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## Singapore's cooling measures and its housing market<sup>☆</sup>

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### ABSTRACT

With real estate markets booming in Asia, governments are trying to stabilize property prices to address deteriorating affordability conditions, especially for superstar cities. There have been various economic interventions across countries, but little has been learnt about the true effects of such policy actions for housing markets or the broader economy. In this paper, we use both macro-level economic data and micro-level house transaction datasets to evaluate the effects of the cooling measures in Singapore. We find that the policies appear to have achieved their primary goals: house prices have fallen by 10%–15% according to different price indices for the public and private sectors. We also show that there is no clear evidence that the cooling measures caused significant collateral damage to the broader economy.

### 1. Introduction

Superstar cities are those that experience high house price growth relative to the increase in housing supply increase over long periods of time. Since the influential paper by Gyourko et al. (2013), superstar cities have drawn increasing attention.<sup>1</sup> One key feature of these markets is that strong demand worsens affordability conditions and crowds out low-income families. To address this problem in superstar cities, governments across the world have adopted various policies, but little has been learnt about the true effects of their policy interventions. In this paper, we study the impacts of ten rounds of cooling measures during a recent housing market boom in Singapore.

Housing is an incredibly important asset in Singapore, not least because just over 90% of all households own their units. Home equity is 40% of household sector net worth in Singapore, which is far greater

than the analogous share of 14% in the United States.<sup>2</sup> The residential building sector comprises a significant share of overall economic activity, too. Expenditures on 'Residential Buildings' comprised 28% of all gross fixed capital formation in Singapore for 2015, and amounted to just over 7% of GDP. Additionally, governments around the world have a strong interest in their housing markets for social reasons, too. Housing is the locus of where people spatially organize their personal and professional lives. Distributional issues often are relevant in the sense that affordability conditions can be a central concern for policy-makers (McMillen, 2008).

These factors often lead governments to intervene in their housing markets, and Singapore is no exception. This government is centrally involved in the property markets generally via sales of public land for private (and public) building. More recently, the government decided to respond to a large increase of 40%+ in its aggregate housing prices

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<sup>1</sup> Some recent papers that study the phenomenon of persistently high house price growth include Himmelberg et al. (2005), Watson et al. (2006), Shiller (2007), Aura and Davidoff (2008), Saks (2008), Card (2009), Van Nieuwerburgh and Weill (2010), Paciorek (2013), Behrens et al. (2014), Gyourko and Molloy (2014), Johnson (2014), and Favilukis et al. (2017).

<sup>2</sup> All figures in this paragraph are from *Yearbook of Statistics Singapore, 2016*. The next section goes into more detail on the importance of housing in the Singaporean economy.

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following the global financial crisis. In addition to potential financial stability worries raised by this sharp increase, affordability conditions deteriorated by about one-third between 2007 and 2010, as reflected in rising price-to-income ratios for those buying modest-sized HDB flats.<sup>3</sup>

The Singaporean government decided to try to cool its housing market via a series of ten interventions that began in September 2009, with the last round implemented in December 2013. Housing prices in the public (HDB) and private sectors kept rising through the middle of 2013, around the time of the eighth specific policy announcement (each of which is described more fully in Section 3). Subsequently, prices fell by 10%–15% according to different price indices for the public and private sectors. Over this same time period, economic growth in Singapore has slowed, but statistical analyses we conducted to test for comovement between housing price and economic fundamentals such as GDP and consumption do not show a tight link between changes in the series. This does not mean that real estate has no impact on the broader economy; it does; rather it indicates that Singapore's cooling measures have not generated any type of major collapse in the broader economy. Affordability conditions as we measure them in terms of price-to-income ratios for modest quality purchasers in the HDB sector have returned to pre-price jump levels.

These are beneficial outcomes, but caution remains in order regarding the magnitude of the overall success of the intervention. The drops in prices are relatively recent; they began in mid-2013 with stabilization occurring within the past year or so. There could be lagged responses in terms of households slowly adjusting consumption or firms altering their investment plans downward that our statistical tests based on currently available data are not powerful enough to pick up. Moreover, there are the standard economic concerns about inefficiencies generated from deadweight losses associated with each imposition of a tax as reflected in a new and different seller's stamp duty. Many were imposed throughout the long cooling process. Different policies were imposed roughly every six months, making it virtually impossible for us (or the government) to know what the impacts of any one intervention were. Such a strategy is bound to raise uncertainties for households, builders, and investors. That can generate its own efficiency losses in a complex durable goods market such as housing.

To evaluate the effects of the cooling measures in Singapore, we use micro-level house transaction datasets. We focus on Seller's Stamp Duty (SSD), Additional Buyer's Stamp Duty (ABSD), Total Debt Servicing Ratio (TDSR), and the general loan-to-value (LTV) in Singapore in this study. We investigate the effects of policy changes in September 2009, February 2010, August 2010, January 2011, December 2011, October 2012, January 2013, June 2013, August 2013, and December 2013, respectively. We employ different identification strategies. To estimate the net effects of these policies on housing market, we apply the regression discontinuity method.

This paper is one of the first studies on the effectiveness of government intervention in property market and its implications to the general economy. As such, the empirical results provides important implications for the future policy design. Moreover, the use of large scale micro-level transaction data, together with the identification strategy design, enable us to obtain credible estimations of the policy effects.

The remainder of the paper proceeds as follows. The next section provides an overview of Singapore's housing market and its role in the general economy. This is followed in Section 3 with a detailed description of Singapore's series of cooling efforts, along with two statistical tests of their effects. The paper closes in Section 4 with a broader discussion of the benefits and costs of Singapore's intervention strategy and suggests some changes that we hope will improve similar efforts in

the future.

## 2. Real estate in the Singaporean economy

Singapore is a city-state with very limited land resources. Its population density is high at just over 8000 people per square kilometer, as a resident population of 5.784 million lives on a total land area of 719.1 km<sup>2</sup>. The country is also highly developed, as its gross domestic product (GDP) per capita is Int\$87,855, which ranks Singapore among the top four in the world (International Monetary Fund, 2016).

Real estate is a very important component of Singapore's national economy. The category 'Residential Buildings' comprised 28% of all Gross Fixed Capital Formation in the country in 2015. In absolute Singaporean dollars, this was 28.8 billion out of 102.7 billion in total Gross Fixed Capital Formation.<sup>4</sup> That amounts to 7.2% of the 402.5 billion in GDP that same year. This is much higher than the analogous share in the United States, which was 3.4% of American GDP in 2015.<sup>5</sup>

The economic importance of the housing sector is highlighted by how much of it there is, how valuable it is and by its share of total assets in the household sector's balance sheet. The stock itself is large and the ownership rate is high in Singapore. There were 1,322,900 residential dwelling units according to the *Yearbook of Statistics Singapore, 2016*, more than enough to house the 1,225,300 households recorded in the *General Household Survey 2015*. A breakdown of unit types is as follows: 74.1% (or just over 980,000) were HDB flats, 19.4% (about 257,000) were condominiums or other private sector apartments, with 5.6% (about 74,000) being landed homes, and just under 1% being of another typically low-quality unit (e.g., shop houses, zinc-roofed units, etc.). The vast majority of these units is owned, as Singapore's homeownership rate is just over 90%, compared to a little over 60% in the United States.

In 2015, Residential Property Assets were worth 833.5 billion Singaporean dollars and comprised nearly 49% of the 1.82 trillion in total assets held by the household sector according to *Yearbook of Statistics Singapore 2016*. On average, Singaporean households do not have a substantial amount of mortgage debt taken out against their homes. In 2015, there were 224.8 billion in mortgages outstanding according to the *Yearbook of Statistics Singapore, 2016's* data on the household sector balance. That implies about a 27% aggregate loan-to-value ratio of homes for the household sector overall ( $224.8/833.5 \approx 0.27$ ). Not surprisingly, housing's share of the net worth of Singaporean households is quite high—at 55% ( $833.5/1518 \approx 0.55$ ), although home equity's share of net worth is only about 40% ( $608.7/1518 \approx 0.40$ ). These numbers show housing to be a more important component of household sector net worth than even in the United States. In America, total house value is on 22% of all household sector assets.<sup>6</sup> That this is only 25% of American household sector net worth is at least partially due to the higher homeownership rate in Singapore, which was 90.8% in 2015 versus about 63% in the United States. Home equity as a share of household sector net worth in America was only 14% in 2015.

These data demonstrate how important housing wealth is in the Singaporean economy. The large share in the Singaporean household

<sup>4</sup> All Singaporean national accounts figures are for 2015 and are from the *Yearbook of Statistics Singapore, 2016*. This includes public and private residential building, with the private sector contribution being 80% of the total in 2015.

