Foreign Liquidity and Ripple Effect to Singapore Housing Market

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Abstract

Globalization enables foreign liquidity to access and affect the local real estate market. Concerning Singapore, this paper depicts a strong connection between foreigners’ property acquisitions and regional house price movements. Examining structural break points, it illustrates a ripple effect of prices from central locations to suburbs. A structural vector autoregressive model incorporates these two observations, and the impulse responses and variance decompositions attribute 35% fluctuation of house price growth in the central region and 25% in the non-central region to the shocks to foreigners’ buying activities in central locations. Thus, foreign liquidity to real estate also largely affects the suburban market, even though foreign buyers are inactive there. As governments now often consider implementing policy shocks to influence on foreigners’ buying activities to impact the housing markets, this paper’s findings have useful implications on policy effectiveness.

Keywords: housing; house price dynamics; foreign real estate; ripple effect; structural break; structural vector autoregression
1. Introduction

Globalization has induced various forms of financial liberalization, and foreign liquidity has played increasingly important roles in shaping regional and local markets. There is no exception for real estate. An emerging global trend of foreign liquidity in local property market has surfaced (Real Capital Analytics, 2011). In 2007, about 10% volumes of real estate sales in Americas were made to foreigners. The figure was even substantially higher in the Asia Pacific region. Liquidity from foreigners constituted close to 35% real estate transactions. Foreign liquidity can be a cure for a bearish property market. However, it may worsen housing affordability when the market is tight. In Singapore, a small city state, the government has long used foreign liquidity to stabilize the nation's real estate market. The government may ease rules and regulations on foreign investment when the market is dull and may tighten them when the market overheats. Foreigners often respond quickly. Understanding the effects of their activities on the real estate market is important, as this may offer insights to policy makers.

Housing market is segmented, particularly across geography. While a positive relationship between foreigners’ acquisitions and national property-price movement is apparent, the effect of their acquisition activity on regional property prices is less obvious. Are there any differential impacts on regional submarkets? Are the submarkets being affected through the same mechanism?

This paper aims to shed light on the above questions, and Singapore is an interesting case for the purpose. Foreigners’ purchases have weighed a handsome
share of property transactions in the city state. About 11% of private-property sales were made to foreigners (excluding permanent residents) between year 2004 and 2011. However, the foreign liquidity to Singapore is uneven across its geography. Foreign buyers have acquired more real estate in prime areas than in emerging suburbs. During 2004-2011, sales to foreigners on average weighed 14% of total sales in the Central region, but the weight was only 5% in North East and North regions. Possibly due to the low concentration of foreign purchases in suburban areas, we find that although the growth of central region’s residential properties sold to foreigners significantly impact house price growth in that region, the growth of foreigners’ acquisitions in the non-central region has small effect on the region’s property prices. Nevertheless, this research shows that the growth of suburban house prices is still significantly affected by foreign buyers through the “ripple effect”. The influx of foreign liquidity to the central region’s housing submarket can trigger an upsurge of property prices in that region, and the effect of the upsurge can ripple out to the non-central region.

The literature on house price dynamics has concerned the *ripple effect* that a house price shock in one location may drive other areas’ house price movements. Some studies have provided cross regional evidence (e.g., Chien, 2010; Chen et al., 2011, Holly et al., 2011; Oikarinen, 2004), and others have examined the ripple effect across submarkets within a city (e.g., Estes and Richey, 2009; Oikarinen, 2004). A complete definition of the ripple effect should have two parts. First, there is a pronounced *shock* entering into a market (submarket) that is significant in the regional
Second, a *price-diffusion* mechanism exists, and it allows the price movement, which is due to the shock, of the significant market to affect the prices of other markets (submarkets). While the second part of the definition on price diffusion has gained much attention in the literature; the first part, about the content of the shock, has been played down. A study like ours that makes efforts on both parts can be helpful, especially in understanding the impact of large policy shift that can swing a particularly segment of the market.

The extant literature on international real estate acquisition mostly concerns why investors choose to own international real estate, and it focuses on the benefits of diversifying property assets internationally. The studies are in the context of either mixed-asset portfolio or real-estate-only portfolio, but they commonly adopt the mean-variance framework. Almost all these studies conclude that efficient portfolios that include international real estate outperform those that do not. International diversification appears to be important. Sirmans and Worzala (2003) provide a good review of the literature and summary of these findings. Our paper is different from the existing literature as it offers a new angle to research on international real estate acquisition from the recipient country’s perspective, with a focus on how the foreign liquidity to local real estate affects price dynamics. Thus, the research can generate new insights and policy implications.

