INTERNATIONAL REAL ESTATE REVIEW

2020 Vol. 23 No. 4: pp. 467 – 482

The Impact of Population Aging on Housing Prices: A Comparative Study of Singapore and the U.S.

Fathali Firoozi
Department of Economics, University of Texas at San Antonio. Email: fathali.firoozi@utsa.edu

Abolhassan Jalilvand*
Department of Finance, Loyola University Chicago. Email: ajalilv@luc.edu.

Donald Lien
Department of Economics, University of Texas at San Antonio, Don.Lien@utsa.edu

Mikiko Oliver
Private consultant. Email: mikikomoliver@gmail.com

Population aging and its economic impact have been receiving increasing attention in many countries around the world. This study offers an analysis of the impact of aging on the housing prices in Singapore relative to the U.S. as the benchmark. The study uses semiannual series over the period of 1998 to 2019 with the age subgroups organized in 5-year intervals. The literature contains conflicting arguments on the impacts of aging on housing prices. Based on observations made for Singapore and the U.S., this study supports the arguments that the elderly part of a population has a damping effect on housing prices. A novel behavioral divergence between Singapore and the U.S. emerges when the analysis focuses on the impact of the finer age subgroups on housing prices in the two countries. The "turning age", which is defined as the approximate cut-off age when the impact of aging on housing prices turns from positive to negative, is approximately 55 years old in Singapore and 60 years old in the U.S.

* Corresponding author

Keywords

Age Subgroups, Economics of Aging, International Housing Markets; Upper Age-House Price Correlation.

1. Introduction

A population report by the United Nations (2015) states that "… virtually every country in the world is experiencing growth in the number and proportion of older persons in the population … with implications for nearly all sectors of society, including labor and financial markets, the demand for goods and services such as housing, …". The literature has long established that changes in the composition of the population have significant impacts on various economic measures, including housing price indices. Since the housing market is an important driver of various manufacturing and employment sectors of the economy, any understanding of the connection between the changes in demographic composition and housing prices can go a long way in explaining the impact of population aging on overall economic activity. As will be elaborated in the next section, the existing literature on the connection between population aging and housing prices contains several studies with different orientations and objectives.[1] The existing studies generally support the theory that a relative increase in the middle-age groups of a population has a positive impact on housing prices. The results, however, are mixed in regard to the association between upper-age groups and housing prices.

The core interest of this study is to empirically highlight the impact of aging on the housing market prices in Singapore based on a time series observations set over the period of 1998 to 2019. As a benchmark for the comparative component of the analysis, we use the parallel relationship between aging and housing market prices in the U.S. The following are some of the reasons for choosing the U.S. as the benchmark for the study. A city-state like Singapore is rather unique and it is not easy to find a state for comparative purposes. Since Hong Kong returned to China within the sample period, there is concern about structural changes in the Hong Kong data. In terms of the demographics and market system, Singapore comes close to some of the urban centers in the U.S. However, the U.S. urban markets are highly connected at the national level. Singapore is a thriving East Asian country with a strong economic orientation towards the U.S. market system. Despite having significantly smaller land and population sizes than the U.S., Singapore as a city-country reflects many of the regional characteristics of the U.S. metropolitan areas. Similarities of Singapore to the U.S. extend to their multi-ethnic populations, welcoming immigration policies, and strongly trade-oriented open economies. According to a recent

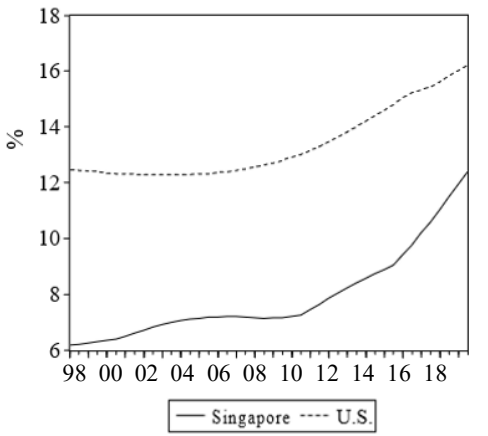
[1] In Section 2, which is the literature review, existing and relevant single-country and multi-country studies on the impact of aging on the housing market are reviewed.

study by Phang and Helble (2016) on behalf of the Asian Development Bank Institute, the population in Singapore of 5.54 million in 2015 consisted of 3.38 million citizens, 0.53 million permanent residents, and 1.63 million foreigners. The stated study also notes that the homeownership rate of 90% in 2015 in Singapore is one of the highest among the market economies.

