THE SINGAPORE RESIDENTIAL PRICE INDEX [SRPI] WHITE PAPER

Basket-based Property Price Indexes for Singapore Non-landed Private Residential Properties

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1. Introduction

1.1 An overview of the SRPI

The Singapore Residential Price Index [SRPI] is a transactions-based index that tracks the month-on-month price movements of private non-landed residential properties in Singapore. The rationale for creating the SRPI is two-fold. First, the SRPI provides a reference index for the development of property derivatives that would help expand the suite of financial products offered in Singapore, particularly in the context of managing portfolios and risks associated with direct real estate. Second, the SRPI complements existing property information on the state of the Singapore residential market.

The SRPI is developed by the Institute of Real Estate Studies at the National University of Singapore [NUS IRES] with support from the Monetary Authority of Singapore [MAS], the Singapore Land Authority [SLA] and the Urban Redevelopment Authority [URA]. It benefited from discussions and consultations with local and foreign members of the finance and real estate community, real estate researchers as well as index providers.

The SRPI is computed based on the market value of a fixed basket of properties selected to represent the private non-landed residential market. As at the end of December 2009, the current SRPI basket comprises 364 non-landed private residential projects that have been completed, according to the date of receipt of Temporary Occupation Permit [TOP] status, between October 1998 and September 2009. Projects with fewer than 40 units and developments that may have been targeted for *en bloc* sales are excluded.

The private non-landed residential market in Singapore consists of projects with freehold land title as well as those with leasehold land title. Both tenure types are represented in the SRPI basket. The prices of leasehold properties are converted to equivalent freehold prices before being incorporated in the index calculation; such adjustments are necessary since leasehold properties will depreciate in value against equivalent freehold properties as the remaining lease maturity shortens. The SRPI thus represents the market price movement in terms of (equivalent) freehold prices.

The computation of the SRPI employs two sets of data:

(i) property data, such as the address point (x-y spatial coordinates), project completion (TOP) date and leasehold maturity of the residential projects constituting the SRPI basket, as well as the floor level and the strata area of all the individual dwelling units in these projects, which are provided by the SLA; and

(ii) transaction data, such as sales price, date of contract and unit identity, which are provided by the URA.

The property data are acquired during the constitution (and re-constitution) of the SRPI basket while the transaction data are procured on a monthly basis and reflect the caveat information posted on the URA information portal REALIS.

The SRPI is computed based on the market values of all the individual properties in the SRPI basket. These values are "marked-to-market" each month according to the transacted prices of the units in the basket that are observed for the month. The calculation of the SRPI, therefore, closely resembles that of a stock market index, which is based on a basket of stocks representing the stock market. However, unlike the stock market where stocks are traded at higher frequency and the shares of the same stock are perfect substitutes, individual properties in the residential market are traded infrequently and are imperfect substitutes of each other. Consequently, the SRPI relies on a *mark-to-market* algorithm to impute the price movement of each property in the basket that is not traded in a particular month. The algorithm uses a Locally Weighted Regression [LWR] model (explained in Section 2) which allows the market values of the individual properties to move differently according to the sales signals observed in their vicinity relative to the overall price movement of the basket. Such spatial sensitivity of the algorithm enhances the accuracy of the SRPI's representation of the price movement of the market when different parts of the market are affected by localized demand and supply changes. The algorithm also accommodates differentiated responses in terms of the speed and extent of adjustment of prices to city-wide demand and supply changes. Like a stock market index, sub-indices of the SRPI can be easily computed based on the price movements of different sub-baskets representing different sub-markets. For the purposes of this paper, two sub-indices are calculated to represent the Central and Non-Central regions in addition to an aggregate index for Singapore. The Central Region comprises postal districts 1, 2, 3, 4, 9, 10 and 11 while the remaining postal districts are in the Non-Central region.

1.2 The flash and revised estimates of the SRPI

The computation of the SRPI relies on transaction data that are provided by the URA based on the sales caveats lodged with the SLA. Such lodgement is voluntary and typically lags the actual transaction. Depending on the timeliness of the lodgment process, some transactions concluded in month t may not be reflected in the data by the time the SRPI is compiled in month $t+1$. It is therefore necessary to report both the flash and the revised estimates of the SRPI.

The flash SRPI for month t is computed with caveat data captured by the 21st (or the next business day) of month $t+1$. A revised estimate of the SRPI for month t will be computed in month $t+2$ using the same cut-off date rule. Both the flash and revised SRPI estimates will be published on the 28th (or the next business day) of every month.

It is important to note the difference between the SRPI revision due to data delay and the *index revision* problem for the conventional repeat-sales index. The SRPI value for month t, by design, reflects the market value of the property basket in month t relative to the market value of the same basket in the base period and will not be affected by sales subsequent to month t. In contrast, the conventional repeat-sales index depends on past as well as future sales; hence, sales observed in each month will not only affect the current index value but also the entire history of the index—an issue known as the index revision problem.

1.3 The outline of the SRPI White Paper

Section 2 describes the SRPI methodology, including its key features and the computation procedure. Section 3 shows the historical performance of the indices based on the SRPI method. Two appendices follow. Appendix A describes the technical details for the construction of the SRPI while Appendix B documents the composition of the current SRPI property basket.

2. The SRPI Methodology

2.1 Key features

Several important features of the SRPI methodology distinguish it from conventional residential price index methodologies, namely the hedonic price method and the repeat-sales method (explained in Appendix A). First, the SRPI method is basket-based; it is designed to track the market value of a predetermined basket of properties over time. To the extent that the composition of the basket adequately represents the market to be tracked by the index, the basket-based approach ensures that the resulting index is representative of the market. Moreover, it makes the index both transparent and robust with respect to what the index is designed to measure, even when the underlying mix of properties sold each month varies from period to period. Thus, changes in the SRPI reflect changes in the value of the reference basket rather than changes in the mix of properties that is traded. In comparison, changes in the mix of traded properties can significantly impact the value of an index that is not based on a fixed basket of properties, a problem known as *sample selection bias*. The basket-based approach consequently minimizes the basis risk — the uncertainty in what the index actually measures.