The rest of this paper is organized as follows. Section 2 reviews government policy shifts on regulating foreigners’ ownership of real estate property in Singapore. It helps the readers to see the large effects of foreigners’ buying activities on the real
estate price cycle of the nation. Section 3 concerns data and estimation. It starts with a brief introduction on our data source and a discussion on the construction of house price indices. Then, an analysis of structural break points is carried out and it reveals an interesting spatial pattern of ripple effect. Motivated by these two notable features of the housing market — the connection between the foreigners’ acquisitions and property prices, and the ripple effect — a structural vector autoregressive model is constructed to formally analyze the impact of foreign liquidity on regional property price movements. The conclusion is made in Section 4.

2. Background: Foreign Home Buyers in Singapore

Property Market

Regulations on foreign buyers’ home purchases dated back to 1973. To ensure affordable and sufficient housing for Singaporeans, the Residential Property Act imposed restrictions on foreign ownership of private residential property. Foreigners could only acquired apartments in buildings higher than six stories or in approved condominium developments.

However, housing market had been dull after the bust of the Dot-Come bubble in late 2000 and the outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003. A strong recovery from the market downturn was necessary to the city-state’s economy, because prolonged housing decline can lead to highly persistent urban decline due to durable housing (Glaeser and Gyourko, 2005). Moreover, as housing asset is the largest component of household wealth, the prolonged decline can cause financial
hardship especially to the elderly whose retirement savings are largely in the form of housing assets (Ronald, 2010). In response to that, the government introduced several measures to boost the market. First, foreigners have been allowed to buy both land parcels and completed homes at Sentosa Cove since August 2004. The favorable policy led to a surge of foreign liquidity in the private residential market. The percentage of buyers who were foreigners rose from 6% to 10% within two quarters. The presale segment experienced an even sharper increase from 6% to 17%. Singapore house prices started to rise. In mid 2005, the government further removed the restriction for foreigners to own apartments below 6 stories, and raised the loan-to-value limit and reduced the cash down payment for them. A bullish upward trend in house price appreciation had been observed until end 2007. Foreign buyers were very active. Between 2005 and 2007, they accounted for 10% and 15% sales in the entire private residential market and the presale segment, respectively. On the contrary, between 2000 and 2004, the sales made to them only weighed 6% in both the entire market and presale segment. The rise in foreign buyers was in tandem with the recovery of Singapore housing market. It is often acknowledged in the press and literature that the rebound in house prices in 2004 was led by an influx of foreign liquidity into high end private housing market which then aid in the general recovery of the market (e.g., Deng et al., 2012).

Even after the Global Financial Crisis, foreign investment has still played an important role in supporting or driving up Singapore’s residential property prices. For
instance, in the recent recovery from the last down turn, significant appreciation of house prices and upsurge of foreigners’ buying activity were both observed.

The foreign liquidity to Singapore property market is sensitive to government policy shifts. Previous changes in regulations had been successful in attracting foreigners to buy properties in Singapore. Concerning continual hike in house prices could cause issues in housing affordability, the government recently introduced a cooling down measure. The Additional Buyer’s Stamp Duty (ABSD), which targeted mainly at foreigners and non-individuals, was implemented in December 2011. The ABSD cost 10% of property value. As the result, foreigners became inactive, and prices in the central region dropped. Overall home prices had also fallen for the first time in almost three years in the first quarter of 2012.

3. Estimation and Results

3.1. Data

The primary data source is Singapore Urban Redevelopment Authority’s (URA) database, the Real Estate Information System (REALIS), which provides micro transaction data of private residential properties (non-public housing). The research records 255,452 transactions from the second quarter of 1996 to the fourth quarter of 2011. Specific information of the sales such as the contract date and transaction price and other characteristics of the properties such as the floor level, floor area, tenure type, and dwelling location are used to construct quarterly hedonic house price indices.
URA delineates Singapore into 55 planning areas. Among them, 38 areas had transactions occurred during the sample period. These areas with housing sales are grouped into 25 “consolidated planning areas” through merging those places which had less than 2000 transactions with their adjacent places having a higher volume of transactions. The 25 consolidated planning areas are the geographic units of later analysis.