<sup>5</sup> In the U.S. national income accounts, this category is called Residential Fixed Investment. Its share got as high as 6.1% near the height of the U.S. housing boom in 2005, but 2%–4% are more typical numbers across American housing cycles.

<sup>6</sup> All U.S. household balance sheet data in this section are from Table B.101 Balance Sheet of Households and Nonprofit Organizations (1) from the *Federal Reserve Statistical Release Z.1 Financial Accounts of the United States, Historical Annual Tables 2005-2015*.

<sup>3</sup> This is based on calculations we made of affordability conditions over time. Section III provides more detail.

sector's balance sheet suggests that there could be potentially important economic ramifications of changes in house prices (via possible wealth effects on consumption) or housing unit construction (directly impacting measured GDP). Thus, the consequence of regulatory interventions could impact not only the real estate industry but the broader economy. We will return to these potential impacts later in this study.

### 3. Government intervention in the land and housing market in Singapore

#### 3.1. Overview

The Singapore government has played a pivotal role in developing and managing the residential land and property market. In 1960, the Singapore Government Housing Development Board (HDB) was established to address the fact that 1.3 million people, out of an estimated population then of 1.89 million, were squatters in slums. A quarter-century later in 1985, Singapore had virtually no squatters, no ghettos, and no large ethnic enclaves. That success is far more than a housing development and regulation story, of course, as it reflects broad and deep economic development at the societal level. Still, the Singaporean government has been an active participant in its housing market for many decades.<sup>7</sup>

Since its inception, HDB has built 1,116,485 residential dwelling units (including 8,650 HDB Design, Build and Sell Scheme (DBSS) units.<sup>8</sup> Just over four-fifths (82%) of Singapore's resident population lived in HDB flats as of 2016. This publicly-provided housing constitutes the largest stock of affordable units, with landed and non-landed housing units in the private market being much more limited in number, but providing a variety of choice of unsubsidized housing units for middle- and high-income households. In a typical upward housing mobility process, households facing liquidity constraints start the housing ladder by buying public housing units at concessionary prices from the government. One of the government's goals is for households to build housing wealth through price appreciation and non-cash subsidies in the form of concessionary prices for new public housing purchases. As the data reported above show, the government has been successful in this respect, as housing wealth is a very large component of the typical Singaporean household's net worth.

Fig. 1's chart of the shares of state versus private land in total land sales over time shows that the Singaporean government has a very strong presence in the land market, too. Since 1970, the share of overall land sales coming from public sector holdings has exceeded that from the private sector. Presently, the vast majority of land sales for future development are from state-owned parcels. More generally, the government sets reserve prices which serve as triggers for formal auctions if a private party signifies a willingness to pay the reserve price. Price-setting is one way in which the government can control the supply of land available for developers.

The supply of residential units has been highly volatile over time, both from the HDB and private sectors. Fig. 2 plots construction activity of HDB flats annually since 2007. Note that HDB completions fell very close to zero in 2008 before ramping up to nearly 20,000 in 2011. Since then, completions have ranged from barely 10,000 in 2012 to well over 25,000 in 2014 and 2015. Thus, annual completions of HDB flats have ranged from roughly 0%–2.5% of the national stock of housing units over the past decade. Until very recently, permits have exceeded completions which implies that units 'under construction' have been rising. This is indeed the case as Fig. 2 shows, although part of the

<sup>7</sup> See Deng, Sing and Ren (2013), and Phang and Kim (2013) for more elaborated discussions on Singapore's public housing market and government's active participations in the housing sector over the last several decades.

<sup>8</sup> DBSS was introduced by the HDB in 2005 where flats built by the private developers under the DBSS scheme are for public housing.

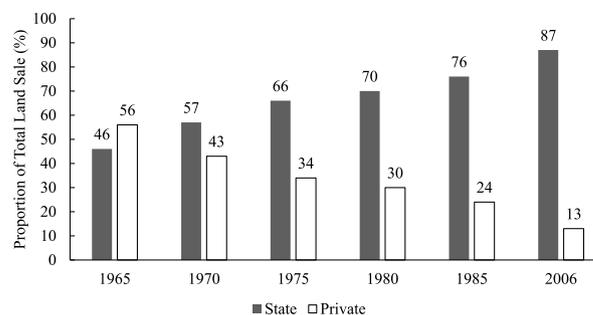


Fig. 1. Singapore state vs private land shares over time. Notes: the data are from the Singapore center for livable cities.

increase in this series reflects inventory from years prior to 2007.

Volatility in supply-side activity in the private sector has been high, too. Fig. 3 plots annual private sector unit approvals and completions since early 2009. Approvals have varied from 5000 units (in 2009) to 25,000 per year (in 2007 and 2010) over very short time spans. Approvals have been trending down since 2010–2011 and are back to the lows seen in the global financial crisis. In contrast, completions have trended up over this time period, although their rate of growth slowed over the last couple of years. Since 2014, private sector completions have averaged around 20,000 units per year, or roughly twice the levels observed in most prior years this century.

Actual purchases of housing units also show substantial volatility over time. Figs. 4 and 5 plot sales volumes of HDB and private sector units, respectively. HDB flat sales have varied from just under 5,000 in 2009 at the height of the global financial crisis to well over 20,000 per year in 2014 and 2015 (and in 2000 and 2001). For many years prior to the global financial crisis, purchases of HDB flats exceeded new units constructed, sometimes by as many as 10,000 homes.

Since 2009, construction has outpaced sales annually. Transactions volumes in the private sector also have varied substantially over time. Fig. 5 (red bars) shows they quintupled over the 2006–2007 period alone, before falling back to virtually zero in late 2008 and early 2009. They bounced back sharply over the ensuing year, but have trended down since then. Thus, in the private sector, we see a market in which permits have fallen to very low levels, but completions are relatively high while purchase activity is low.

Fig. 6 reports prices in the public sector. This series tracks resale prices of HDB flats. This HDB Resale Price Index (RPI) is calculated using resale transactions registered across towns, flat types, and models. The base period is the 1st quarter of 2009 so that RPI has a value of 100 in 1st quarter 2009.<sup>9</sup> Note that the HDB index increased by nearly 50% from early 2009–June 2013, before flattening out and then falling by 10.4% from an index value of 149.4 in June-2013 to 133.9 in March-2017.

Fig. 7 then reports a private sector series published by the National University of Singapore's Institute of Real Estate Studies.<sup>10</sup> This series

<sup>9</sup> The details of the construction the HDB RPI can be found in HDB InfoWEB, Resale Statistics, Resale Price Index (RPI), (<http://www.hdb.gov.sg/cs/infoweb/residential/buying-a-flat/resale/resale-statistics>).

<sup>10</sup> The Singapore Private Residential Price Index [SRPI] is a monthly transactions-based housing price index developed and maintained by the Institute of Real Estate Studies (IRES) at the National University of Singapore which tracks the price changes of completed private non-landed residential properties. The SRPI is computed based on the market value of a fixed basket of properties selected to represent the private non-landed residential market. The private non-landed residential market in Singapore consists of projects with freehold land title as well as those with leasehold land title. The prices of leasehold properties are converted to equivalent freehold prices before being incorporated in the index calculation; the SRPI thus represents the market price movement in terms of (equivalent) freehold prices. Interested readers should see the publication "[http://www.ires.nus.edu.sg/webapp/srpi/srpi\\_im.aspx](http://www.ires.nus.edu.sg/webapp/srpi/srpi_im.aspx)"

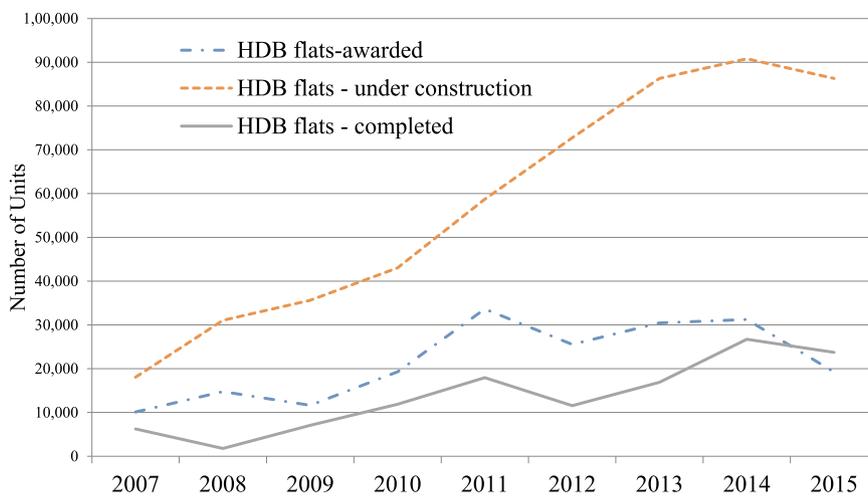


Fig. 2. Public sector building activity. Notes: the data are from data.gov.sg.