Despite the presence of significant housing regulations in Singapore compared to the metro areas of the U.S., Singapore has made significant advances towards the deregulation and privatization of its housing market over the last two decades. However, a study of the Singapore housing market under its relatively significant housing regulations can provide an experimental setting for housing policy designs that may also be beneficial to the U.S. metro areas.

On the issue of aging, Figure 1 exhibits the time series of the ratio of the size of the age group 65 and older (65+) to the total population size as an aging measure for Singapore and the U.S. over the 1998-2019 period.

Figure 1 Time Series of the Ratio of Population Age 65 and Over to Total Population for Singapore and the U.S. Over 1998-2019.

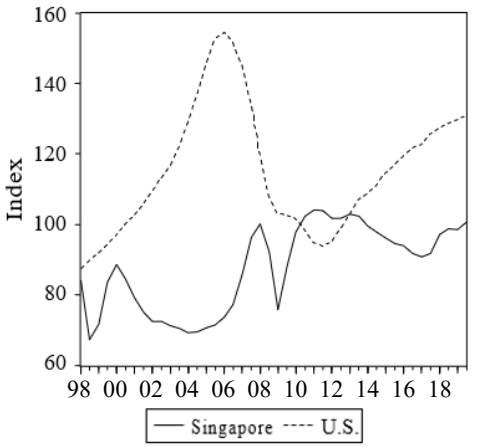


***Sources*:** Statistics Singapore, the U.S. Census Bureau, and the United Nations.

The ratio has been consistently lower for Singapore over the sample period relative to that of the U.S., thus suggesting that Singapore has had a younger population than the U.S. However, the rate of increase in the ratio has been consistently higher in Singapore relative to that of the U.S., thus suggesting that Singapore has been aging at a faster rate than the U.S. The rate of aging in the U.S. has been rising notably since 2006.

Figure 2 exhibits the time series of the real residential property price index in Singapore and the U.S. over the period of 1998 to 2019.[2]

Figure 2 Time Series of Real Residential Property Price Index for Singapore and the U.S. Over 1998-2019.



***Source*:** Bank for International Settlements.

The U.S. housing bubble and its subsequent crash of 2007-2008 are clearly shown in the U.S. component of Figure 2. The Singapore housing market exhibits a relatively milder and delayed crash in 2009 but also shows an overall milder recovery than the U.S. market in the post-crash period leading to 2019.

The literature has consistently established that the middle-age groups in a population have a positive correlation with housing prices. However, the existing results on the correlation between the upper-age groups and housing prices are mixed. The core objective of this study is to use parallel observations over the period of 1988 to 2019 in Singapore and the U.S. to address the three following questions: (i) Whether the correlation between age groups and housing prices turns from positive to negative at the upper ages, (ii) what is the approximate turning age around which the correlation turns negative, and (iii) whether Singapore and the U.S. differ in terms of the two issues in (i) and (ii).

We are motivated to investigate these issues based on the arguments that suggest a study of the Singapore housing policy in regard to its upper age population could carry utility for housing policy in the U.S urban housing markets. In terms of the lessons from housing policies in Singapore for a large

[2] The Singapore price data is the private property price index. As the Singapore housing market has a large public sector, we provide justification for our use of private property price data in the last paragraph of Section 3.

country like the U.S., the following statement from Phang (2018b) offers a justification: "Although it is a small city-state, Singapore's experience in transforming its housing sector since independence can be relevant to larger countries as the urban housing market is a highly localized market." Phang (2018a) focuses on the policies related to upper-age financing by home equity extractions and argues that such policies are likely to be more relevant to local urban areas of some of the larger countries where the demographic structure is likely to be similar to that in Singapore.