The second distinguishing feature of the SRPI methodology is its use of a Locally Weighted Regression [LWR] model to mark-to-market the values of the properties in the basket every month based on the transaction prices observed in the same period. The LWR model (specified in Appendix A) has an intuitive appeal in that, when imputing the value of a subject property, it attaches greater importance to transactions in the more immediate vicinity of the subject property than to more distant sales observations. The rate at which the influence decays with distance reflects both spatial heterogeneity in property and location attributes and the diffusion of price adjustments across locations. The use of the LWR model eliminates the need to impose common price trend assumptions that are necessary for estimating the price indices associated with more conventional hedonic price and repeat-sales approaches. Hence, the SRPI method avoids potential specification errors that could arise from inaccurate assumptions about the price dynamics in the market.

Third, the SRPI method is efficient in that all relevant information pertaining to the valuation of a property — hedonic, repeat-sale, as well as the spatial correlation both in unobserved hedonic attributes and in price changes — is utilized for the estimation of period-to-period prices. In this respect, the SRPI method represents an improvement over the conventional hedonic price index model and repeat-sales price index model, which often utilize considerably less information.

Another important attribute of the SRPI method, derived from the LWR model in the mark-to-market algorithm, is its robustness with respect to the sample size of the sales available to estimate the price movement of the basket. With normal transaction volumes, revisions due to data delay are fairly small in magnitude (see section 3.3). In circumstances of exceptionally low market liquidity, the algorithm has a built-in mechanism to dampen the impact that a very small number of observed transactions could have on the SRPI movement, so that the index will not be unduly volatile under such circumstances.

2.2 The SRPI computation procedure

The SRPI computation procedure is divided into two stages:

- the base-period property basket formation and valuation procedure; and
- the post-base-period mark-to-market property value updating and index calculation procedure.

2.2.1 Base-period property basket formation and valuation procedure

The basket formation and valuation procedure involve three tasks:

(i) selecting residential projects for the basket to represent the market to be tracked by the index;

(ii) inventorizing all the properties in the selected projects together with their relevant attributes; and

(iii) estimating the market value of these properties as of the base period.

The *base period* is the reference month — the values of all the properties in the basket in the base period serve as references against which subsequent transaction prices are compared for determining price change.

<u>Selection of projects for the basket</u>

The SRPI aims to track the price movement of the private non-landed residential market in Singapore. Several criteria have been adopted in the selection of projects for inclusion in the SRPI basket to ensure a representative benchmark portfolio. First, the properties should be transacted for their existing use. Second, the projects should provide a level of amenity reasonably reflective of the private non-landed housing market. Third, there should be an adequate cross-sectional representation of projects to reduce the possibility of index manipulation.

To address these criteria, only transactions in completed projects are used for computing the SRPI where completion means the receipt of a Temporary Occupation Permit (TOP). This ensures that the base-period valuation of the properties in the basket can be established and also reduces the influence of pre-completion sales by developers or sub-sales that may have different price dynamics. With respect to the current base period of December 2009, the basket includes projects completed between October 1998 and September 2009. By selecting relatively younger projects, there is less variation in the amenity level across included developments. Older projects also tend to have low transaction volume, suffer greater functional obsolescence and are often traded for potential redevelopment gains. Regardless of age however, projects that are subject to potential *en bloc* activity (based on media reports and other information in the public domain) at the time of basket formation are also omitted.

To keep the basket size manageable, projects with fewer than 40 dwelling units are excluded as they tend to be less liquid and their prices are less influential on the overall market. A few projects completed in the first three quarters of 2009 have incomplete information for inventorization and are therefore excluded from the current basket as well. Appendix B documents all the 364 projects in the current basket; these projects are located in 26 of the 28 (two-digit) postal districts in Singapore.

Over time, the basket will be adjusted to include new projects as they become available and to remove old projects. The maximum age of the projects in the current SRPI basket is kept at about 10 years — this may be increased in future as the pace of redevelopment activity in Singapore subsides. We envisage the need to adjust the composition of the basket every two years to reflect the changes in the completed stock of private non-landed residential properties in Singapore. The SRPI basket constituted at the previous base period, December 2007, comprised 358 projects in 25 of the 28 postal districts. 65 of these projects that were completed before October 1998 are excluded from the latest (December 2009) reconstitution of the SRPI basket, which includes 71 new projects completed between October 2007 and September 2009.

Inventorization of the properties

An inventory of all the dwelling units in the selected projects is made with information supplied by the SLA. Each unit is identified by its project name, building block (house number), unit number, and floor level. The strata area of each unit is recorded together with the building TOP date, project land tenure (including the start date of the leasehold title and the original maturity), and the geographic address point (x-y coordinates). These variables will be used in the estimation of the base-period market value and the subsequent value updating. The inventory database keeps records of the base-period valuation as well as the subsequent mark-to-market value updates of every unit in the basket on a monthly basis.

Base-period valuation

Base-period prices of all the properties within the SRPI basket are needed as a reference for determining the extent of future price movements. The estimation of these prices uses all observed sales in the basket up to (and including) the base period and accounts for differences both in the observed attributes (such as strata area, floor level and the identity of the project) and in the spatially correlated but unobserved attributes (such as views and noise levels) of the properties. In addition, all leasehold prices are converted to their freehold equivalent prices.

2.2.2 Post-base-period mark-to-market value updating and index calculation procedure

Mark-to-market value updating

Each month after the base period, value updating is carried out using the observed monthly sales data and the spatial information from the inventory database. This updating employs the LWR algorithm to perform the following steps:

(i) The price changes of all transacted properties in the current period relative to their values in the previous month are calculated.

(ii) The price change of each property in the basket is predicted using a weighted average of the price changes calculated above according to the LWR algorithm.

(iii) The predicted price change is used to mark-to-market the value of every property in the basket. For the properties that are actually transacted in the current period, their updated market value equals their observed sale price (or the freehold equivalent price in the case of leasehold properties).