Additionally, several quarterly time series are also obtained. They are the gross domestic product (GDP) and consumer price index (CPI) from Singapore Department of Statistics, mortgage interest rate of 15 years housing loan from the Monetary Authority of Singapore, and location specific quantities of housing stock and private residential property sales to foreigners from REALIS.

3.2. **Hedonic House Price Index**

The initial step of this research is to construct location-specific house-price indices. Although URA and the Institute of Real Estate Studies (IRES) at the National University of Singapore regularly report national house price indices, they do not publish the indices by detailed location.

We prefer the hedonic price index to the repeat sales index among the quality adjusted price indices, because lack of repeat sales observations can become an issue when the sample is divided into locations. For planning-area price indices, we estimate the model below for each area $j$: 
where $\rho_{j,t}$ is the time fixed effect and is area $j$’s price index in time $t$ relative to the base period (4th quarter, year 2001). Additionally, $P_{i,j,t}$ is the house price, and $X_{i,j,t}$ is a vector of observable housing characteristics. The parameter $\alpha_j$ captures the value of amenity in area $j$, and $\beta_j$ reflects the implicit prices of the housing characteristics. Similarly, for regional price indices, we estimate the following model for each region $r$:

$$\ln(P_{r,t}) = \alpha_r + \beta_r X_{r,t} + \rho_{r,t} + \xi_{r,j} + \epsilon_{r,t}$$

where $\rho_{r,t}$ is the regional price index in time $t$, and the location fixed effect $\xi_{r,j}$ of area $j$ in region $r$ and $\alpha_r$ capture the prices of amenities. This model is also used for the estimation of national price index.

Fig. 1 presents all the hedonic house price indices of individual planning areas, and Fig. 2 presents the national price index. The area indices exhibit a similar general trend to the national index. Singapore’s housing market had gone through several booms and busts during the 16 years of the study period. The first peak of prices occurred in the second quarter of year 1996, which was at the beginning of the time series, followed by a period of contraction after the Asia Financial Crisis. The second peak was reached in the first quarter of 2000, and subsequently the prices went down after the bust of the Dot-Com bubble and the outbreak of SARS. The most recent peak happened in the fourth quarter of 2007, before the occurrence of US subprime mortgage and global financial crises. The market tumbled down sharply, but a pronounced rebound happened in 2009. Since then, the market has experienced an
upward trend of house price movement. Consider the house price trend and foreigners’ buying activity depicted earlier, one can note that the property price movement in Singapore could be connected to foreigners’ property acquisitions. In fact, the correlation between the foreigners’ share of property purchases and the national price index was 0.7 during the 16 years of our study period.

[Insert Fig. 1 here]

[Insert Fig. 2 here]

3.3. Geographic Diffusion of Structural break Points

Another notable feature of the Singapore market is price diffusion across space, in addition to strong correlation of house prices with foreign liquidity in the market. We illustrate this point with a presentation of the structural break point of each consolidated planning area’s house price index.

Break-point analysis is a growing literature not only in finance, but also in real estate (e.g., Chen, 2010; Ferreira and Gyourko, 2011 & 2012). Banerjee and Urga (2005) provide an overview of the literature on the econometric analysis of structural break. We use the year 2000-2008 period as a case study, and the structural break point of each area-specific house-price index during this time is estimated. The estimation requires a time series of a substantial length. Thus, the 9-year period, which is Singapore’s most recent and complete real-estate cycle where the price peaked in 2007, is chosen. With 36 quarters of data, this period is most suitable for a break-point analysis as compared with other short cycles in our entire study period.
Moreover, the 9-year period consisted a time during which a surge in foreigners’ acquisitions of housing properties occurred.

The estimation of structural break points follows the strategy of Ferreira and Gyourko (2011 & 2012). The growth rates of prices are generated by dividing the estimated value of the price index in period $t$ by the value in period $t-4$ to control seasonality in housing transactions. As the resulting series of growth rates may consist of multiple jumps, the quarter in which the global structural break occurred needs to be determined. For each planning area $j$, we estimate:

$$PG_{j,t} = \alpha_j + \beta_j 1[q_{j,t} \geq q_{j,t}^*] + \gamma_j t \text{ for } T_{j,1} < q_{j,t} < T_{j,N}$$