The results from a set of semiannual data organized in 5-year age subgroups over the period of 1998 to 2019 show that: (a) in both Singapore and the U.S., a proportional increase in the middle-age group is associated with an increase in housing prices, (b) in both Singapore and the U.S., the upper age groups have a dampening effect on housing prices, and (c) in the U.S., the age groups 50-54 and 55-59 exhibit positive correlations with housing prices, but the correlation turns negative for the adjacent higher age group 60-64. While the age group 50-54 in Singapore exhibits a positive correlation with housing prices, the correlation turns negative for the age group 55-59. Therefore, the younger age of 55 in Singapore emerges as the approximate turning age at which the correlation turns from positive to negative, as opposed to the older turning age of 60 in the U.S.

The organization of this study is as follows. Section 1 is the introduction. A review of the existing literature is given in Section 2. Section 3 discusses the empirical study. The data are presented in Section 3.1. The estimation results are presented in Section 3.2, and some of the relevant peculiarities of the Singapore housing market are discussed in Section 3.3. Finally, some of the implications of the results appear in the last section.

2. Literature Review

Aging is a global phenomenon that is impacting many aspects of domestic and international interactions and policy designs. Among the many studies on this issue, Harper (2006) focuses on the drivers behind global aging and its social implications. In this section, we first focus on some of the studies in the larger subset of the literature that contains the core underlying arguments regarding the impact of aging on the housing market in single-country studies, and then briefly review some of the studies in the rather smaller subset that focuses on multi-country studies. Mankiw and Weil (1989) observe that housing demand has a positive correlation with the age group 20-30 and negative correlation with the age group 40 and older (40+). Mankiw and Weil (1989) suggest that the increase in the U.S. housing prices between 1970 and 1980 is a partial consequence of growing demand for houses by the baby boomers who were at the time in the age group 20-30. Mankiw and Weil (1989) also predict that when the baby boomer generation members move into the retirement age group, their

housing demand weakens and real housing prices would decline. Accordingly, McFadden (1994) predicts that demographic factors would slow the housing market growth over the next 60 years. A report from the Bipartisan Policy Center (2012) also predicts that the baby boomer generation will start selling houses beginning around 2015, which will then create an excess of supply over demand and a subsequent negative impact on housing prices and new construction.[3]

Contrary to the arguments listed above, Green and Hendershott (1993) find that the willingness to pay for quality living remains flat after age 40 and point out that a decline in housing prices suggested by Mankiw and Weil (1989) is unlikely to happen. Green and Hendershott (1993) suggest that the aging of the baby boomer generation would not lead to lower demand for housing and thus would not lead to lower housing prices. Green and Lee (2016) argue that baby boomers have relatively higher education and income than the average person with an interest to maintain living standards and thus their retirement is unlikely to initiate a housing market decline. The stated argument is similar to that in Shoven (1996) who suggests that the elderly as a whole do not reduce their housing demand as a consequence of moving to retirement age. Fisher and Woodwell (2015) note that the U.S. will see an additional 10.3 million owner households and 5.6 million new renter households over the next ten years. Fisher and Woodwell (2015) argue that both owner and renter household growth will be driven by the baby boomers, thus distancing themselves from the suggestions that population aging will dampen housing demand. Thus, the findings in the existing literature are mixed with regard to the sign of the correlation between upper age population and housing demand.

In regard to aging for groups prior to retirement, Peek and Wilcox (1991) observe that the ratio of the households headed by the age groups 20-29 to 30-54 is negatively correlated to housing prices, thus suggesting that the high housing demand by the middle age group 30-54 dominates the low demand by the younger age group 20-29. Peek and Wilcox (1991) also show that income is positively correlated with housing prices while the unemployment rate is negatively correlated with housing prices.