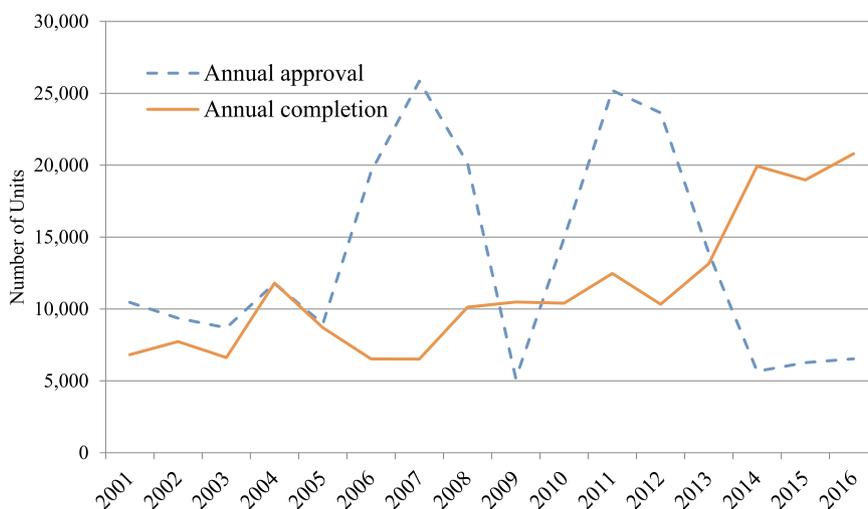


Fig. 3. Private sector residential approvals and completions, annually, 2001–2016. Notes: the data are obtained from the urban redevelopment authority (URA) of Singapore. These series exclude hostels, HDB flats, tenement houses, parsonages and Executive Condominiums.

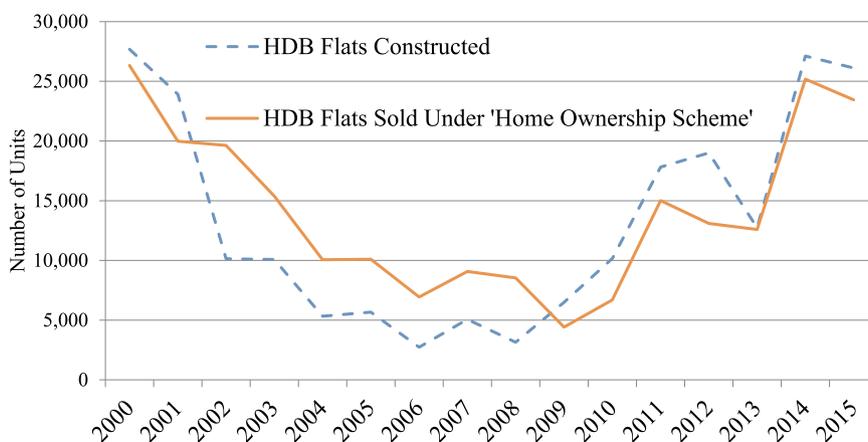


Fig. 4. HDB flats constructed and sold, annually, 2000–2015. Notes: the data are from data.gov.sg.

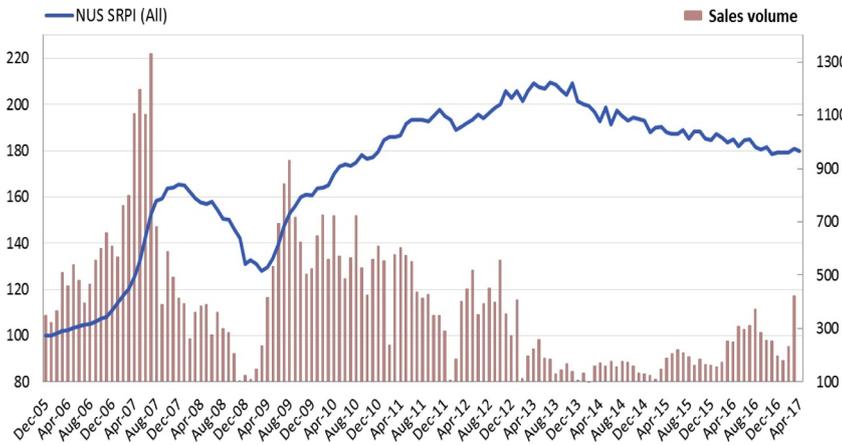
begins further back in time so that we can see the sharp rise in values before the global financial crisis, the bust during that crisis, and then the 40.6% increase to its peak in July 2013. This series shows a 13.8%

(footnote continued)

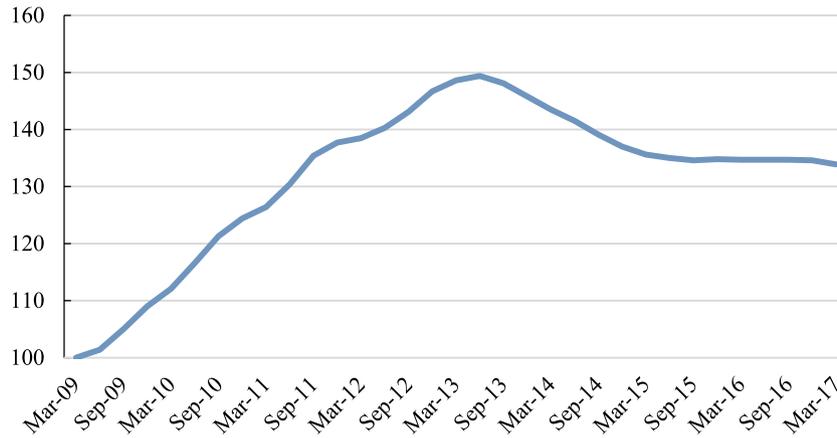
for more detail on how changes in unit quality are controlled for in this series.

decline since then.

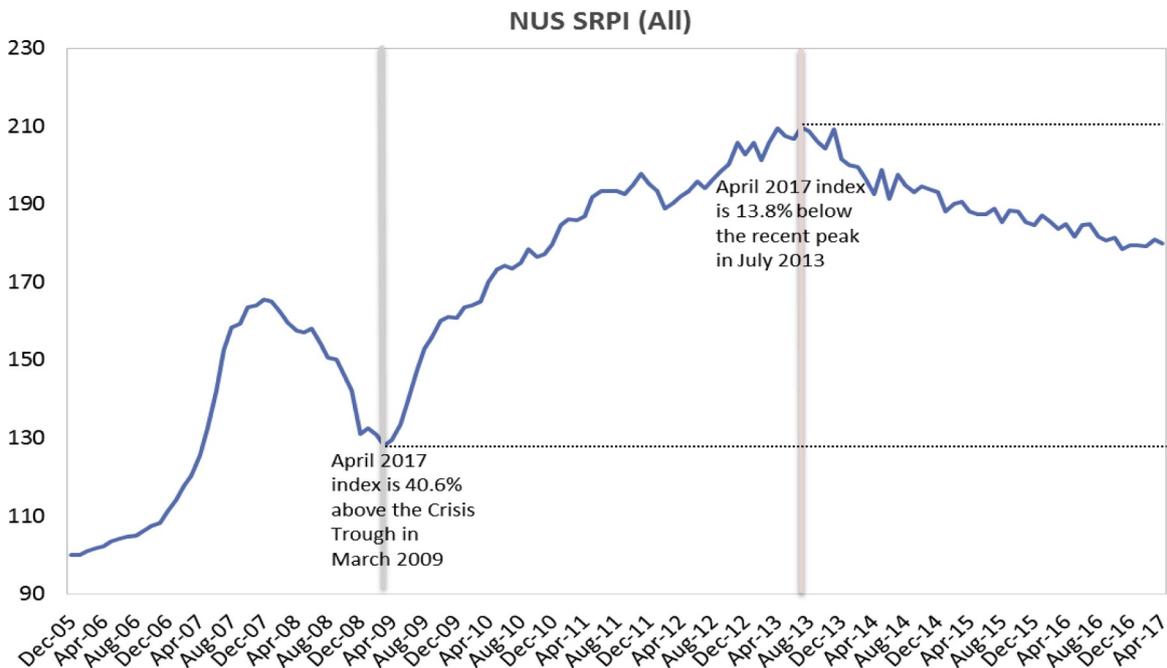
Thus, these two price-series show house price appreciation of from 40%–50% from the beginning of 2009 through mid-2013, followed by drops of just over 10% since their 2013 peaks. The sharp rise in prices after the global financial crisis certainly played a major role in the government's decision to intervene to cool the housing market. As the



**Fig. 5.** Sales volumes in the Singaporean private property market (2009.03–2017.04; 2005.12 = 100). *Notes:* the NUS SRPI is constructed by NUS Institute of Real Estate Studies. The sales volume data are obtained from the REALIS of URA. See the URL at <https://spring.ura.gov.sg/lad/ore/login/index.cfm> for more detail about the REALIS dataset.