Index calculation

Once the value of each individual property in the basket has been updated based on the observed monthly sales, indices may be computed using different definitions and for different sub-baskets. For the purposes of this paper, equal-weighted and value-weighted indices have been computed.

(i) An equal-weighted [ew] index is computed based on the average of the changes (expressed as the log difference) in mark-to-market values of the properties in the basket (sub-basket) between the current and the base period. All the constituent properties in the basket (sub-basket) have equal influence on the index.

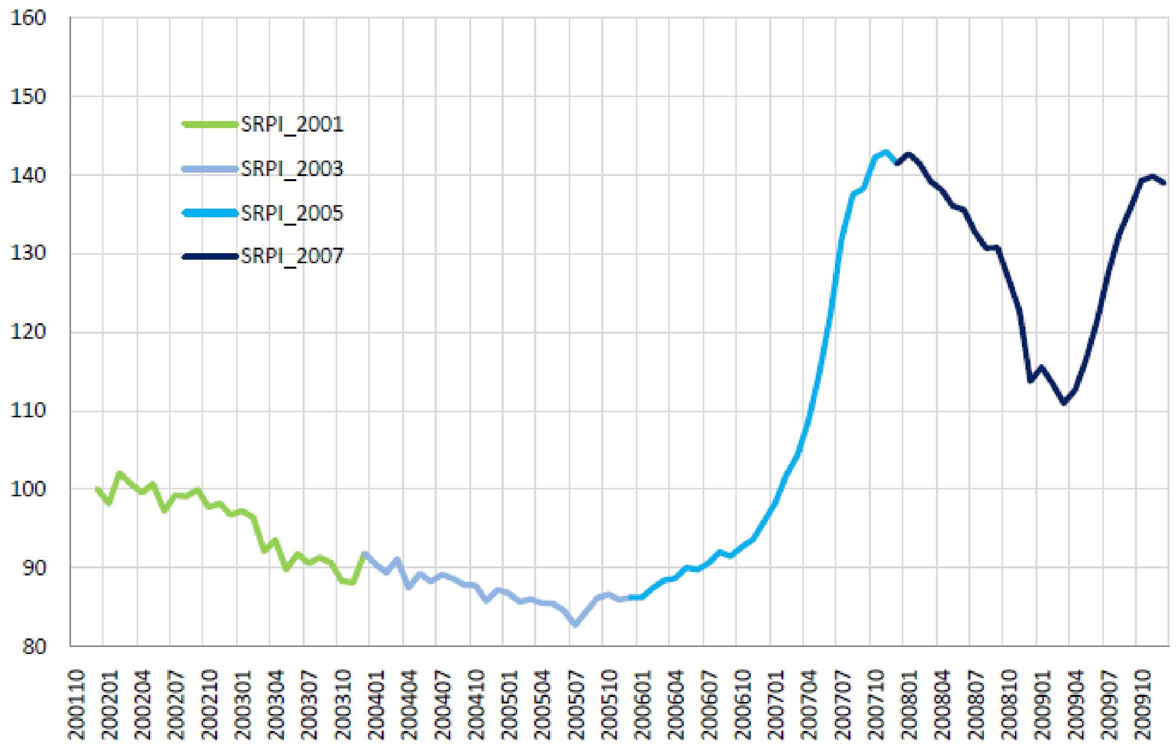
(ii) A value-weighted index [vw] is computed as the ratio of the total mark-to-market value of the basket (sub-basket) in the current period over its total mark-to-market value in the base period. The influence of a property on the index calculation is proportional to its capital value in the base period.

3. The Performance of the SRPI

3.1. The historical movement of the SRPI

Figure 3.1 presents the value-weighted SRPI index since December 2001. It is computed by tracking the price movement of four successive index baskets of non-landed residential projects and uses all observed transactions captured as at 21 February 2010. The first basket is formed in base-period December 2001 (denoted as 2001:12) and SRPI_2001 is the value-weighted SRPI index that reflects the price movement of the properties in that basket. The index basket is revised biennially. Following the first revision in base period 2003:12, SRPI_2003 is constructed and chained to SRPI_2001 such that the value of SRPI_2003 is set equal to the value of SRPI_2001 in December 2003. Likewise, SRPI_2005 and SRPI_2007 are computed when the index basket is next reviewed in December 2005 and December 2007 respectively. (Note that given the SRPI methodology and basket selection criteria, there is insufficient data to begin the SRPI series earlier.)

Figure 3.1 The SRPI (December 2001 to December 2009; 2001.12=100)