The literature also contains studies on the connection between aging and housing prices in multi-country settings. Takats (2012) analyzes data for 22 advanced countries that consist of mostly European countries and the U.S., but not Singapore. The Takats study employs a universal aging measure that

[3] Downsizing at old age has been stated as one of the reasons for withdrawal of some assets out of the housing market with damping effect on housing prices. An underlying assumption in such statements is that the savings that result from downsizing exit the housing market and will not return to the housing market in another form. In a dynamic setting, savings of downsizing by the elderly could possibly return to the housing market by those who inherit the savings or the investment banks that hold the savings. A recent reference on downsizing and age is Doughty (2016).

consists of the ratio of the size of the population sub-group 65 and above to the age subgroup 20-64, which is denoted as 65+/(20-64). No decomposition of populations into finer age subgroups is employed in the Takats study. The Takats study utilizes the classic life cycle hypothesis to argue that moving into the upper age group generally leads to a reduction in household residential spending. Takats (2012) concludes that the general demographics in a sample of 22 countries have contributed about 30% to housing price increases over the years of 1979-2009, but predicts that aging in the next 40 years will contribute to an 80% decline in housing prices. Saita et al. (2016) analyze data on aging and housing prices in Japan and the U.S. with focus on regional areas or states within Japan and the U.S. over the sample period of 1975-2011. Saita et al. (2016) also conclude that the universal aging measure 65+/(20-64) and housing prices are negatively correlated in both Japan and the U.S. Like other comparative studies, Saita et al. (2016) do not evaluate the impact of finer age groups within the populations on housing prices. The population report by the United Nations (2015) uses the ratio of the sizes of the population sub-groups 65+/(15-64) as a universal measure of aging that is applied to all countries in its study of world aging. One common feature of the existing multi-country studies is the use of 65 years old as the universal cut off age for turning old. In the following sections, we perform a comparative empirical study of aging and housing price correlation based on a data set with finer age subgroups than those applied in the literature.

3. Empirical Study

The core objective is to derive the empirical inferences on the impact of aging on housing prices in Singapore with the U.S. as the benchmark. The two sections that follow first elaborate on the data and then on the estimation results. As indicated in the literature review, there is substantial international evidence with consensus of a positive association between the middle age population and housing prices. However, there is no consensus on the impact of upper age population on housing prices, although there is substantial evidence that the association between age and housing prices turns negative at some point in the higher ages. We apply the 5-year age subgroups to shed further light on three questions about Singapore relative to the U.S.:

(i) Does the correlation between aging and housing prices turn from positive to negative at the upper ages,
(ii) (ii) what is the approximate turning age at which the correlation turns negative, and
(iii) do Singapore and the U.S. differ in terms of the two issues in (i) and (ii)?

3.1 The Data

The data for the empirical study consist of the housing price index (HPI) which refers to the real residential property price index as the dependent variable and three classes of independent variables as listed below.

X_1: Population variables that consist of age groups.

X_2: Housing market condition represented by supply of houses and mortgage rate.

X_3: Overall economic condition represented by the unemployment rate.

The data set includes semiannual series for the stated variables over the period of 1998 to 2019 for Singapore and the U.S. The data sources and data descriptions are listed in Table A-1 of the Appendix. As shown in Table A-1, the age subgroups in this study consist of 25-34, 35-44, 45- 54, 55-59, 60-64, and 65+.

3.2 The Empirical Model and Estimations

A model of housing prices is devised along the lines suggested by Peek and Wilcox (1991) and Fisher and Woodwell (2015). The general empirical model for the HPI as the dependent variable and three classes of independent variables ($X1, X2, X3$) as defined in Section 3.1 above is stated as follows:

$$\Delta HPI_t = \beta_0 + \beta_1 \Delta X_{1t-j} + \beta_2 \Delta X_{2t-j} + \beta_3 \Delta X_{3t-j} + \varepsilon_t \qquad (1)$$

where Δ denotes the semiannual percentage change in a variable, t is the time index, and j is the lag order. The unit root tests and estimations use percentage changes for variables that are not already in the form of rate of change.

Unit root tests. The unit root tests of the percentage changes and rate series and their lags are shown in Table 1. The calculations are done by using the augmented Dickey Fuller (ADF) test with a constant, and the Schwarz's Bayesian Criterion (SBC) was used to select the optimal lag for the model from a set of lags that contained up to 9 lags. The results in Table 1 show that the series are stationary at rather significant levels.

