univariate normal distribution. The high p-value ( $p = 0.648$ ) indicates that we do not reject the null hypothesis of normality.

**Table 6: Robustness Checks**

Residual Diagnostics	
Lagrange multiplier test for autocorrelation	
Equation-specific diagnostic	$\chi^2 = 5.234, p = 0.813$
Jacque-Bera test for normality	
1 <sup>st</sup> order	$\chi^2 = 4.211, p = 0.648$

Note: LM test statistic shown is for all equations. \*\*\* Significant at 1% level. \*\* Significant at 5% level. \* Significant at 10% level.

## 6. DISCUSSION

This study provides evidence of the short-run and long-run link between housing and fertility decisions. It is consistent with previous studies in other East Asian contexts that established the negative relationship between house prices and fertility (Clark, Yi, and Zhang 2020; Yi and Zhang 2010). In particular, the paper found that the HDB resale price index, even when other measures of wealth are factored into the model, can negatively affect aggregate levels of fertility. Given the use of the HDB resale index, it sought to confirm whether the wealth effects created by home ownership can increase the likelihood of having more children as found in the US (Lovenheim and Mumford 2013). However, the Singapore case provides contrasting evidence. For households that have already been formed, the wealth effects generated by owning a public flat negatively shape childrearing decisions.

Several reasons could point to the lack of a positive relationship between resale prices and fertility. First, the lack of a positive relationship could mean that house price inflation may not necessarily generate wealth effects. Phang (2004) found that house price inflation does not increase consumption owing to liquidity constraints and possible larger bequest motivations. This is exaggerated by the limited market for commercial loans since the CPF can be used for downpayments (Phang 2001). The demand for greater flow of wealth from parents to children means that housing can be used for intergenerational wealth transfer rather than using it for residential mobility. Second, it could also mean that decisions to sell public flats could be motivated not by generating additional wealth but by social forces like status or the perception of upward mobility (Ong and Sing 2002). Tu, Kwee, and Yuen (2005) established that households with a younger household head, less access to alternative public housing units, and a more stable income are more likely to move to private housing. Interestingly, household size negatively affects the likelihood of moving because bigger families are probably less liquid given their higher nonhousing consumption expenses (Tu, Kwee, and Yuen 2005). Third, the imposition of the minimum occupation period and the resale levy could diminish the wealth effect of price inflation with fertility. Given the late age of marriage of Singaporeans, the five years requirement would decouple the observed relationship between fertility and house prices in other contexts because of the difficulty of childrearing at a later age. It also increases the age at which upgrading could occur. Bank regulations on the maximum length of borrowing significantly reduces the access to credit of households with older household heads. Thus, a mix of regulatory and market constraints to using the wealth generated from public house resale limits the ability of house price inflation to encourage a bigger family size.



The study still provides evidence on the link between home ownership and fertility decisions. It might not be through wealth formation as some studies have suggested. The negative relationship between the HDB resale index and fertility could confirm the assertion of economic theories about the increase in the cost of childrearing. This study's findings hold particularly for households that had already formed and had purchased their homes. For young homeowners, an increase in the price of housing, given the constraints on resale, could immediately dampen fertility intentions because of perceptions of foregone income. This is a possible mechanism in the short run as shown by the bidirectional causality of price inflation on fertility rates, but such causality is not found between fertility and income.

## 7. CONCLUSION

The study confirms the theory that underpins public and political discourse about the negative relationship between house prices and fertility in Singapore. House price is an important factor in determining fertility decisions among Singaporeans. The cointegration analysis reveals a long-run effect of housing prices and income on fertility rates, which is consistent with existing empirical studies (Lee and Ng 2012; Yi and Zhang 2010). In line with the theoretical assertions of Becker's new family economics and Easterlin's relative income hypothesis, an increase in house prices reduces aggregate levels of fertility rates. The results are robust even considering different models of random walk in error correction regression. Subsequent tests for autocorrelation and normality of distribution suggest that the residuals are independent and can be used for cointegration analysis.