**Fig. 6.** HDB Flats Resale Prices (2009Q1 = 100). *Notes:* The data are obtained from the HDB InfoWEB, Resale Statistics, Resale Price Index (RPI).



**Fig. 7.** Private Sector Price Series (NUS Singapore Residential Price Index, SRPI). *Notes:* The NUS SRPI is constructed by NUS Institute of Real Estate Studies. See footnote 9 for more details.

next subsection documents, it did so via a sequence of policy changes.

### 3.2. Policy measures to cool Singapore's housing Market: September 2009-December 2013

The government's interventions to cool the housing market are detailed in Appendix Table 1. The first intervention occurred on September 14, 2009, with the removal of then extant policies to boost the housing market. This was followed by nine other measures that were imposed between February 20, 2010, and December 9, 2013.

The initial September 2009 policy abolished the then extant Interest Absorption Scheme (IAS) and Interest-Only Housing Loans (IOL) programs. At the same, it was announced that January 2009 budget assistance measures pertaining to the Residential Property Act would not be extended.

Within a half year on February 20, 2010, the government clearly was still worried about negative consequences of speculative activity, as it introduced a Seller's Stamp Duty (SSD) for properties sold within 1 year of purchase (up to 3% of the sales price) and simultaneously lowered the loan-to-value ratio (LTV) to 80% for all housing loans provided by Financial Institutes.

After another roughly half year period, on August 30, 2010, the SSD was changed to be levied on properties sold within 3 years of purchases (more specifically, 3% for properties sold within 1 year; 2% for 2 years and 1% for 3 years). For buyers already having one or more outstanding housing loans (including HDB loans), the required minimum cash payment was increased from 5% to 20% of purchase price, and LTVs were lowered from 80% to 70%.

The fourth round of cooling measure was announced on January 14, 2011. The SSD was increased again, this time to cover properties sold within 4 years of purchase. The effective tax rates became much higher, too: 16% for properties sold within 1 year; 12% for 2 years; 8% for 3 years and 4% for 4 years. The LTV was further lowered to 50% for purchasers that were not individuals or households. For individuals and households with one or more outstanding housing loans, the LTV was lowered to 60%.

Nearly a year passed before the government introduced an Additional Buyer's Stamp Duty (ABSD) on December 8, 2011. This included an additional 10% duty for foreigners, added 3% for a primary resident's second property, and 3% for a Singaporean's 3rd + property.

Cooling round 6 was initiated on October 6, 2012, with the announcement that the length of all residential loans would be capped at 35 years. Loans with terms in excess of 30 years would have more burdensome LTV requirements, a rule that was applied to both private and HDB properties.

As Figs. 6 and 7 show, house prices in both the public and private sectors continued to rise. So, on January 12, 2013, the government introduced a new set of cooling measures that included provisions for ABSDs, LTVs, and minimum cash requirements at purchase. Appendix Table 1 provides more detail on these features, which involved the strengthening of already existing measures. A new intervention was the imposition of a mortgage service ratio (MSR) for HDB loans used to finance purchases or refinancings. No more than 30% of a borrower's gross monthly income could be used to finance payments on housing. Another policy introduced was a requirement that primary residents would have to sell their HDB flat within six months of purchasing a private sector housing unit.<sup>11</sup> Finally, this portfolio included restrictions on Executive Condominiums (EC). The maximum strata floor area of new EC units was capped at 160 m<sup>2</sup>. Sales of new dual-key EC units were restricted to multi-generational families. Developers of future EC sale sites from the Government Land Sales program were permitted to launch units for sale fifteen months from the date of the award of the sites or after the physical completion of foundation works, whichever

was earlier. And, private enclosed spaces and private roof terraces were to be treated as gross floor area (GFA). The GFA of such spaces in non-landed residential developments, including ECs, would be counted as part of the 'bonus' GFA of a residential development and subject to payment of charges. This is in line with the treatment of balconies under URA's current guidelines.<sup>12</sup>

In the summer of the same year (June 29, 2013), the government instituted a total debt service ratio (TDSR) that was capped at 60% for property loans taken out against Singaporean and overseas properties (whether by individuals or entities established solely to purchase properties). Later that same summer, on August 28, 2013, the government reduced the maximum HDB loan tenure from 35 to 30 years and made the maximum LTV on HDB loans more binding for certain types of loans and borrowers.

The tenth and final cooling round occurred on December 9, 2013. With this initiative, the government introduced three new measures to refine its Executive Condominium Housing Scheme.

Appendix Table 1 describes each of these measures more fully. No further cooling measures were introduced, but it was not until March 10, 2017, that the government formally announced changes that ended the string of interventions to cool Singapore's housing market. Changes to the SSD and TDSR were announced, but there were no changes to extant ABSD or LTV limits.

### 3.3. Evaluating the impact of Singapore's efforts to cool its housing market

There are formal and informal ways to investigate whether the Singaporean government interventions had substantial impacts on the housing market specifically or the broader economy more generally. Informally, one can simply look at what happened to the price growth series. Both public and private market series kept rising for almost three years after the first cooling initiative was announced and only started to fall by the latter half of 2013. However, such 'eyeball econometrics' certainly cannot attribute causality to any one intervention or to a group of interventions.<sup>13</sup> And, those aggregate series can mask important heterogeneity in how prices changed across different subsets of the housing market.

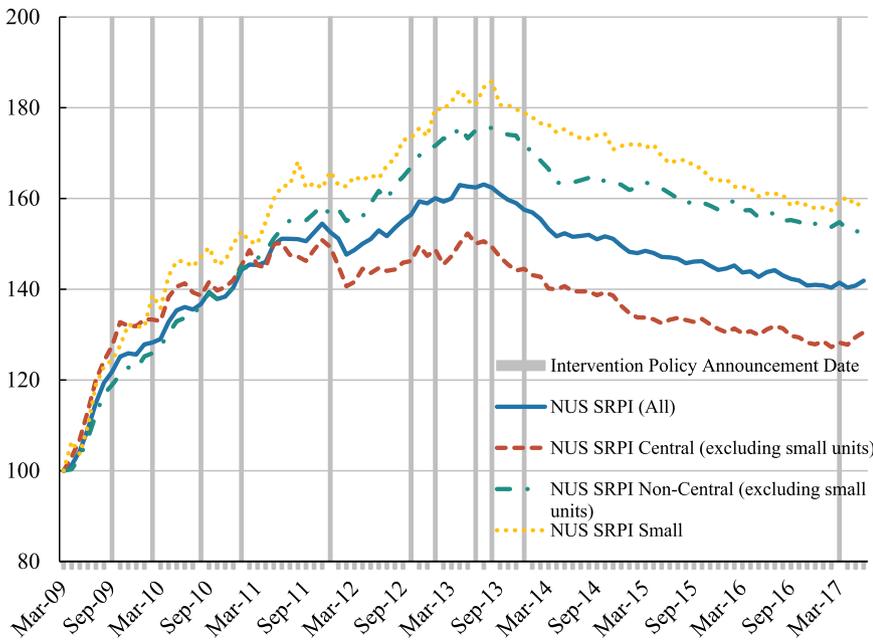
The potential importance of looking in more detail within a market is illustrated in Fig. 8's plot of price indexes for different sectors of the private, non-landed market. The highest-end part of the market is depicted by the red curve for the Central Sector of Singapore. Lower quality, smaller units are tracked in the yellow curve, with the green line for units outside the Central Sector. All sectors are indexed to a value of 100 in the third quarter of 2009. Individual policy interventions are marked by the blue, vertical dashed lines. Note that price growth in the more expensive neighborhoods in the Central Sector experienced little more than half the appreciation seen outside the Central Sector and among smaller units. Price appreciation across higher versus lower quality units started to diverge in mid-2010 and widened more dramatically from 2011–2013.