Model estimations. Various forms of the model in Equation (1) were estimated for Singapore and the U.S. and subjected to the usual tests for goodness of fit, significance, and error autocorrelation. The least squares method was applied to the stationary variables. In absence of a concern about the existence of a combination of regressors that is stationary, methods such as cointegration are not particularly helpful.

The two estimation results for Singapore and the U.S. reported in Table 2 are the models that passed the overall screening among the group of models experimented. The residuals for the estimated Singapore and the U.S. equations

do not show a significant correlation, thus a system method of estimation does not offer significant improvement over individual country estimation. The equations were estimated with and without a binary control variable for the crash period of 2007-2008 in the U.S. and 2008-2009 for Singapore. Inclusion of the crash binary variables does not produce a significant difference as expected since the presence of the unemployment rate in the model sufficiently captures the crash periods. Some of the t-values of the coefficient estimates are not high to the usual levels but the estimates have the correct theoretical signs and their contributions to the overall fitness warrant inclusion.

Table 1 Augmented Dickey-Fuller (ADF) Unit Root Tests for the Variables, Singapore and U.S. Data: Semiannual Percentage Changes, 1998-2019.

Series	ADF-Singapore	ADF-U.S.
45-54 *t*	-3.798****	-3.762****
45-54 *t*–1	-3.759****	-3.829****
45-54 *t*–2	-4.987****	-3.922****
55-59 *t*	-3.984****	-4.262****
55-59 *t*–1	-3.889****	-4.203****
55-59 *t*–2	-3.843****	-4.153****
60-64 *t*	-2.277*	-3.508***
60-64 *t*–1	-2.272*	-3.460***
60-64 *t*–2	-2.271*	-3.432***
65+ *t*	-2.938**	-2.413*
65+ *t*–1	-2.829**	-2.427*
65+ *t*–2	-2.410*	-2.410*
Property price *t*	-5.911****	-2.754**
Property price *t-1*	-5.844****	-2.736**
Property price *t-2*	-5.751****	-2.695**
Lending interest rate *t*	-6.020****	-5.843****
Lending interest rate *t–1*	-5.955****	-6.091****
Lending interest rate *t–2*	-5.880****	-5.939****
Supply of houses *t*	-5.555****	-4.439****
Supply of houses *t*-1	-5.496****	-4.451****
Supply of houses *t*-2	-5.416****	-3.977****
Unemployment rate *t*	-4.954****	-3.988****
Unemployment rate *t–1*	-4.864****	-3.948****
Unemployment rate *t–2*	4.803****	-3.890****

Note: * p<0.15, ** $p < 0.1$, *** $p < 0.05$, and **** $p < 0.01$.
Data Sources: See Appendix.

Lags. As shown in Table 2, all of the remaining regressors for Singapore and the U.S. are identical and have identical lags of either zero (contemporaneous effect) or one except for the mortgage rate. As for the mortgage rate, the fitted

models that pass the theoretical sign criteria for the mortgage rate produce zero lag for the Singapore mortgage rate, and 4 lags (two years) for the U.S. mortgage rate, as shown in Table 2. The above is mainly explained as follows.

Table 2 **Estimates of Model (1) for Singapore and the U.S.**
Dependent variable: Real residential housing price index (HPI). *t*-values are in the parentheses.

Singapore		U.S.	
Explanatory variable (% change)	Estimate		Estimate
Intercept	3.841**	Intercept	2.435**
	(1.807)		(2.088)
Ages 45-54 *t*	1.194	Ages 45-54 *t*	0.489
	(1.439)		(0.683)
Ages 55-59*t*	-0.970***	Ages 55-59*t*	1.342***
	(-2.663)		(2.419)
Ages 60-64 *t*	-0.573	Ages 60-64*t*	-2.009****
	(-1.118)		(-3.544)
House supply *t-1*	-0.209***	House supply *t–1*	-0.077**
	(-2.287)		(-1.785)
Mortgage rate *t*	-0.581*	Mortgage rate *t–4*	-0.039
	(-1.597)		(-0.566)
Unemployment *t*	-0.151*	Unemployment *t*	-0.103***
	(-1.549)		(-2.143)
p-value on joint	0.002	*p*-value on joint	<0.0001
R^2	0.419	R^2	0.554

Note: * p<0.15, ** $p < 0.1$, *** $p < 0.05$, and **** $p < 0.01$.
Data Sources: See Appendix.
Data: Semiannual percentage changes, 1998-2019.