The study reponds to the call made by Zavisca and Gerber (2016) for more empirical work outside the US and Europe on the effects of housing on fertility. The study is also one of the first to systematically generate evidence on how housing prices can influence fertility decisions in Singapore. Previous studies may prove to be spurious owing to their inability to test for unit root in time series. The findings of the study provide robust evidence of the "no flat, no child" belief prevalent among Singaporeans.

Policymakers in Singapore need to seriously consider this effect in crafting housing and population policies. The approach needs to be holistic and integrative so as to rethink the emphasis on homeownership within the framework of a normal family. Monetary incentives may prove inadequate if other aspects of family life in Singapore do not significantly change. The government needs to examine how housing affordability can be used as an instrument to drive higher fertility rates. It is important to acknowledge the finding that couples expecting house price inflation would tend to correct their fertility by about 50% at the aggregate level. What this means is that the adjustment is slow, emphasizing short-run demand smoothing measures as an immediate policy intervention not only to ease the price of HDB flats but also to encourage early marriage and childrearing (Abeyasinghe 2011). If the little attention given to housing policies' effect on fertility is continued, more direct pro-natalist policies may prove ineffective.

More broadly, housing policies should thus be folded into "reverse one-child policies" that incentivize larger families (Tan, Morgan, and Zagheni 2016). Although Singapore has adopted a priority scheme for families with three children, the current housing policy prioritizes younger couples, which essentially establishes housing as a precondition for marriage and childbearing – no flat, no child. These policies should be transformed to shape the tempo of family formation, by decoupling housing and marriage. Kohler, Billari, and Ortega (2006) suggested a mixture of housing-related

financial incentives to decouple housing and marriage, including mortgage reductions at the birth of each child. Building on Spain's housing and fertility crisis, Bernardi (2005) suggests that interventions should take the form of promoting "social and private renting sectors" that allow younger couples access to housing even before being "financially ready" to invest in homeownership. Other policies can include subsidies for young single people in condominiums.

While the results are robust, there are some limitations to the analysis that make the findings indicative at best. The limited number of observations across time limits the use of analysis of different cointegrating relations that might exist if there was a longer time period. The use of lagged variables has sometimes diminished the statistical power of the analysis. To solve this, the Singaporean government can provide estimates of the HDB resale index pre-1990, but such estimations may be less accurate. It should be acknowledged that the analysis presented here is only conditional or partial analysis, which is the inherent nature of cointegration analysis. Data on women's wage and father's income would have completed the verification of the theoretical model, but adding other explanatory variables would significantly reduce efficiency and the strong requirement for variables to be  $I(1)$  will not allow for larger specification of the model. As in the case of Lee and Ng (2012), the restriction can be relaxed but findings might be less robust and spurious in terms of what the authors have conceded. The short time series also limits the external validity of the findings, making the comparison of results with other studies difficult. Another limitation is the use of GNI per capita as a measure of wealth derived from means other than housing. Although GNI per capita has been used as a proximate measure of the level of development by the World Bank in classifying countries by income and by the UNDP in measuring the Human Development Index, it still remains a rough and imperfect measure. In particular, it may be a weak proxy for household income owing to how they are conceptualized and measured (Nolan, Roser, and Thewissen 2016). Although imperfect, GNI per capita performs better than GDP per capita in terms of being closer to household consumption measured through surveys (Birdsall and Meyer 2015).

The paper's findings could be better corroborated by survey data that could tease out the micro-behavior of households. More specifically, they could take into account the asymmetric appreciation of housing units and how this could result in a differentiated effect on fertility (Phang 2001). Future studies could also extend the time series to improve the validity of the findings. Housing affordability indices similar to the one proposed by Abeyasinghe and Gu (2011) can be computed for HDB flats for a longer time frame. Comparative studies can also consider whether the housing-fertility relation is present in other economies like Taipei, China and the Republic of Korea that suffer from extremely low fertility rates. The impact on fertility in other countries with soaring housing prices like the PRC can be a subject of future research.

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