where $PG_{j,t}$ is the house price growth over the past four quarters. $q_{j,t}$ indicates the corresponding quarter of the observation; $T_{j,1}$ indicates the first quarter of the time series in the regression; $T_{j,N}$ indicates the last quarter of the time series in the regression, and it is the quarter that returns the highest growth of area $j$ between 2000 and 2008. $q_{j,N}$, which is an element of $\{T_{j,1}, \ldots, T_{j,N}\}$, is the quarter that is considered as the potential structural break point, and it is arbitrarily picked and fixed in each regression. $1[q_{j,t} \geq q_{j,t}^*]$ is an indicator function that maps $\{T_{j,1}, \ldots, T_{j,N}\}$ to $\{0,1\}$, and its value is 1 if $q_{j,t} \geq q_{j,t}^*$ and 0 otherwise. Thus, $\beta_j$ is the effect of the potential structural break point on the price growth. For each planning area $j$, we run a total number of $N_j$ regressions, from which the first (last) regression considers the first (last) quarter in $\{T_{j,1}, \ldots, T_{j,N}\}$ as the potential break point. The $q_{j,t}^*$ in the regression that returns the maximum $R^2$ is the estimated structural-break point. Generally, the $R^2$ of the regression that returns the maximum $R^2$ and identifies the structural break point of its
respective planning area ranges from 0.30 to 0.73 with an average of 0.57. The estimation results including the estimated structural break points of the planning areas are reported in Table 1.

[Insert Table 1 here]

The map in Fig. 3 presents the structural break point of every consolidated planning area, and it visualizes an interesting spatial diffusion pattern. The figure broadly categorizes the areas into two groups: early boomers and late boomers. The early boomers were those with a structural break occurred in 2004 or 2005, and the late boomers were those with a structural break occurred in 2006 or 2007. The figure clearly shows that the earlier boomers were clustered in the URA-defined central region, and the late boomers were mostly in the URA-defined non-central region. Unless the price change of a region is mostly affected by factors specific to the region, the information presented in the figure would suggest that the shock causing structural breaks of house prices in the central region rippled out and caused structural breaks in the non-central region. It is interesting to know the underlying shock and understand the shock’s ability to explain regional price movements.

[Insert Fig. 3 here]

The influx of foreign liquidity into the housing market could be the underlying shock. As mentioned in Section 2, a surge of foreigners’ acquisitions of residential properties started in late 2004 upon the relaxation of the restrictions on foreign ownership, and this bred the rebound of house prices. As foreigners mainly purchased properties in central areas, the influx of foreign liquidity would only cause structural
breaks of house prices there. Nevertheless, when house prices in central areas upsurged, the positive sentiment could generally affect the entire housing market of the small island, and thus the strong house price growth in central areas would ripple out and cause structural breaks and house price booms in non-central areas. This explanation can coherently interpret the observed spatial diffusion pattern of the structural break points of area housing prices illustrated in Fig. 3.

3.4. **Structural vector Autoregressive Analysis**

This section formally analyzes the impact of foreign liquidity on regional house prices using Structural vector Autoregression (SVAR). A good introduction to the method can be found in Kilian (2011), StataCorp (2009) and Stock and Watson (2001). Foreigners’ property acquisitions in the central region are found to have large effects on house price changes in both the central and non-central regions. On the other hand, sales to foreigners in non-central region have much smaller effects on prices in both regions.

We choose SVAR for two reasons. The first is the need to model multiple endogenous variables jointly. Foreign liquidity may be endogenous. Although a positive shock to foreign liquidity may increase housing demand and breed price growth, the stronger growth could subsequently attract more foreign buyers. Also, regional house prices can be interdependent. A type of Vector Autoregression (VAR) to handle the endogeneity is helpful in this regard. Second, we attempt to assess the
causal effects of foreign liquidity shocks on regional house prices. As the traditional
VAR cannot facilitate such inferences, the use of SVAR becomes necessary.

A typical VAR model with \( p \) lags can be written in the following form:

\[
y_t = c + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t
\]

where \( y_t \) and \( c \) are \( K \) vectors of endogenous variables and constant terms, respectively, \( A_1 \) through \( A_p \) are \( K \times K \) square matrix of parameters, and \( \varepsilon_t \) is a \( K \) vector of white noise with \( \varepsilon_t \sim N(0, \Sigma) \) and \( E(\varepsilon_t \varepsilon_s')=0 \) for \( t \neq s \). As the cross-equation error variance-covariance matrix is not diagonal, causal interpretation is not possible.