(i) Given that the U.S. residential housing market is less regulated than the Singapore market, it is likely that prior planning plays a more pronounced role in the U.S. residential housing market than in the Singapore housing market. Accordingly, changes in the mortgage rate have a long term effect in the U.S. market as market participants evaluate the long-term repercussions of a current mortgage rate change before making adjustments in their future investments. (ii) A closer look at Figure 2 reveals that the financial crisis of 2007-2008 had a subsequent adverse effect on residential housing prices that lasted nearly three years. The residential housing market in the U.S. did not recover until about 2011-2012, almost two years after the Federal Reserve launched a quantitative easing program which brought the real interest rate down to almost zero. The estimated 4 lags (two years) in Table 2 is within the realm of the stated crisis and its aftermath in the U.S. In Singapore, however, the residential price

response to the financial crisis of 2007- 2008 was rather brief and short-lived, as shown in Figure 2.

Aging effect. In regard to the effects of the main three upper-age subgroups, the results in Table 2 show that the correlation between upper age and housing prices do in fact turn negative at some point in both Singapore and the U.S. However, the approximate age at which the impact of age on housing prices turns negative, or the "turning age" as defined earlier, is 55 in Singapore but 60 in the U.S. The impact of the age groups on the HPI turns negative for Singapore at the age group 55-59 with an estimated negative coefficient of -0.970 and t-value of -2.663, but turns negative for the U.S. at the older age group 60-64 with an estimated negative coefficient of -2.009 and t-value of -3.544. The estimated coefficients of all three control variables in Table 3 have negative signs, which is consistent with the underlying theory and expectations. The regression significance as reflected by the estimated R^2-values suggest that the overall regression results are more reflective of variation in housing prices in the U.S. than in Singapore. Overall, the regression estimates reported in Table 2 offer sufficiently significant observations in regard to the impact of population subgroups on the HPI in Singapore and the U.S.

3.3 The Singapore Housing Market

Some of the relevant peculiarities of the Singapore housing market are discussed in this section. These peculiarities can partly explain for the divergences between Singapore and the U.S. that are evident in Table 2. The Singaporean government also greatly interferes with the housing market.

Furthermore, given the heavy government interference in housing market in Singapore, it is highly likely that most of the housing price fluctuations in the price data for Singapore are associated with the non-public housing market which mostly affects non-citizens. The majority of the Singapore housing market consists of flats that the citizens and permanent residents lease or mortgage from the Housing and Development Board (HDB).[4]

This study uses the private (non-HDB) residential price index series. We now provide justification for our use of the private residential price index. Under certain conditions listed by the HDB,[5] HDB flats can be re-sold by residents, thus HDB flats have their own market resale price index. Since the regression results emerge from variations in price indices, the relevant factor for the study is essentially the variation of the price index series. We compare the variation of the private residential price index series with that of the HDB resale price index

[4] Phang (2018b) offers one of the most recent and comprehensive reviews of the Singapore housing market and the role of the government in that market.

[5] The HDB conditions for resale by residents are listed in https://www.hdb.gov.sg/cs/infoweb/residential/selling-a- flat.

series over our study period of 1998-2019.[6] It turns out that the two series reflect almost identical variations over every sub-period of 1998-2019, except during the crash of 2008-2010 when the HDB resale price index shows a milder fall than the private residential price index.[7] An implication is that the correlation results that emerge from our study are expected to generally hold if we use the HDB resale price index, or a weighted average of the two price indices.