That what happened on average in a market differs from what happened away from the mean can be highly relevant for policy analysis. It begs the question of whether the government intended to have a larger impact on the high end of the housing market relative to the lower end. One of the potential downsides to any intervention is

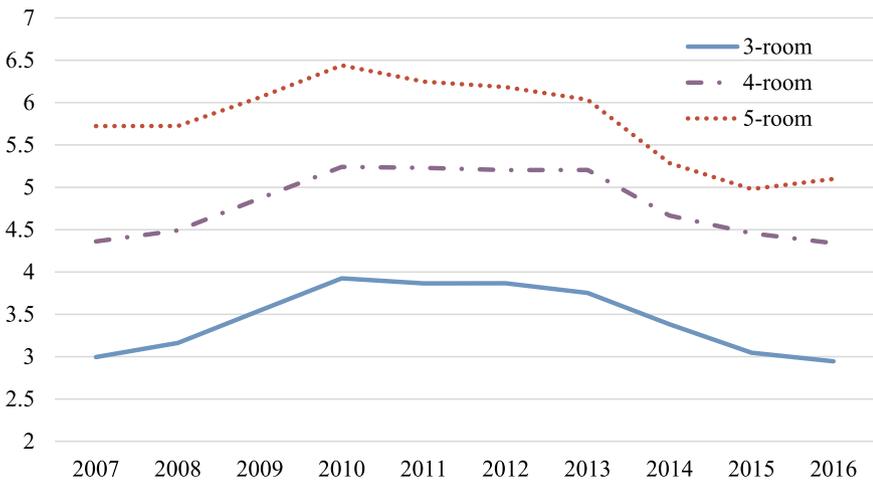
<sup>12</sup> Interestingly, this announcement also included the first SSD for non-residential properties. For Industrial properties, the SSD was 15% on properties held for under one year, 10% for those held between one and two years, 5% for those held between two and three years, with no duty imposed on properties held for at least three years.

<sup>13</sup> More specifically, one should not jump to the conclusion that the restrictive TDSR regulation imposed in late June of 2013 was the causal factor. We will address this issue more formally below, and will show that there were not any materially differential changes in price when comparing activity just after the intervention to just before the intervention.

<sup>11</sup> There also were rules introduced prohibiting the subletting of entire flats.



**Fig. 8.** Prices across Space and Quality in the Private Sector NUS Singapore Residential Price Index (SRPI) (2009.03–2017.07, 2009.03 = 100). *Notes:* The NUS SRPI is constructed by NUS institute of real estate studies (See footnote 9 for more detail). The red line measures the house price movements for the Central region, the high-end market; Green line is the index for the non-central region; and the yellow line is the index for the market of small housing units. The vertical lines indicate the dates of announcement for the cooling measures.



**Fig. 9.** Housing affordability for the median income household purchasing 3-, 4-, and 5-room HDB Flats. *Notes:* HBD price data are obtained from the HDB official website (<http://www.hdb.gov.sg/cs/infoweb/residential/buying-a-flat/resale/resale-statistics>). Household income can be found here <http://www.tablebuilder.singstat.gov.sg/publicfacing/create-SpecialTable.action?refId=12313>.

unintended consequences, and this could have been one of them.

That said, housing affordability for the typical Singaporean did not deteriorate, especially for the median income household who almost certainly resides in an HDB flat. Using data from the HDB official website and median household income data, we computed the number of years of income needed to buy 3, 4, and 5 room flats, as well as so-called Executive units. Fig. 9 plots the results. For a modest quality, 3-room flat, the price-to-income ratio for the median income household was about 3 in 2007 before the big run-up in price. That ratio increased to nearly 4 by 2010 but has now returned to pre-boom levels. A similar pattern can be seen for other types of housing units. Across the time span of the different cooling measures, high-quality units may have appreciated the least in percentage terms, but there still is no meaningful sense in which one can conclude that affordability conditions are worse now for the typical Singaporean household, especially for modest quality units.

### 3.3.1. Cointegration analysis

The discussion above documenting housing's importance in both the household sector's balance sheet and in Singapore's aggregate economy more generally raises the possibility that if policy interventions change house prices (or if house price changed exogenously for some other

reason), then we might also see ramifications in other macro variables. For example, changes in house prices could affect consumption (or output) as follows. We know from above that housing equity is a major component of overall household wealth for the typical Singaporean household (who is an owner-occupier). Thus, if prices fall so that home equity declines, the household may need to reduce consumption to restore its desired household wealth position.<sup>14</sup> It is also possible that the scale of the real estate industry documented above could engender a tight link between prices (or price changes) and the broader economy as reflected in measured GDP.

We use cointegration tests to identify whether house prices covary over time with macroeconomic indicators such as GDP, consumption, exports or imports, etc. They are obtained from the Singapore Department of Statistics (<http://www.singstat.gov.sg>). The quarterly private house prices and transaction volume variables are constructed

<sup>14</sup> Agarwal and Qian (2017) study the consumption response to a housing policy experiment in Singapore that resulted in a decrease in access to home equity. They report a statistically significant negative consumption response to the housing market cooling policy shock, but their time period of analysis was before prices actually fell, so it is not precisely the right experiment for our purposes.

based on the REALIS dataset. The REALIS dataset provides us details of each transaction on private residential properties since 1995. By taking the average of house prices in each quarter, we get the quarterly private house price variable. The transaction volume is defined as the total number of transactions on private residential properties in each quarter. For the public sector, we use the Resale Price Index obtained from the HDB InfoWEB. The formal models we estimate, along with the statistical results, are described in Appendix 2. Our tests use data from 1995(1)–2015(1).

Abstracting from the technical estimation details, we do not find convincing evidence that house prices (whether measured by the HDB series or a unit housing price series we construct) move together strongly with GDP, consumption, exports or imports. More formally, we fail to reject the null that the housing market price series are not cointegrated with the different macro variables in levels or first differences (i.e., price changes). Thus, the data do not provide support for the contention that falls in house prices have resulted in materially lower consumption in aggregate, which suggests that there is not a strong aggregate housing wealth effect channel in the Singaporean data.<sup>15</sup>

Does this imply that we were wrong above in arguing that real estate in general and housing, in particular, are important components of the Singaporean economy? No, and the reasons are as follows. One is that changes in house prices that affect home equity may not actually impair household wealth in a way that impacts consumption. To see why, consider a household that owns a \$500,000 home that appreciates by 20% and is now worth \$600,000. Is the household really \$100,000 wealthier (presuming debt and all else is held constant)? Not necessarily. The household could sell its home for \$600,000 in the current market, but it needs to live somewhere. If it cannot trade down in quality and buy a cheaper home, so that continues to live in the same quality house, then it will cost \$600,000 to buy that unit. This household is not really wealthier from the rise in price.<sup>16</sup> In this sense, homes are different from stocks and other purely financial assets. If the same household bought a stock portfolio for \$500,000 last year and it is now worth \$600,000, the household is \$100,000 wealthier, as it can maintain ownership of \$500,000 worth of stocks, sell the rest and spend the proceeds on consumption without lowering its original holdings of stock.<sup>17</sup>

Another potentially important reason why changes in prices might not move together with changes in output, consumption, imports or exports are that the impacts might occur only with a long lag and that we need more time to observe the impact of the recent drop in prices in particular. This could happen for a number of reasons. One is that adjustment costs may be high enough that households cannot (or do not want to) change spending patterns very quickly. Another is that it may take a long time for changes in house prices to be salient enough for households to recognize what has happened. The recent drop since 2013 has been fairly mild (at the median) and has occurred slowly over

<sup>15</sup> One might be concerned that this index also reflects changes in the quality of transacted units over time. To address this issue, we constructed another index which includes transacted unit fixed effects. That new index was then used to re-run our cointegration analysis. The results indicate that our conclusions are robust to the different type of indexes. Results for both exercises are available upon request.

<sup>16</sup> More formally, Poterba's (1984) user cost of housing model implies that the costs to this owner of living in the home rise proportionally to the rise in asset value. The two effects counterbalance and there is no net change in wealth.

<sup>17</sup> Other reasons to think that housing-related wealth effects might exist is that financially constrained households might be able to borrow against rises in home equity to finance added consumption. This is widely believed to have happened in the United States during its last boom, but that requires a capital market and government regulator that supports cash-out refinances. These are much less prevalent in Singapore (and other major Asian countries such as China).

time. More dramatic spikes or falls such as those that occurred at the end of the last U.S. housing cycle in markets such as Las Vegas and Phoenix might have different impacts.