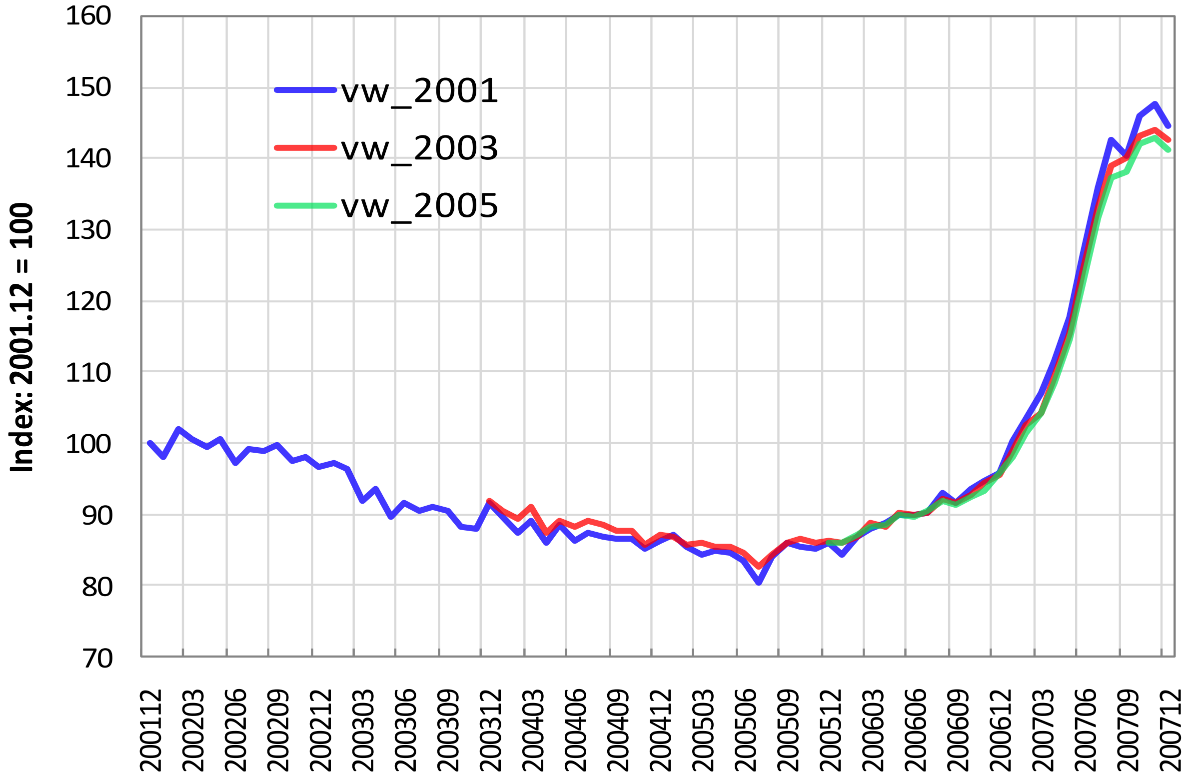


The SRPI indicates that the private non-landed residential market peaked in November 2007 before falling some 22% to its lowest level post-crisis in March 2009. Since then, it has appreciated by about 25% as at the end of 2009 and by 28% based on the flash SRPI estimate for January 2010.

3.2. Changes in the composition of the SRPI basket

Revisions of the index basket may influence the SRPI over time. To examine this, two of the value-weighted (vw) indices based on earlier baskets in Figure 3.1 are extended to December 2007: vw_2001 denotes the value-weighted index based on the basket formed in base period 2001.12 and is an extension of SRPI_2001 while vw_2003 is the index corresponding to the 2003.12 base-period basket, or the SRPI_2003, calculated to December 2007. vw_2005 is the same as SRPI_2005. These historical indices are computed based on all observed transactions as at August 2008 and the three series are shown in Figure 3.2 below.

Figure 3.2 The SRPI indices based on three successive property baskets (December 2001 to December 2007; 2001.12=100)



To facilitate comparison, the indices are chained in the same way as the SRPI in Figure 3.1, that is, the value of vw_2003 equals the value of vw_2001 in base period 2003.12 and the value of vw_2005 equals the value of vw_2003 in base period 2005.12. Note also that due to data limitations, earlier baskets are in effect sub-sets of later baskets. For example, the basket corresponding to the 2003.12 base period comprises the projects in the 2001.12 base-period basket as well as additional projects completed between October 2001 and September 2003.

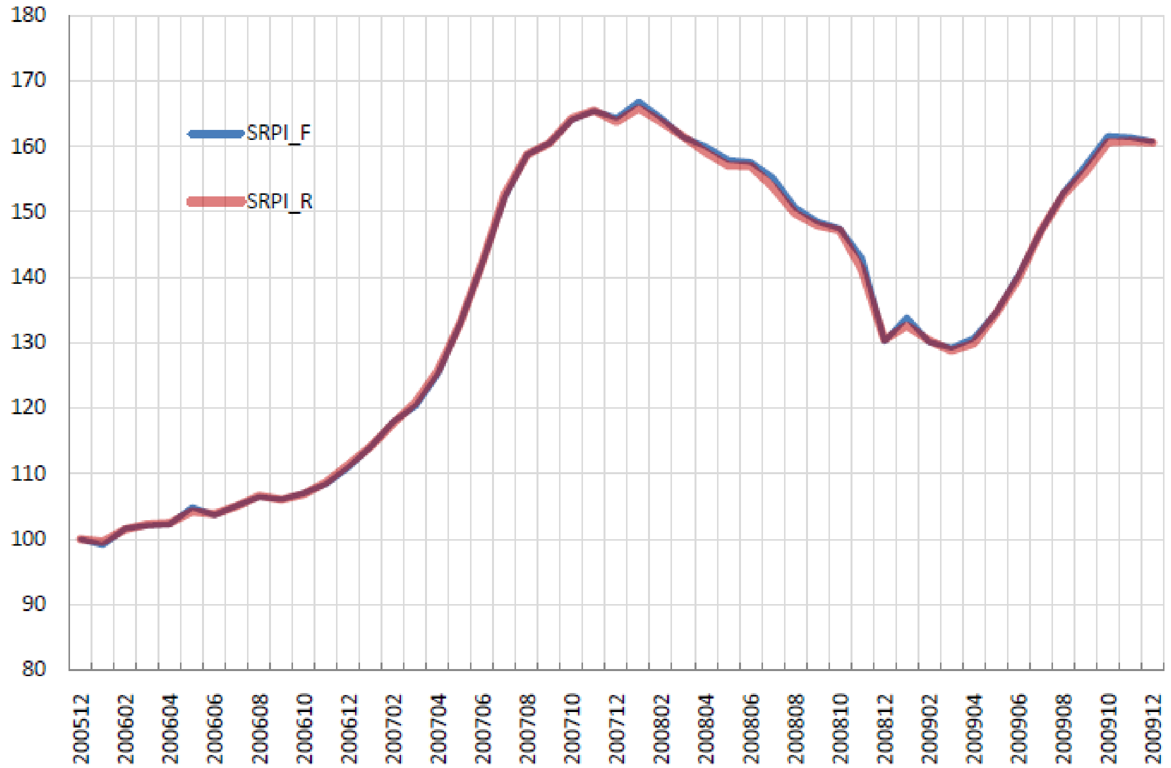
Overall, the three indices based on successive baskets move quite closely with each other although vw_ 2001 appreciated marginally more in the last few months of 2007 than the indices based on the later baskets. The difference is due to an increased representation of outlying projects in the non-central region over time. These outlying projects experienced relatively smaller price gains during the 2007 property market boom compared to more centrally located projects. As a result, the indices that are associated with the December 2003 and December 2005 baskets — vw_2003 and vw_2005 — appear to have appreciated less than vw_2001.