The estimated divergence in turning age between Singapore and the U.S. could be partially explained by the fact that the formal retirement age in Singapore is lower than that in the U.S. The divergence could also be partly the consequence of a large number of underlying factors that separate the socio-economic climate in Singapore from that in the U.S. Two of the more recent comprehensive studies that focus on some of the core distinctive factors related to the Singapore housing market are Phang and Helble (2016) and Statistics Singapore (2016).[8]

4. Concluding Remarks

This study empirically highlights some of the features of the economic activity of the upper age population in the housing market in Singapore relative to that in the U.S. The study uses parallel observations over the period of 1998 to 2019 on upper age subgroups in Singapore and the U.S. The results find that the elderly part of the population has a damping effect on housing prices in both Singapore and the U.S. A behavioral divergence between Singapore and the U.S. emerges when the analysis focuses on the impact of the finer upper age subgroups on housing prices in the two countries. The "turning age", defined as the approximate cut-off age when the impact of aging on housing prices turns from positive to negative, is roughly 55 in Singapore and 60 in the U.S. Several distinctive features of the Singapore housing market could explain for the divergence in the turning age.

The results here suggest that the cross-country policy applications that rely on the economic impact of aging are likely to require a prior understanding of the

[6] The source for the stated two series is the Singapore government data bank. The series chart for the private residential price index is shown in https://data.gov.sg/dataset/private-residential-property-price-index-by-type-of-property , and the series chart for the HDB resale price index is shown in https://data.gov.sg/dataset/hdb-resale- price-index.

[7] The result is also validated in Chia et al. (2017) in which the prices of public and private housing are found to be highly correlated with a correlation coefficient of 0.95 between 1990 and 2015.

[8] The behavior of the upper-age population group in Singapore has been the subject of some of the recent studies. While we focus on the behavior of that group in the housing market, a recent study by Takagi et al. (2020) focuses on a different behavioral aspect of that group, namely, the impact of gender differences in social relationships within that group.

impact of age subgroups at the country-specific level. For instance, if one adopts an economic definition of the cut-off age for getting old as when the correlation between age and housing prices turns negative, the results show that the cut-off age is roughly 55 in Singapore but 60 in the U.S. Such a differential could be useful to some of the international agencies such as the World Bank, International Monetary Fund (IMF), and the United Nations in some of their programs such as those that provide housing assistance to the elderly in various countries.

References

Bipartisan Policy Center (2012). Demographic Challenges and Opportunities for U.S. Housing Markets. March, Washington DC, Available at https://www.urban.org/sites/default/files/publication/25166/412520-Demographic-Challenges-and-Opportunities-for-U-S-Housing-Markets.PDF

Chia, W., Li, M. and Tang, Y. (2017). Public and Private Housing Dynamics in Singapore: The Role of Fundamentals. *Journal of Housing Economics*, 36, 44-61.

Doughty, E. (2016). What Is the Best Age to Downsize? We have the Answer. The Telegraph. March 28. Available at: https://www.telegraph.co.uk/goodlife/11729379/What-is-the-best-age-to-downsize-We-have-the-answer.html

Fisher, L. and Woodwell, J. (2015). Housing Demand: Demographics and the Numbers Behind the Coming Multi-Million Increase in Households. Mortgage Bankers Association, Washington D.C., mba.org/research, July report.

Green, R. and Hendershott, P. (1993). Demographic Factors and Real House Prices. Working Paper No. 4332, National Bureau of Economic Research.

Green, R., and Lee, H. (2016). Age, demographics, and the demand for housing. *Regional Science and Urban Economics*, 61, 86-98.

Harper, S. (2006). Addressing the Implications of Global Ageing. *Journal of Population Research*, 23, 205-223.

Mankiw, N. and Weil, D. (1989). The Baby Boom, Baby Bust, and the Housing Market. *Regional Science and Urban Economics*, 19, 235-258.

McFadden, D. (1994). Demographics, the Housing Market, and the Welfare of The Elderly. In D.A. Wise (ed.), *Studies in the Economics of Aging.* 225-288. University of Chicago Press.

Peek, J. and Wilcox J. (1991). The Baby Boom, "Pent-Up" Demand and Future House Prices, *Journal of Housing Economics*. 1, 347-367.