The second set of results in Appendix 2 estimates the degree of cointegration of transactions volume in the housing market with the same macroeconomic variables. We do find cointegration between transactions volume and macro variables when we do not restrict the trend, but those results are not robust to imposing a trend. Thus, it is possible that the cointegration relationship we do find is due to spurious trend co-movement between the two series. The scale of the building activity relative to the overall economy suggested that there would be some linkage, but the evidence is not strong. In addition, one needs to be careful that cointegration does not imply a specific direction of causality (e.g., from housing to the broader economy).

We do not encourage interpreting these particular results as indicating that changes in the housing market have had literally no impact on macroeconomic aggregates in Singapore. As just noted, there is some evidence that transactions volumes in the housing market might be cointegrated with macro variables such as output, consumption, exports, and imports. And, house prices (and their changes) may have complex and lagged effects that our tests and data simply cannot identify. That said, the lack of strong cointegration with prices does indicate that the Singaporean government's interventions to cool the housing market have not as yet resulted in major (negative) changes in aggregate consumption or output.

### 3.3.2. Regression discontinuity (RD) analysis

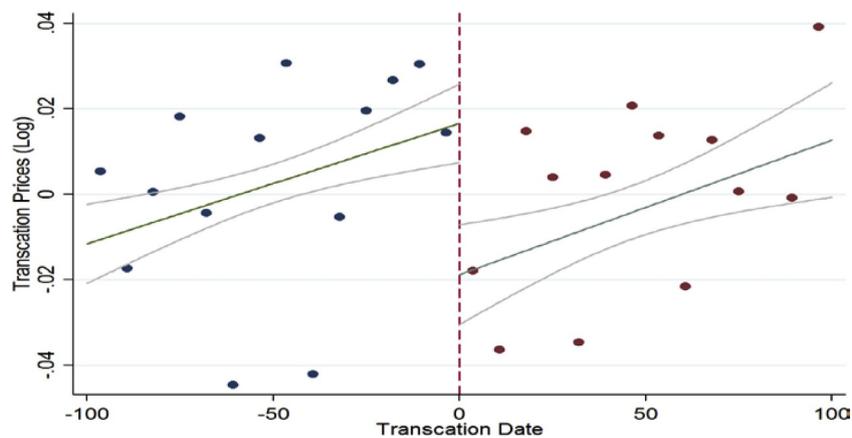
Formal statistical evaluation of the impacts of Singapore's individual moves to cool the housing market is challenging for many reasons. For example, the policies themselves were implemented at specific times during the boom or crisis periods when housing market conditions are also being buffeted from shocks to the macro economy in Singapore market, in the region (e.g., China) or even globally. This makes it difficult to cleanly identify a treatment group and a control group for the purpose of estimating the counterfactual status of treated samples in case of no treatment. In addition, the regulations usually were implemented as a policy package over a fairly narrow time frame, often within six months of one another. Thus, disentangling the treatment effects of each measure is nearly impossible. Policy evaluation research like this also tends to suffer from a lack of suitable micro-level data, although we are more fortunate than many researchers in this respect. That said, the low frequency of house price data increases the difficulty of inferring the causal effects of property market policies.

Our empirical approach here is to use regression discontinuity analysis to estimate whether prices changed around the time of the announcement. This is done using micro data on property market sales prices and transactions volumes. The underlying data are from REALIS, which is described above. Hence, these tests are implemented using data from the private sector, not the HDB sector.

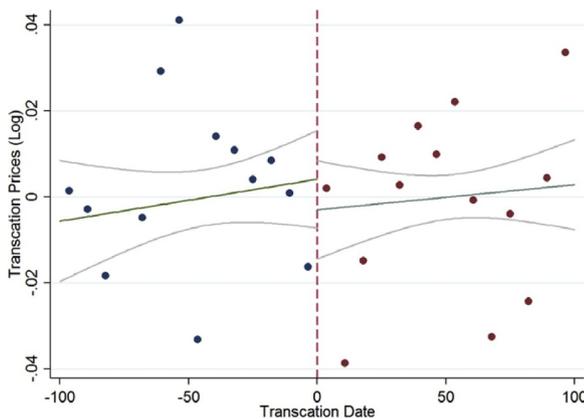
Fig. 10 reports the results from a specification that tells us whether prices changed just after the initial September 14, 2009, announcement of the initial cooling measure that scrapped the IAS and IOH programs for all private properties. Each dot represents the model's estimate of (log) transactions prices in a given week. The vertical dashed line at zero marks the policy announcement date. The other lines show the path of prices leading up to and from September 14, 2009, with a two-standard-deviation band also shown. The results indicate that there was a statistically significant drop in prices of over three percent in the week after the announcement date compared to the week prior that date, but there is no meaningful change in the slope of the path of prices.<sup>18</sup>

The first SSD and tightening of LTV requirements were not

<sup>18</sup> Appendix 3 also includes results for non-linear RD specifications. They also show a similarly large drop in prices immediately following the first policy announcement, as well as a lower slope for the path of prices.



**Fig. 10.** RD analysis for price changes around the initial intervention (Sept 14, 2009). *Notes:* the cooling measure is that the interest absorption scheme (deferment of installments until TOP) and interest-only housing loans (interest payment only until TOP) were scrapped for all private properties.

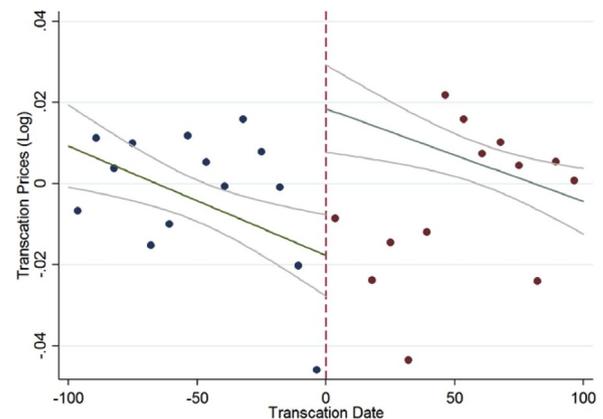


**Fig. 11.** RD analysis for price changes around the second round intervention to introduce SSD (Feb 20, 2010). *Notes:* the interventions include: (1) Introduction of SSD for residential property and land sold within one year of purchase; and (2) LTV lowered to 80% from 90% on all housing loans except HDB loans.

introduced for another five months on February 20, 2010. Fig. 11 plots those results. Note that there is no change in prices or the slope of the price path around the event date. Appendix 3 documents that the same result holds for the next two interventions in August 2010 and January 2011, which lengthened the holding period needed to avoid paying SSD (first to 3 and then 4 years) and dramatically raised the effective duties (to as high as 16% for those flipping properties within one year).

Caution is in order when interpreting this set of results, as they highlight the strengths and weaknesses of the estimation techniques being used. Taken literally, they imply that scrapping a couple of minor subsidy programs had a material impact that lowered prices in the short term, but that imposing increasingly strict taxes on short-term property flipping had no impact. A plausible alternative interpretation is that the initial intervention to cool the market was a real surprise and signaled the government would intervene further if necessary, with that implication helping explain the immediate drop in prices and the fact that there were no changes associated with the next three policy announcements. In essence, some of the future policies may have been anticipated by market participants.<sup>19</sup> It also is the case that this technique only measures short-term changes around the time of the announcement.

<sup>19</sup> That said, we experimented with specifications that presume the policy was known some time ahead. That does not change our conclusions on these or other policies, so there is no evidence from our analysis that they were leaked ahead of time.



**Fig. 12.** RD analysis for price changes around the 5th round intervention to introduce ABSD (Dec 8, 2011). *Notes:* the interventions include: (1) Foreigners and non-individuals pay 10%, PRs buying second and subsequent property pay 3%, Singaporeans buying third and subsequent property pay 3%; and (2) developers purchasing more than four residential units and following through on intention to develop residential properties for sale would be waived ABSD.

Fig. 12 reports on the changes in prices around the December 8, 2011, policy that introduced the ABSD which included differentially higher effective duties on foreigners. Note that there is a discrete jump, not fall, in prices after this announcement. The change is a statistically significant 4%. That this policy resulted in an immediate increase in prices indicates that at least some of the true economic incidence fell largely on the buyers. Sellers did not have to lower prices by the full amount of the duty. Foreigners especially appear to have had such an inelastic demand for Singaporean housing that they were willing to bid up values in the face of the tax. Appendix 3 indicates that something similar happened over a year later in January 2013, when further changes to the ABSD were announced, with foreign purchasers again being treated differentially (harshly). That is, prices jumped after the policy announcement, once again by 3%–4%. However, none of the remaining three policy interventions were associated with a meaningful change in prices around the announcement dates.

Finally, we note that these results hold in placebo tests not reported here for space reasons.