3.3. Flash and revised SRPI indices

Figure 3.3 presents both the flash and revised estimates of the SRPI computed from December 2005 to December 2009 using December 2005 as the base period, where:

- SRPI_F is the flash SRPI that begins in December 2005 with the basket of properties formed in the 2005.12 base period. The basket is subsequently revised in the 2007.12 base period and the price movement of this current basket is reflected in the SRPI from January 2008 onwards. The flash SRPI for month *t* uses caveat data captured by the 21st (or the next business day) of month t+1.
- SRPI_R is the (once) revised version of SRPI_F. The revised SRPI for month *t* uses caveat data captured by the 21st (or the next business day) of month t+2.

Figure 3.3 Flash and revised SRPI (value-weighted)
(December 2005 to December 2009; 2005.04=100)



Over the January 2002 to March 2009 period, about 75% of the total number of transactions that are eventually lodged for a given month is captured in time for the computation of flash indices while around another 17% is available a month later for calculating the revised indices. Thus, the flash and revised indices are expected to reflect about 75% and 92% respectively of all month *t* residential sales that eventually appear in the caveat database.

The flash and revised SRPI indices are quite identical. Over the 2005.12 to 2009.02 period, for example, the mean absolute difference between the flash and (once) revised SRPI index values is 0.317%. (When the index is computed on an equal-weighted basis, the mean absolute difference is 0.211%).

3.4. Regional indices

Figure 3.4 shows the SRPI as well as sub-indices based on the sub-baskets of properties in the Central and Non-Central regions using December 2001 as the base period. The Central region comprises postal districts 1 to 4 and 9 to 11 while the Non-Central region comprises the remaining postal districts. (Appendix B provides the details.)

Indices that are disaggregated by region can be useful for monitoring price behaviour in different segments of the non-landed residential market. SRPI_C, the index for the Central region, shows that properties there appreciated at a faster pace than properties located in the Non-Central regions between mid-2005 to end-2007 and depreciated at a comparatively faster pace till March 2009.

SRPI_C is also more volatile than SRPI_NC, the index for properties in the Non-Central region. While the overall price trends are broadly similar for both regions, SRPI_C peaked in November 2007 whereas SRPI_NC peaked in January 2008. The regional sub-indices as well as the overall SRPI bottomed in March 2009. As the private non-landed residential market recovered, property prices in the Central region have risen more than those in the Non-Central region. Despite its slower pace of increase, SRPI_NC has already exceeded its previous peak by October 2009.

Figure 3.4 The SRPI, Central Region SRPI and Non-Central Region SRPI (December 2001 to December 2009; 2001.12=100)

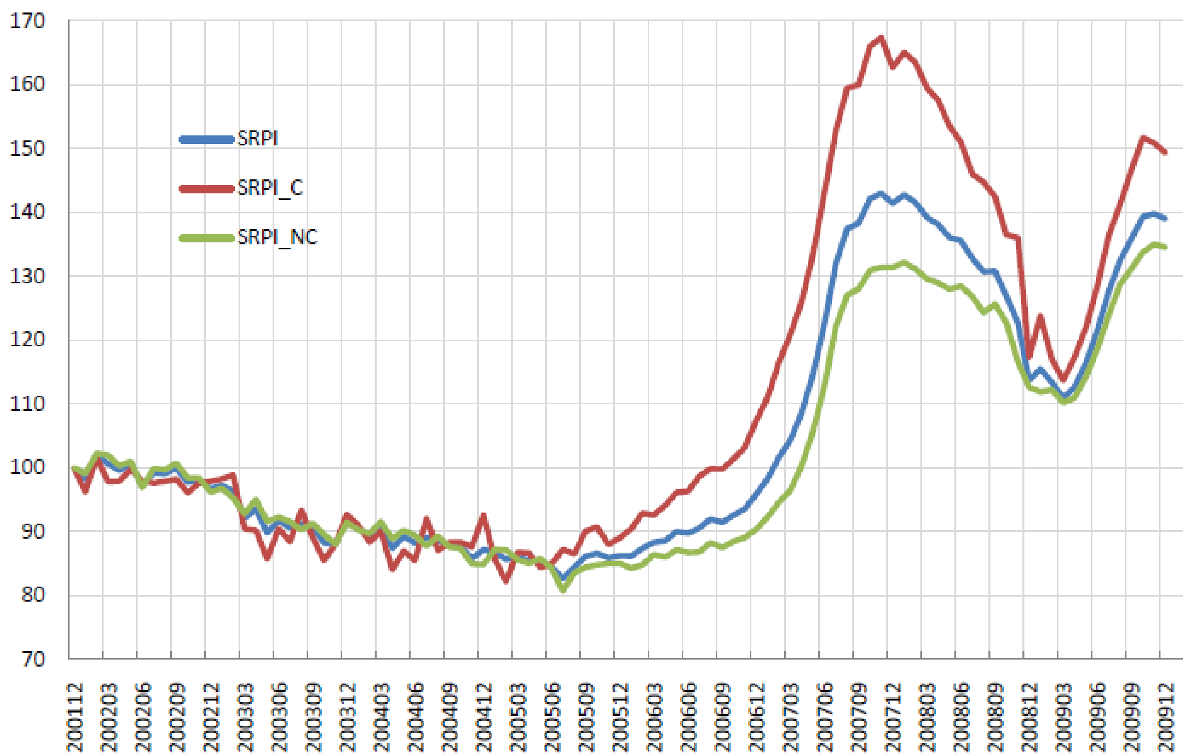
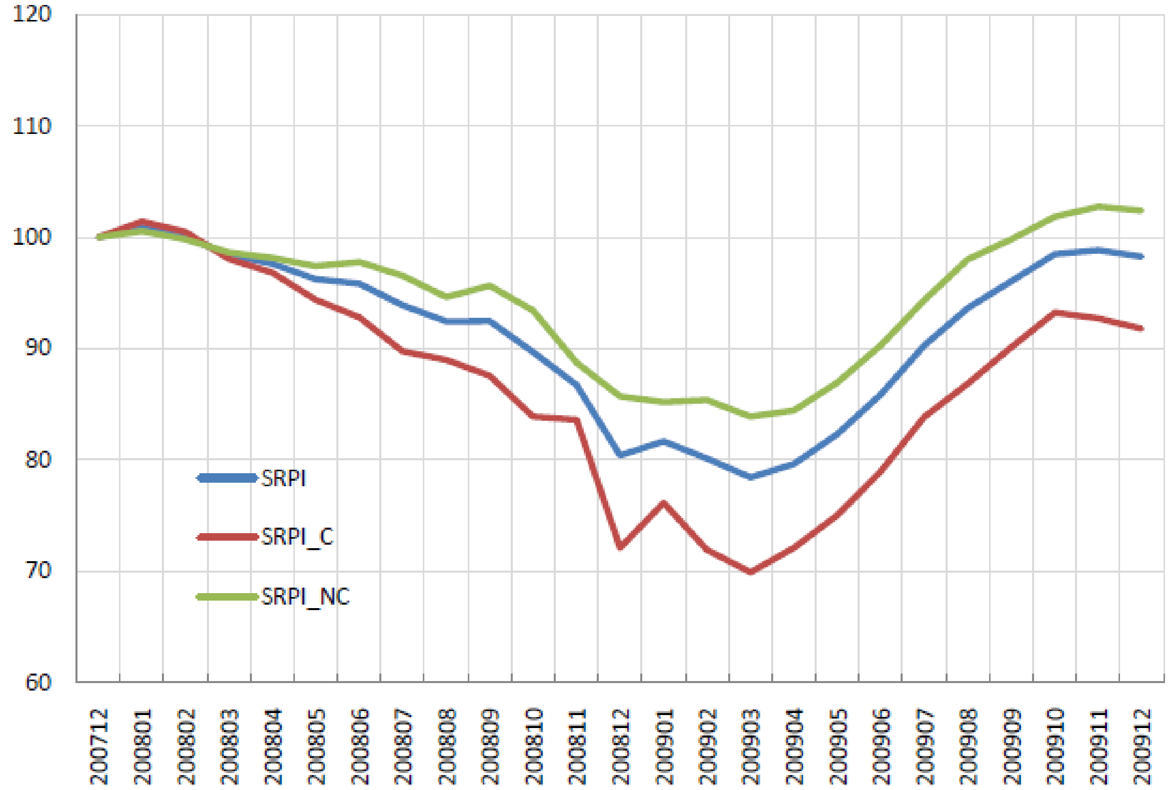