A remedial method to facilitate causal interpretation is SVAR, and a short-run
SVAR model is constructed for our purpose. The model is associated with identifying
assumptions on the contemporaneous correlations between the endogenous variables.
In general, a short-run SVAR can be written as

\[
A(L) y_t = A \varepsilon_t = B e_t
\]

where \( A \) and \( B \) are \( K \times K \) nonsingular matrices. The underlying VAR is inside the
parenthesis since \( L \) is the lag operator. Importantly, \( e_t \) is a \( K \) vector of orthogonalized
disturbances with \( e_t \sim N(0, I_K) \) and \( E(e_t e_s')=0 \) for \( t \neq s \). Let \( P \) denote \( A^{-1} B \) and note that
\( \Sigma = PP' \). Thus, the \( P \) matrix, which can be identified by the identifying assumptions
made to \( A \) and \( B \), defines a transformation of \( \Sigma \) to orthogonalize the disturbances. If
the underlying VAR is stable, then with orthogonalized disturbances, the structural
impulse response functions and forecast-error variance decompositions associated
with the SVAR can be used to offer causal interpretations; the system dynamics can
be analyzed in terms of a change to an element of $e_t$. More details are available in StataCorp (2009).

Specifically, our SVAR model concerns relationships among the house price, foreign liquidity and housing supply of the central and non-central regions, and the geographic division into the two regions is motivated by the spatial diffusion pattern exhibited in Fig. 3. Although the central question is how foreign liquidity shocks would affect regional house prices, housing supply is also considered because one may expect the supply to affect the system. The regional house-price series are our estimated hedonic price indices, and the regional-specific foreign liquidity and housing supply are represented by the number of private residential property sales made to foreigners and the quantity of private housing stock in the region. Together, we have 6 time series of endogenous variables. Additionally, the model also incorporates the effects of GDP and the interest rate of 15 years housing loan, since SVAR allows inclusion of exogenous variables. Deflated by CPI, these two time series and the house price indices are in real term. Lastly, all the variables are in the logarithmic form. The summary statistics and the abbreviations of these variables and their first differences are reported in Table 2.

[Insert Table 2 here]

Table 3 presents the augmented Dickey-Fuller unit-root test on each of the above time series. The levels of these variables are non-stationary except the housing stock in the non-central region. However, their first differences are all stationary at 1% significant level. As the constructions of the structural impulse response functions and
forecast-error variance decompositions require a stable underlying VAR, the first
differences are used as the variables in our SVAR.

The contemporaneous correlations of the SVAR are governed by matrices $A$ and $B$ in Eq. (1). The later is assumed diagonal as in the vast literature. The structure of matrix $A$ assumes that the growths of housing stock and foreigners’ purchases in a region both have an immediate impact on house price growth in that region, as they reflect changes in housing supply and demand, respectively. Additionally, the growths of house prices and foreign liquidity in the central region may have a spillover effect to the other region given central region’s dominant importance, which may drive the sentiment in the market. Lastly, as matrix $A$ consists of the over-identifying restrictions, testing the validity of these restrictions is important.

The underlying VAR structure is assumed with two lags, which maximize Akaike's information criterion (AIC) in selecting lag length. A few constraints are also imposed, using the knowledge learnt from unreported regression without the constraints. The effects of a variable’s lagged variables on another variable is assumed zero, if the coefficients of the two lags are both highly insignificant in the unreported regression. The constraints reflect the following assumptions. The regional growth of housing stock is affected by previous growth of quantities and prices of the regional housing market. The regional house price growth is determined by its own previous growth and the past regional growth in quantities of housing stock and foreigners’ purchases, which reflect past situations of supply and demand. Additionally, the
central region’s house price growth can subsequently affect the growth in the non-central region, and this ripple effect is motivated by the diffusion pattern in Fig. 3. Lastly, no constraints are placed on the regional growth of foreigners’ purchases. Foreigners’ decisions of property acquisitions are assumed dependent upon all pieces of historical information including foreigners’ buying activities and housing prices and quantities in both regions. The imposed constraints allow the system to follow theory, although unreported regression without these constraints produces similar results.