Phang, S. (2018a). Home Equity Extraction for Retirement Financing. In S. Phang, *Policy Innovations for Affordable Housing in Singapore*. Palgrave Advances in Regional and Urban Economics, 149-185.

Phang, S. (2018b). *Policy Innovations for Affordable Housing in Singapore*. Palgrave Advances in Regional and Urban Economics.

Phang, S. and Helble, M. (2016). Housing Policies in Singapore. Asian Development Bank Institute, Working Paper 559.

Saita, Y., Shimizu, C. and Watababe, T. (2016). Aging and Real Estate Prices: Evidence from Japanese and US Regional Data. *International Journal of Housing Markets and Analysis*, 9(1), 66-87.

Shoven, J. (1996), Comment on Is Housing Wealth a Sideshow? In D.S. Wise (Ed.), *Advances in the Economics of Aging*. University of Chicago Press. 268-271.

Siegel, J.S. and Swanson, D.A. (2004). *The Methods and Materials of Demography*, 2nd Ed. Elsevier Academic Press.

Statistics Singapore (2016). Households Spending by Age Groups. *Statistics Singapore Newsletter*, September.

Takagi, E, Saito, Y. and Chan, A. (2020), Gender Differences in the Association Between Social Relationships and Loneliness Among Older Adults in Singapore. *Journal of Population Research*. 37, 243-263

Takats, E. (2012). Aging and House Prices. *Journal of Housing Economics*, 21, 131-141.

U.S. Census Bureau (2009). Dependency Ratio in the United States: A State and Metropolitan Area Analysis. Social, Economic, and Household Statistic Division, U.S. Census Bureau, U.S. Department of Commerce, Washington, DC.

United Nations (2015). World Population Ageing 2015. Report by Population Division, Department of Economic and Social Affairs, United Nations. Available at:
https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf

Appendices

Table A-1 Descriptive Statistics for Singapore and the U.S., 1998-2019.
The sources are included in the right column of the table.

Variable	Mean	Std Dev	Minimum	Maximum	Source
Singapore					
Real residential property prices (Index 2010 = 100)	87.700	12.332	67.270	104.180	Bank for International Settlements
Population by age group					Derived by the authors from the Statistics Singapore and United Nations
Ages 45-54	806,015	148,687	509,070	956,389	
Ages 55-59	304,881	113,215	134,262	479,364	
Ages 60-64	242,682	92,868	119,675	401,172	
Ages 65+	390,688	133,760	234,872	719,331	
Ages 65+/total population (%)	7.911	1.617	6.171	12.393	Derived from the Statistics Singapore and United Nations
Supply of houses (All types private residential properties vacant)	18,122	5,030	11,685	29,517	Urban Development Authority of Singapore
Lending interest rate (%)	5.504	0.438	5.250	7.440	International Monetary Fund, International Financial Statistics
Unemployment rate (%)	3.234	0.932	1.700	5.200	International Labor Organization

(***Continued…***)

(Table A-1 Continued)

Variable	Mean	Std Dev	Minimum	Maximum	Source
U.S.					
Real residential property prices (Index 2010 = 100)	115.034	18.113	87.440	154.600	Bank for International Settlements
Population by age group					Derived from the U.S. Census Bureau
Ages 45-54	41,742,406	2,953,314	34,100,000	45,006,716	
Ages 55-59	18,316,125	3,273,864	12,079,000	22,409,366	
Ages 60-64	15,331,880	3,467,788	10,162,000	20,429,652	
Ages 65+	40,903,085	5,957,637	34,285,000	53,340,089	
Ages 65+/total population (%)	13.350	1.272	12.275	16.210	
Supply of houses (Ratio of houses for sale to houses sold,%)	5.655	1.877	3.800	11.067	US Department of Housing and Urban Development
Freddie Mac 30-year fixed mortgage rate (%)	5.374	1,356	3.456	8.290	Freddie Mac
Unemployment rate (%)	5.870	1.824	3.661	9.939	U.S. Bureau of Labor Statistics