Figure 3.5 provides another perspective on the latest trends in the price movement of the regional indices based on the basket formed in base period 2007.12. The indices are all set at 100 in this base period to highlight the differences in price change between January 2008 and December 2009. SRPI_C shows that prices in the Central region have dropped by about 30% from January 2008 to March 2009 compared to a decline of about 16% for properties in the Non-Central region. By October 2009, the Non-Central region index has surpassed its level in January 2008. However, the Central region index was still about 9.7% below its December 2007 level.

Figure 3.5 The SRPI, Central Region SRPI and Non-Central Region SRPI (December 2007 to December 2009; 2007.12=100)



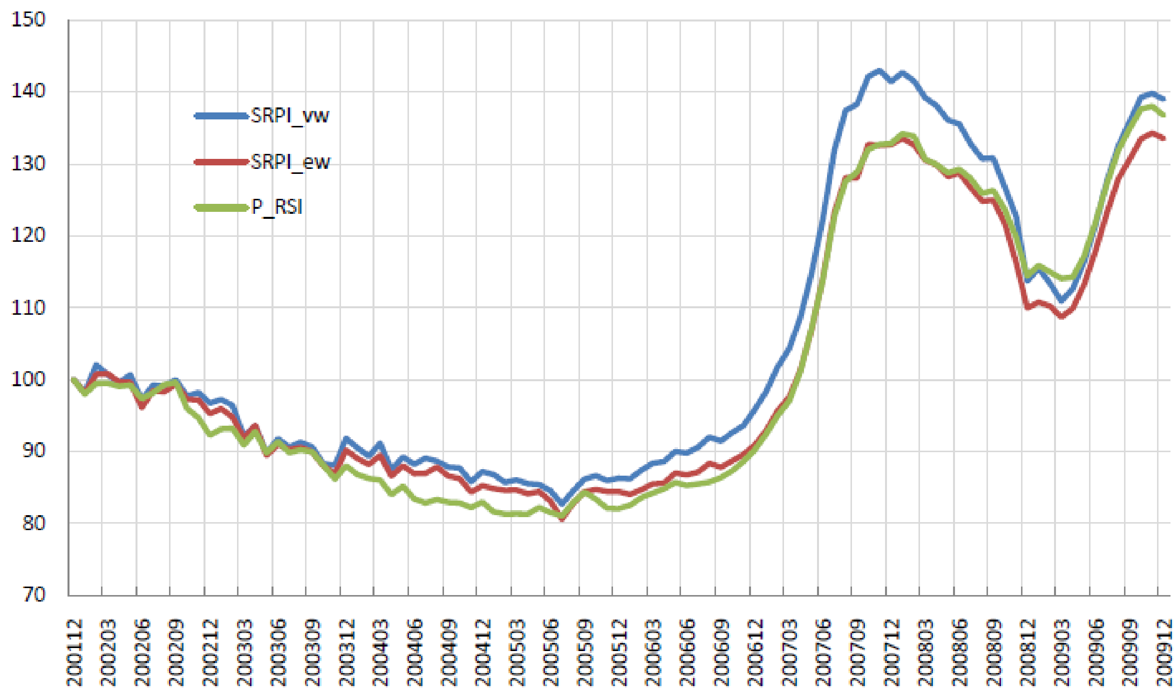
3.5. Indices using different weighting schemes

Figure 3.6 shows the effect of using different weighting schemes on the index for the period from 2001.12 to 2009.12. SRPI_vw is the value-weighted index (identical to the SRPI in Figure 3.4). The extent of the influence that the price movement of each property exerts on this index is proportional to the capital value of the property in the base period. On the other hand, the price movement of each property in the basket has an equal influence on the equal-weighted index, SRPI_ew. Compared to the equal-weighted index, the value-weighted index appreciated faster since mid-2005 to end 2007 and depreciated marginally more between January 2008 and March 2009. Since March 2009, it has also risen more than the equal-weighted index as it is more sensitive than the equal-weighted index to the price movements of more expensive properties. These properties experienced greater price volatility during the recent property market cycle in Singapore.