Table 4 reports the estimates of matrices $A$ and $B$ and the underlying VAR. The likelihood ratio test of identifying restrictions cannot reject the validity of any overidentifying restrictions (null hypothesis) at 10% significance level, and the equation-level model tests suggest that none of the equation has zero number of significant coefficients at 1% significance level, indicating proper model specification. The coefficient estimates in matrix $A$ suggest that the growth of foreigners’ purchases in the central region has a significant positive contemporaneous effect on house price growth in that region.\(^2\) This is also true for the non-central region, albeit a smaller coefficient. Additionally, higher growth of house prices and foreigners’ purchases in the central region also significantly and contemporaneously increase growth of their respective non-central-region counterparts. On the underlying VAR, the estimates suggest importance of GDP growth in explaining changes of house prices and foreigners’ purchases in general, as GDP reflects housing demand and economic fundamentals which may attract foreigners. The estimates also suggest a significant
positive relationship between the growth of foreigners’ purchases and the subsequent house price growth in the central region, but such a relationship is insignificant in the non-central region. The estimates additionally indicate significant ripple effect that house price growth in the central region can subsequently breed the growth in non-central region.

[Insert Table 4 here]

Although the estimates in Table 4 are informative, impulse response functions are required to predict the effects of a shock to an endogenous variable on itself and on other endogenous variables, given complex dynamics of the SVAR. Fig. 4 presents the impulse responses of regional house prices to shocks on foreigners’ purchases. The first and second charts of row 1 concern the effects of a shock, which adds 1% growth of central region’s sales to foreigners, on the growth rates of prices in the central and non-central regions, respectively, and the two charts of row 2 present the effects of an equivalent shock to foreigners’ purchases in the non-central region. The 95% confidence intervals are also plotted. These estimated impulse responses suggest that the shock adding 1% growth of foreigners’ purchases in the central region can lead to 0.025% higher growth of the region’s house prices in the current quarter, and a significant impact remains for another quarter. This shock also significantly boosts house price growth by 0.018% in the non-central region through the ripple effect of regional house prices, even though foreign liquidity to central region’s real estate does not directly affect prices in the non-central region. The significant impact gradually fades away in one year. On the other hand, an equivalent shock to foreigners’
purchases in the non-central region has much smaller impact. It only results in 0.008% higher growth of prices in that region, and the impact shrinks by one half in the next quarter. Also, its impact on central region’s price growth is minimal.

[Insert Fig. 4 here]

The shocks to foreigners’ purchases in the central region have non-trivial effects on house price growths. Calculating the predicted and actual growths of private residential property sales to foreigners, we find a 79% unexpected growth of the sales in the central region in association with the removal of the foreigners’ buying restrictions in mid 2005. This implied immediate 1.98% and 1.42% of extra house price growths in the central and non-central regions respectively. Also, there was a 223% of unexpected growth of sales to foreigners in the central region in association with the price recovery in mid 2009, indicating immediate 5.58% and 4.01% of extra house price growths in the central and non-central regions, respectively. Furthermore, when the extra stamp duty on foreigners’ property acquisition was imposed in the last quarter of 2011, an unexpected 75% decline of sales to foreigners occurred in the central region, suggesting the policy shock would concurrently slow down the price growth by -1.88% in the central region and -1.35% in the non-central region. Unexpected shocks to foreigners’ purchases in the central area could largely account for the house price growths in both the central and non-central regions.

Forecast-error variance decomposition allows inference over the ability of shocks to explain future movement of the data (Kilian, 2011). That is, it can be used to estimate the proportion of movement in a time series that can be explained by shocks
to the time series itself or to another time series (Enders, 2004). Specifically, the forecast-error variance of the endogenous variable of interest can be broken down into fractions attributable to each of the endogenous variables in the system. Recent applications include Giordani (2004), Kim and Roubini (2000) and Shan (2002).

Fig. 5 presents the forecast-error variance decomposition of the central and non-central region’s house price growth due to shocks to foreigners’ purchases of private residential properties. The first and second charts of row 1 indicate the fractions of prices movements, for which the shocks to central region’s sales to foreigners can account, in the central and non-central regions, respectively, and the two charts of row 2 show the proportions of price changes in the two regions that can be explained by the shocks to the non-central region. The shocks to foreigners’ purchases in the central region can contribute about 35% and 25% of fluctuations of house price growth in the central and non-central regions, respectively. On the other hand, the shocks to the non-central region only account for about 1% and 6% of the fluctuations of price growth in the central and non-central regions, respectively. The small impact of the shocks in the non-central region may be because foreigners’ purchases only weigh a small fraction of private residential property sales in that region, and thus a high growth of foreigners’ purchases there only increases the demand slightly.