Following the method in Carneiro et al. (2015), we consider the first-round cooling measure which started on September 14th, 2009 as an example, and test whether there was a discontinuity on September 14th 2008. By doing this, we examine whether the discontinuity that we find is driven by seasonal effects. We find that our results pass the placebo tests in all cases.

In sum, this set of tests focusing on whether there was any

immediate impact of a specific policy announcement on prices in the private housing market provides mixed results. There is evidence that the initial intervention was influential.<sup>20</sup> However, the long sequence of subsequent interventions makes it hard to identify individual effects, with most RD results showing no near-term impact on prices. The fact that the specific announcements regarding ABSD with special treatment of foreign buyers resulted in jumps in prices is also interesting, as it suggests those buyers had very inelastic demands for Singapore housing. They were willing to pay more in the face of the tax, as opposed to forcing the sellers to lower their prices by the full amount of the special duty.

#### 4. Discussion and conclusions

Evaluating any government's intervention in its housing markets always is a challenging undertaking because housing itself is a complex durable goods which makes the market itself complex. Moreover, the housing market is closely linked with so many other economic sectors that it is virtually impossible to 'hold all else constant' in empirical analysis. Still, there is a conceptual goal for intervention that can help guide regulators to more efficient outcomes. That framework is described in the next subsection before we conclude with comments on Singapore's recent efforts to cool its housing markets.

##### 4.1. Economically efficient housing market outcomes: a target for government intervention

Governments around the world regularly intervene in their housing markets in a variety of ways because housing is so socially and economically important. Housing is the sector in which citizens organize their lives spatially, and any responsible government cares about how their citizens live. 'Making housing affordable' is a typical goal, and it is useful to interpret that from a market efficiency perspective.

For example, one question faced by government is whether it should try to reduce high house prices to help achieve its affordability goal.<sup>21</sup> In terms of pure economic efficiency, the correct answer is 'not necessarily', as high prices may be serving a valuable economic role of signaling a shortage and the need for added supply or the development of substitutes or other alternatives. The answer would be 'yes' if monopoly power or other artificial supply restrictions exist that are generating the high prices.<sup>22</sup> Another justification for intervention would be the need to maintain financial stability—if the government believed that prices were high for speculative reasons not driven by fundamentals.

In housing, there is a benchmark one can use to help make sense of when markets are affordable versus unaffordable from a supply-demand perspective. Developed by Glaeser and Gyourko (2008), the argument rests on simple microeconomic fundamentals. In housing markets, in which we typically believe that homebuilders can replicate a building at fairly close to constant cost (in free land and labor markets), then the supply of (constant quality) housing should be fairly elastic. That is depicted below in Fig. 13, where  $Q^*$  equals the current size of the housing stock.

That overall cost is what Glaeser and Gyourko (2008) term minimum profitable production number of housing units in the market,

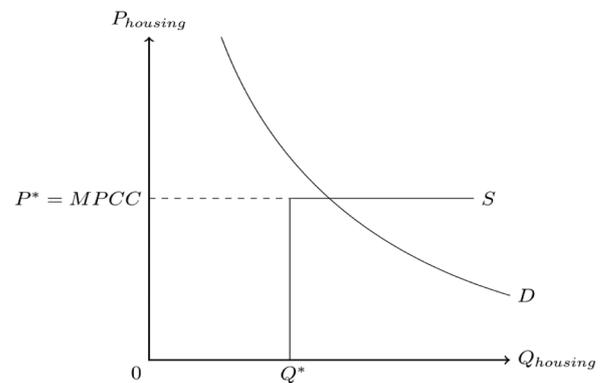


Fig. 13. The minimum profitable production cost (MPPC).

and the flat supply schedule indicates that more could be built at the same cost (MPPC). It is made up of three terms: (a) the price of land (L) that would obtain in a free market in which it could be traded at will; (b) the physical cost of construction (CC), which includes all labor and materials costs needed to put up the building itself; and (c) a normal entrepreneurial profit (DevProfit) for the homebuilder to compensate him for taking on development risk. Thus,  $MPPC = L + CC + DevProfit$ . In a market with elastic supply, price will equal this amount (i.e.,  $P = MPPC$ ) because demand will intersect supply on its horizontal part as long as the city is growing.

This is not just the market price in equilibrium, but MPPC represents the true social cost of supplying another unit of housing to the market. That cost is made up of the use of additional land, additional labor and materials, and risk taken on by the builder. It is inefficient if the price consumers pay for the unit is less than or greater than the true social cost (or MPPC). If market prices are below MPPC, then people are not paying the full social cost of bringing the marginal unit to market, and too much is being built; conversely, if market prices are well above MPPC, then it is almost certainly the case that supply is being restricted and land prices being bid up; existing landowners benefit, but that is an economic rent that they did not truly earn, and it comes at the cost of too little housing being built, with demanders losing out by having to pay artificially high prices.

From an efficiency perspective, governments should use the gap between market prices and MPPC as guides for policy intervention.<sup>23</sup> If market price equals MPPC, then there is no obvious need for intervention, as builders are supplying new units and households are buying them at their full social cost. It is not possible to produce a new unit at less the total social cost, so no attempts should be made to price below that level.<sup>24</sup> If prices have fallen below MPPC, government should re-examine any subsidy programs it has that might have stimulated overproduction. And, if prices are well above MPPC, then it should examine whether there are artificial constraints preventing new supply, as if land and labor are priced fairly in free markets, builders should be

<sup>23</sup> The MPPC can be calculated in markets such as Singapore in which supply is thought to be more inelastic in nature.

<sup>24</sup> There still can be a case for policy intervention on distributional grounds, as there typically are some people in the society who are so poor that they cannot afford housing priced at its full social cost (i.e., MPPC). In this case, the proper response is to transfer income to the impoverished households so that that can buy the desired goods at market prices. Intervening directly in the housing market itself would only distort an already efficient market. There is no single correct answer on transfer policy in this case. Some societies are more egalitarian than others, and will engage in larger income transfers. That is their preference and there is nothing in economics to say that is a poor or incorrect policy. What economics can say is that there are costs to distorting efficiently priced markets, and governments should not do if there are less costly ways to achieve their social goals (which would be an income transfer to poor households in this particular context).

<sup>20</sup> We acknowledge that the long-term response may be different from the short-term effect. But in our settings, the time difference between each two consecutive rounds of cooling measures is only several months. Therefore, we cannot study the long run effects of these cooling measures.

<sup>21</sup> This is also routinely asked regarding energy prices.

<sup>22</sup> Glaeser and Gyourko (2008) have argued that binding city-level restrictions on residential building in America's large coast markets reflect a type of market power that has led to artificially high prices. In this case, the intervention should be to try to increase supply to combat the monopoly-like conditions.

able to earn normal profits if prices are equal to MPPC.

#### 4.2. Putting Singapore's cooling efforts in perspective

The first question one should ask is whether the government had plausible reason to intervene in the housing market. The answer is 'yes' on at least two grounds. The sharp rise in prices across the HDB and private sectors following the onset of the global financial crisis reasonably could have led regulators to believe that destabilizing speculative forces were at work. On social grounds, the government probably was also concerned by the deterioration in affordability conditions. Fig. 9 above shows that the price-to-income ratio for people buying a modest 3-room HDB flat rose by one-third between 2007 and 2010.

That there are reasonable grounds for intervening does not mean the regulators always should act. That depends upon whether they can intervene at low enough cost to justify the alleged benefits. Housing is such an important asset in the Singaporean economy and in terms of household sector wealth that policies to lower its value always run the risk of creating collateral damage in terms of consumption and output. Singaporean economic growth has fallen since the global financial crisis, but co-integration tests do not indicate tight links between housing prices (or price changes) in the private sector and output or consumption changes in the broader economy. Of course, this does not prove that dampening the housing market literally had no effect on the economy; logic suggests otherwise; rather, the proper conclusion is that the impacts were not so significant (thus far, at least) that our statistical tests can pick them up. Moreover, no test is foolproof and our co-integration test is an indirect way to measure this policy effect.

There seems little doubt that the government would be pleased with the improvement in affordability conditions documented in Fig. 9. By the end of the cooling interventions, modest-income Singaporean households were paying the same multiple of income for a HDB flat as before the run-up in price.