For comparison, Figure 3.6 also shows P_RSI, an index computed according to the simple average of the observed price changes of the properties transacted each month. Like the repeat-sales index, P_RSI is exposed to *sample selection bias* due to the shifts in the mix of the properties that get transacted from period to period; hence, P_RSI will be referred to as a proxy repeat-sales index. In contrast, the SRPI mitigates such bias by marking-to-market a fixed basket of properties.

Before the steep run-up in prices that started in September 2006, SRPI_ew and SRPI_vw track each other quite closely but P_RSI generally trends below them. From January 2007 to mid-2008, P_RSI follows SRPI_ew; however, from July 2008 to March 2009, P_RSI shows a smaller decline from peak to trough compared to the two SRPI indices. The differences between the P_RSI and the SRPI indices appear more pronounced in periods of market weakness when the issue of sample selection bias is potentially more problematic.

Figure 3.6 The value-weighted SRPI, equal-weighted SRPI and proxy repeat-sales index (December 2001 to December 2009; 2001.12=100)



Appendix A. Technical Description of the Design of the SRPI

A.1 Property index representation problem

Real estate is heterogeneous, not least because each property is uniquely located. As a result, any demand or supply shock in the market does not necessarily affect all the properties in the same way. This raises the question of how to represent the price movement of the real estate market. The simple answer is that there is no unique way to represent the real estate market movement. Conventionally, there are three types of representation:

1. Median-sales index
2. Hedonic price index
3. Repeat-sales index

The first index method is the simplest to compute and provides a useful indication of the market price movement if it comprehensively captures all transactions and the quality of the median property transacted remains more or less constant. In reality, the quality of the median transacted property varies from period to period and tends to rise over time as the overall quality of the housing stock rises. There are two versions of the representation based on hedonic price models. The non-parametric version estimates the price of a “representative property”, or a chosen bundle of property attributes, using locally weighted regression and uses the estimated price trend of this representative property to represent the market. The merit of such a non-parametric hedonic price index thus depends on the extent to which the “representative property” is adequate to represent the market in question. The parametric version of the hedonic price index and the repeat-sales index share a core feature, that is, both are based on the assumption of one or a few common price trends driving the entire market to be represented by the index. Although the existence of one or a few predominant price trends in the market is often a sensible assumption to make, there could be time periods when sales in the market are dominated by less typical properties whose price trends deviate from the predominant one(s)—hence the potential basis risk introduced by the “common price trend” assumption.

The second fundamental characteristic of the real estate market—the low frequency at which individual properties are sold, or illiquidity—aggravates the problem of accurate representation of market movement. We have to make assumptions regarding the price movement of the properties not sold in each period given the price signals we observe from a small fraction of all the properties that actually sold in the period. With the non-parametric version of the hedonic price model, the estimated price of the “representative property” is inferred according to the price signals of the transacted properties in the period in adjacent characteristic space (with similar location and other attributes). Such inference becomes problematic when few sales are in proximity to the chosen “representative property” in the characteristic space. With the parametric hedonic price model or the repeat-sales model, the inference for the market price movement is based on the “common price trend” assumption, the validity of which is sensitive to the mix of properties transacted in a period.

To overcome these market representation biases inherent in the conventional property index methodologies, the SRPI takes a new approach, which departs from the conventional methodologies in the following respects:

1. *The SRPI is basket-based*. The basket is selected to be broadly representative of the target market. Defining the index as a representation of the price movement of a fixed basket of properties helps to minimize the *basis risk* (that is, the uncertainty in what the index measures because of the changes in the mix of properties sold each period).
2. *The SRPI uses a locally weighted regression [LWR] method to update the mark-to-market value of all the properties in the basket according to the price change signals observed from current sales.* The LWR method is sensitive to the spatial distribution of these price signals, such that the value updating is more influenced by the sales in closer proximity. This design is based on two observations. First, demand shocks are often location-specific (*e.g.* a new MRT station) and hence would affect the price movement of adjacent properties similarly. Second, homes in the same locale often cater to buyers of certain shared characteristics (such as income and social background) and hence tend to respond to economy-wide shocks similarly. The non-parametric LWR method mitigates the specification errors often associated with "common price trend" assumptions required by the repeat-sales and the parametric hedonic price models.

One additional merit of the LWR method for mark-to-market value updating is that it limits the influence of individual price signals to their vicinity. Consequently, the potential for manipulation of sales in order to influence the index is curtailed because it would take more sales in different locations to influence the index even when the market activity is low.

A.2 SRPI mechanics

The construction and updating of the SRPI involves the following components:

1. A basket of projects is selected to represent the target (private non-landed residential) market and the properties in these selected projects are inventorized.
2. The base-period values of the individual properties in the basket are estimated using sales data up to (and including) the base period.
3. The value of each property in the basket is updated in each subsequent period according to the observed sales using the LWR algorithm.
4. The price indices are computed based on the mark-to-market values of the individual properties in the basket.
5. The mark-to-market values of the individual properties and the index values are revised to incorporate additional sales data that were not captured in the flash calculation due to caveat lodgement delays.

The basket formation and inventorization are explained in Section 2.2.1. This section explains the details of the calculations involved in components 2 through 5.

A.2.1 Base-period valuation

The base-period values of the individual properties in the basket provide references against which the price movements of these properties in the subsequent periods can be computed. The base-period value estimate for every property in the SRPI basket is obtained through a three-step hedonic regression method that combines a parametric hedonic model to identify the implicit prices of observed attributes and a non-parametric LWR model to estimate the value of unobserved hedonic attributes.