[Insert Fig. 5 here]

A few alternative model specifications of SVAR are also tried, and the basic results remain similar. For example, when the ripple effect from the non-central to central region is also allowed, the impulse response functions suggest that a 1% shock
to foreigners’ purchases in the central region can breed 0.02% higher growth of house price in that region for two quarters. It also has an effect that causes 0.016% higher growth of non-central region’s prices at the peak, and the effect fades away in one year. On the other hand, an equivalent shock to the non-central region only results in at most 0.008% higher price growth in that region and minimal effect in the central region. When the contemporaneous effect of the central region’s price growth on the price movement of the non-central region is additionally assumed away, the price diffusion mechanisms of the two regions are symmetric, and the ripple effect only occurs in a lead-lag fashion. In this situation, the extra price growth in the non-central region due to the foreign liquidity shock to that region can pick up to 0.014%, while other impulse responses remain similar. However, this case does not pass the test of identifying restrictions.

4. Conclusion

With globalization, foreign liquidity has played an increasingly important role in shaping regional and local markets, including the real estate. Global investors are attracted to international real estate markets, which may be more segmented than highly integrated stock markets, as lower correlation with other asset classes offer diversification benefits. From the perspective of the recipient countries, the governments often like to maintain stable and moderate growth of housing prices. On the one hand, housing is often the largest component of household wealth. On the other hand, housing offers the shelter. Foreign liquidity can lend support to the market,
but it may worsen housing affordability when the market is tight. In Singapore, the
government often eases rules and regulations on foreigners’ purchases when the
market is dull and may tighten them when the market overheats.

This paper finds that such policy shocks to foreigners’ property acquisitions do
have large impact on house price movement. The research depicts a strong
relationship between foreign liquidity to real estate and house price change, and it
finds the ripple effect of regional house prices. The structural vector autoregressive
model, which incorporates these two observations, shows that shocks to foreigners’
buying activities in the central region greatly affect the house price growth and
account for 35% fluctuations of the growth there. The shocks also explain 25%
fluctuations of house price growth in the non-central region through the ripple effect
of regional home prices, even though foreigners’ purchases in the central region do
not directly affect the prices in the other region. Possibly due to low concentration of
foreign home buyers in the non-central region, shocks to foreigners’ acquisitions in
that region have minimal impact on house price movements in both regions. These
findings warrant policy consideration. For instance, the effects of adjusting influx of
foreign liquidity can be general, even though foreign home buyers are mainly
interested in a particular segment of the housing market.

This study also appeals to researchers on the ripple effect. The emerging
literature on the ripple effect of property prices focuses on the diffusion pattern of
prices, and the shock which causes the ripple receives little attention. This paper
shows that investigating the content of the shock can widen possible applications of the ripple effect literature. This can be a rewarding future research direction.

**Notes**

1. For instance, the Spanish Government is launching a reform of immigration regulations in November 2012. The reform is to offer permanent residency to foreign home buyers in order to promote its stagnant housing sector.

2. The off-diagonal elements of matrix $A$ capture the negative of the contemporaneous effects. Thus, the estimated effect on house-price growth in the central region is positive.

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Fig. 1: Hedonic house price indices of individual planning areas
Fig. 2: Hedonic house price index of Singapore
Fig. 3: Diffusion of the structural breaks
Fig. 4: Impulse response functions

- Foreigners' Acquisitions in Central Region to Housing Price in Central Region
- Foreigners' Acquisitions in Central Region to Housing Price in Non-central Region
- Foreigners' Acquisitions in Non-central Region to Housing Price in Central Region
- Foreigners' Acquisitions in Non-central Region to Housing Price in Non-central Region
Fig. 5: Forecast error variance decompositions