That is not a bad report card, and arguably is a pretty good one. Even so, there are worrisome features. One is the high level of volatility in quantities built and bought on the supply side. This is evident prior to the policy intervention, too (see Figs. 3 and 4 above). Singapore is a mature, advanced economy, so it is unlikely that its true underlying fundamentals are changing enough to justify such wide swings in building activity. Given the government's prominent role in the land and housing markets, it probably would be wise to reexamine its own policies that might be contributing to this volatility. Housing is a complex market because it is a long-lived durable goods that cannot be built quickly, so perfect matching of supply with demand is not feasible. However, efficiency will be enhanced in this type of market the more predictable and stable policy is—especially on the supply side.<sup>25</sup>

A second worry relates to the complexity and nature of the recent cooling interventions. It is true that the economy or consumption did not collapse as a result of these interventions, but it still is the case that a deadweight efficiency loss is created with every new tax imposed (and most other regulations).<sup>26</sup> Recall that we find relatively little evidence

<sup>25</sup> Fu et al. (2015) study the impact of the Singapore government's changes in the housing transaction stamp duty policy in recent years and find that the rise in transaction cost substantially reduced speculative trading in the treatment segment, significantly raised its price volatility and reduced price informativeness. They suggest that the results are likely due to a relatively greater withdrawal by informed speculators than by destabilizing speculators following the transaction cost increase.

<sup>26</sup> Deng et al. (2016) study the impact of the effectiveness of the one of the key cooling measures introduced by the Singapore Government – the seller's stamp duty (SSD). They find that SSD is less effective for cooling the housing market in short run, but can play a positive role to maintain market stability in long run. However, the study also finds that aggressively using SSD may weaken the effectiveness of the subsequent additional buyer's stamp duty (ABSD) in curbing a housing market boom and lead to housing market

of near term price effects from most of the interventions analyzed in Section 3.3.2. Given how quickly new interventions were announced (roughly every six months), we doubt the government knew what the individual policy impacts were either, especially in real time. Uncertainty among households and home builders is heightened by this, which can create its own distortions. To reiterate, this did not cause some economic collapse, but the efficiency losses are still there. Over time, they can add up, especially when they are numerous as is the case here.

Moreover, we should emphasize that due to differences in the institutional background between housing markets in Singapore and other parts of the world, one should not presume that government-imposed demand-side cooling measures will have the same effects as we found for Singapore. For example, the Singaporean government's large role as supplier of land for development from its publicly-held inventory certainly could be influencing the results in a way that would be different if (say) the United States or Canada were to implement the same policies.

Implementing policy in rapid sequence that prevents fuller knowledge of effects along the way also increases the risk of unintended consequences. One of the surprises to us was in Fig. 8, which showed that values in the more preferred Central parts of Singapore rose less than other parts of the city-state throughout the cooling efforts period. Presumably, the distributional goals of the government were more concerned with making less expensive neighborhoods and housing units more affordable to modest-income households. This raises the prospect that a different policy mix would have had greater effects in more modestly-priced neighborhood. However, it is possible that the government's distributional goals might have included dampening down prices in the most expensive units in the city. If so, that probably should be announced, as transparency would allow builders and investors to plan accordingly.

A related question involves the costs and benefits of the policies imposing special duties on foreign purchasers, regardless of their holding period of the property. Foreign capital flows can be destabilizing, especially for a small country such as Singapore. But, small countries also tend to interact with and need foreigners to grow and prosper. Targeting flippers is one thing, but specially targeting foreigners is another, and could have longer-term consequences for their view of investing in Singapore. Hence, we wonder how the government conceived of the costs and benefits in this case.

#### 4.3. Final conclusions

As with many other countries around the world, Singapore's government intervenes in its housing markets in various ways. Given housing's importance in the broader economy and as part of the household sector's net worth, it is vital that policy makers always intervene with great care. If the potential costs are too high, it should not intervene and it should never intervene in an effort to drive prices below their true social production cost.

Its recent interventions to cool the housing market, presumably undertaken to address deteriorating affordability conditions for the typical household and to address potentially destabilizing speculation, appear to have achieved their primary goals without significant collateral damage to the broader economy. While that is a good outcome in and of itself, there still are ways to improve policy implementation going forward.

Even before the sharp house price increase following the global financial crisis, supply fluctuations were quite large on an annual basis. It seems unlikely these were driven by changes in underlying fundamentals in such a mature economy as Singapore's. Some of this seems

(footnote continued)  
anomalies.

likely driven by policy itself. More stability and transparency in land sales and permitting activity would reduce uncertainty for market participants, and raise welfare for suppliers and demanders alike.

We also recommend policy implementation that can be well measured so that it can be determined what works and what does not. The rapid sequence of recent cooling measures makes it very hard to evaluate the impact of any one policy. There may have been a need for this process, but it is not ideal as a general rule, because market participants cannot readily anticipate future policies and plan accordingly. In a complex and expensive durable goods market such as housing, that can be costly.

Unintended consequences are inevitable for any significant policy intervention, not just the recent cooling measures. Both the government and private sector should closely monitor consequences across the market and its different participants, and use those data to fine tune policy as appropriate. We found fairly large differences across neighborhoods, with less appreciation in private home values in the more expensive Central locations of Singapore.

Finally, the consequences (especially the potentially negative ones) of all interventions should be considered. Here, we reference the targeting of foreign purchases, independent of whether they involved, short-term flipping strategies. There can be good reasons for such restrictions on foreigners, but there are potentially high long-run costs to such a policy, especially for a small, open economy such as Singapore's.

### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jhe.2018.04.001](https://doi.org/10.1016/j.jhe.2018.04.001).

### References

- Agarwal, S., Qian, W., 2017. Access to home equity and consumption: Evidence from a policy experiment. *Rev. Econ. Stat.* 99 (1), 40–52.
- Aura, S., Davidoff, T., 2008. Supply constraints and housing prices. *Econ. Lett.* 99 (2), 275–277.
- Behrens, K., Duranton, G., Robert-Nicoud, F., 2014. Productive cities: Sorting, selection, and agglomeration. *J. Polit. Econ.* 122 (3), 507–553.
- Card, D., 2009. How immigration affects US cities. *Making cities work: Prospects and policies for urban America*, 2009, 158–200.
- Carneiro, P., Løken, K.V., Salvanes, K.G., 2015. A flying start? Maternity leave benefits and long-run outcomes of children. *J. Polit. Econ.* 123 (2), 365–412.
- Deng, Y., Sing, T.F., Ren, C., 2013. The story of Singapore's public housing: from a nation of home-seekers to a nation of homeowners. *The Future of Public Housing*. Springer Berlin Heidelberg, pp. 103–121.
- Deng, Y., Tu, Y., Zhang, Y., 2016. The behaviors of flippers, rental investors and owner-occupier's in Singapore private housing market. *NUS Institute of Real Estate Studies working papers*.
- Favilukis, J., Ludvigson, S.C., Van Nieuwerburgh, S., 2017. The macroeconomic effects of housing wealth, housing finance, and limited risk sharing in general equilibrium. *J. Polit. Econ.* 125 (1), 140–223.
- Fu, Y., Qian, W., Yeung, B., 2015. Speculative investors and transactions tax: evidence from the housing market. *Manage. Sci.* 62 (11), 3254–3270.
- Glaeser, E.L., Gyourko, J., 2008. Rethinking federal housing policy: How to make housing plentiful and affordable. *American Enterprise Institute Press*.
- Gyourko, J., Mayer, C., Sinai, T., 2013. Superstar cities. *Am. Econ. J.* 5, 167–199.
- Gyourko, J., Molloy, R., 2014. Regulation and housing supply. *NBER working paper w20536*.
- Himmelberg, C., Mayer, C., Sinai, T., 2005. Assessing high house prices: Bubbles, fundamentals and misperceptions. *J. Econ. Perspect.* 19 (4), 67–92.
- Johnson, W.R., 2014. House prices and female labor force participation. *J. Urban Econ.* 82, 1–11.
- McMillen, D.P., 2008. Changes in the distribution of house prices over time: Structural characteristics, neighborhood, or coefficients? *J. Urban Econ.* 64 (3), 573–589.
- Paciorek, A., 2013. Supply constraints and housing market dynamics. *J. Urban Econ.* 77, 11–26.
- Phang, S., Kim, K., Singapore's Housing Policies: 1960-2013. paper for “*Case study knowledge & learning workshop*”, 2013.
- Saks, R.E., 2008. Job creation and housing construction: constraints on metropolitan area employment growth. *J. Urban Econ.* 64 (1), 178–195.
- Shiller, R.J., 2007. Understanding recent trends in house prices and home ownership. *NBER working paper w13553*.
- Van Nieuwerburgh, S., Weill, P.O., 2010. Why has house price dispersion gone up? *Rev. Econ. Stud.* 77 (4), 1567–1606.
- Watson, T., Carlino, G., Ellen, I.G., 2006. Metropolitan growth, inequality, and neighborhood segregation by income. *Brookings Wharton Pap. Urban Affairs*, 1–52.