In the figure, four graphs illustrate the forecast error variance decompositions for different scenarios related to foreign investment in central and non-central regions. The x-axis represents the lag, while the y-axis shows the percentage change in housing prices due to foreign investment. Each graph track indicates the contribution of foreign investment to housing prices over time, with different lines representing various sub-periods or components of the variance.
<table>
<thead>
<tr>
<th>Consolidated planning area</th>
<th>Region</th>
<th>Estimated break point</th>
<th>R²</th>
<th>Break-point coef. $\beta_j$</th>
<th>Consolidated planning area</th>
<th>Region</th>
<th>Estimated break point</th>
<th>R²</th>
<th>Break-point coef. $\beta_j$</th>
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<tr>
<td>Ang Mo Kio</td>
<td>Non-central</td>
<td>Quarter 2, 2007</td>
<td>0.51</td>
<td>0.283*** (0.055)</td>
<td>Kallang</td>
<td>Central</td>
<td>Quarter 3, 2005</td>
<td>0.56</td>
<td>0.183*** (0.033)</td>
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<tr>
<td>Bedok</td>
<td>Non-central</td>
<td>Quarter 1, 2006</td>
<td>0.61</td>
<td>0.195*** (0.032)</td>
<td>Mandai</td>
<td>Non-central</td>
<td>Quarter 2, 2007</td>
<td>0.65</td>
<td>0.240*** (0.034)</td>
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<td>0.52</td>
<td>0.287*** (0.057)</td>
<td>Marine Parade</td>
<td>Central</td>
<td>Quarter 1, 2004</td>
<td>0.56</td>
<td>0.243*** (0.043)</td>
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<tr>
<td>Bukit Batok</td>
<td>Non-central</td>
<td>Quarter 2, 2007</td>
<td>0.73</td>
<td>0.321*** (0.039)</td>
<td>Newton</td>
<td>Central</td>
<td>Quarter 2, 2005</td>
<td>0.61</td>
<td>0.262*** (0.048)</td>
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<tr>
<td>Bukit Merah</td>
<td>Central</td>
<td>Quarter 2, 2007</td>
<td>0.46</td>
<td>0.537*** (0.121)</td>
<td>Novena</td>
<td>Central</td>
<td>Quarter 3, 2005</td>
<td>0.53</td>
<td>0.194*** (0.041)</td>
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<tr>
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<td>Quarter 2, 2007</td>
<td>0.64</td>
<td>0.272*** (0.040)</td>
<td>Outram</td>
<td>Central</td>
<td>Quarter 2, 2005</td>
<td>0.69</td>
<td>0.197*** (0.026)</td>
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<td>Central</td>
<td>Quarter 1, 2005</td>
<td>0.53</td>
<td>0.175*** (0.035)</td>
<td>Punggol</td>
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<td>Quarter 2, 2006</td>
<td>0.67</td>
<td>0.267*** (0.035)</td>
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<td>0.244*** (0.040)</td>
<td>Queenstown</td>
<td>Central</td>
<td>Quarter 4, 2005</td>
<td>0.57</td>
<td>0.196*** (0.036)</td>
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<td>0.217*** (0.073)</td>
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<td>0.315*** (0.046)</td>
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<td>0.193*** (0.059)</td>
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Note: The structure break point is estimated for each consolidated planning area using the area-specific house price index. The potential structure break point in the regression that returns the maximum R² is the estimated structure-break point, and the R² and break-point coefficient reported in the table are estimates returned from this regression. The label *** indicates the corresponding coefficient estimate is statistically significant at 1% level, and the standard error is in the parenthesis.
Table 2: Variable definitions and summary statistics

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<th>Variable</th>
<th>Definition</th>
<th>Endogenous / Exogenous</th>
<th>Level Mean</th>
<th>Level Std. Dev.</th>
<th>Difference Mean</th>
<th>Difference Std. Dev.</th>
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<td>$s_t^c$</td>
<td>Total number of private residential properties in the central region</td>
<td>Endogenous</td>
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<td>$f_t^{nc}$</td>
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<td>$p_t^{nc}$</td>
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<td>0.141</td>
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<td>Real Gross Domestic Product</td>
<td>Exogenous</td>
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<td>0.231</td>
<td>0.011</td>
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<td>$r_t$</td>
<td>15-year mortgage interest rate in Singapore and deflated by CPI</td>
<td>Exogenous</td>
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<td>-0.010</td>
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Note: The values of all variables are in logarithm.
Table 3: Augment Dickey-Fuller unit-root test

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<th>Level P-value</th>
<th>Difference Test Stat.</th>
<th>Difference P-value</th>
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Table 4: Estimation outcomes of SVAR

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<td><strong>Transpose of matrix B</strong></td>
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<td>p-value</td>
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</table>

**LR test of identifying restrictions**

$\chi^2(9) = 14.08$  Prob > $\chi^2 = 0.12$

Note: Matrices A and B are the contemporaneous and residual matrices in the SVAR, respectively. The estimates of the underlying VAR are also reported. ** and * indicate 5% and 10% levels of significance, respectively. Standard errors are in the parentheses.