Step 1. A hedonic price model is specified and estimated using all available transactions in the basket up to (and including) the base period.

This step estimates implicit prices that are used to compute the value of every property in the basket according to its observed attributes. It also generates the estimated hedonic price residuals which will be used in step 2 to compute the value of every property associated with its unobserved attributes.

The hedonic equation accounts for observed property attributes—project fixed effect, floor level, and strata area—as well as price differences due to transaction timing according to (i) the local price trend (*PT*) and (ii) the time-to-TOP (*TTOP*). Purchasing properties before completion (dated by the receipt of a Temporary Occupation Permit, or TOP) usually offers the benefit of interest-free financing via deferred payment schemes but buyers forgo rental income until TOP. Thus the price adjustment to compensate for *TTOP* should increase with the interest rate (*r*) and decrease with the rental yield (*y*). Note that *TTOP* equals zero if the sale occurred after TOP.

Let $Price_{kjst}$ be the sale price of unit *k* in project *j*[1] in region *s* at time *t*, γ the project fixed effect, α the marginal effect of strata area [*A*], λ the marginal effect of floor level [*L*], τ the ground level fixed effect, and ε the hedonic residual. The hedonic price equation is given by:

$$\ln(Price_{kjst} / A_{kj}) = \gamma_j + \tau_s + \alpha_j \cdot \ln(A_{kj}) + \lambda_j \cdot L_{kj} + PT_{st} - y_s \cdot TTOP_j + r_t \cdot TTOP_j + \varepsilon_{kj} \quad (1)$$

Note that (a) the implicit prices α and λ are project-specific and (b) the pre-base-period price index PT_{st} must be jointly estimated with the hedonic parameters and is assumed to be common to projects in the same region. The above hedonic regression is estimated for projects entering the SRPI basket in each base period and is estimated separately for each region. Note that the SRPI basket is formed biennially with the first historical base period starting at December 2001 (2001.12). Thereafter, the basket is adjusted (expanded) in base period 2003.12, 2005.12, and 2007.12. Given the relatively small number of projects in the 2001.12 basket, the hedonic regression for this basket is estimated for two regions, namely the Central Region (including postal districts 1 to 4 and 9 to 11) and the Non-Central Region. In subsequent base periods, the 28 postal districts in Singapore are divided into 6 sub-regions (2 in the Central Region and 4 in the Non-Central Region) for the purpose of estimating the hedonic price equation for the new projects added to the SRPI basket in each base period. Furthermore, these hedonic regressions

[1] In the case where a project is completed in phases, different phases are treated as distinct projects for the purpose of accounting for project fixed effects.

also incorporate the sub-region price index produced by the SRPI basket prior to the current base period through Bayesian updating in order to aid the identification of the implicit prices.

Let T_0 denote the base period and set PT_{sT0}=0. The base-period value of a property according to its observed attributes is given by:

$$\ln\left(\widehat{Price}_{kjsT_0} / A_{kj}\right) \equiv \gamma_j + \tau_s + \alpha_j \cdot \ln(A_{kj}) + \lambda_j \cdot L_{kj} \; . \tag{2}$$

<u>**Step 2.** The hedonic residuals in Equation (1) for those properties in the basket that were sold prior to the base period are used to extrapolate the hedonic value of unobserved attributes.</u>

The value of the unobserved attributes (e.g. views and noise levels) for each property sold prior to the base period is ε_{kj} (or the average value of ε_{kj} in case the property was sold multiple times in and before the base period). These unobserved attributes are often spatially correlated. To extrapolate the hedonic residual spatially, the properties in the basket are sorted according to their project identity, six-digit postal code (unique to individual building blocks within a project), unit number within the project (for buildings with multiple units on each floor), and floor level. Each property not sold in or before the base period is matched with the nearest 6 properties in the same project that were transacted according to the following sorting order—first by the floor level with the same unit number within the same building, then by the unit number, and then by the x-y distance between buildings; its value of unobserved attributes is then computed to be the weighted average of these nearest 6 ε_{kj} values, with the weight declining with the distance in floor level (*DL*), unit number (*DU*), and space between buildings (*DXY*, according to the x-y coordinates unique to each postal code). The rates at which the weight declines with these distance measures (β_1, β_2, and β_3) are chosen to maximize the fit between the estimated residual value and the actual residual value for those properties in the basket sold in or before the base period:

$$\varepsilon_{kj} = \sum_{i \in \Omega_k} \beta_0 \exp(\beta_1 \cdot DL_{k,i} + \beta_2 \cdot DU_{k,i} + \beta_3 \cdot DXY_{k,i}) \cdot \varepsilon_{ij} \tag{3}$$

where Ω_k is the set of the 6 nearest properties matched to property *k* and β_0 is a positive scalar. Equation (3) is used to predict the extrapolated residual value $\hat{\varepsilon}_{kj}$ for the properties in project *j* that were not sold in or before the base period.

<u>**Step 3.** The base-period value of a property is then computed as the sum of the value of the observed attributes and that of the unobserved attributes:</u> $\ln\left(\widehat{Price}_{kjsT_0} / A_{kj}\right) + \hat{\varepsilon}_{kj}$.

A.2.2 Mark-to-market value updating post-base period

The updating algorithm employs a locally weighted regression [LWR] method, which builds on the assumption that contemporaneous price movements across individual properties are spatially correlated. The correlation is assumed to have two components: one influenced by localized events (e.g. a new MRT station or increased demand for properties in particular districts) and the other by market-wide circumstances (e.g. GDP growth or interest rate changes).

The localized component decays with spatial distance; thus, the price changes of two properties, *k*1 and *k*2, at a distance of $DXY_{k1,k2}$ (according to the x-y coordinates of individual building blocks), are assumed to have a correlation coefficient γ determined by:

$$\gamma_{k1,k2} = (1 - \delta \cdot (k1 \neq k2)) \cdot \exp\left(\frac{-\rho \cdot DXY_{k1,k2}^2}{DXY_{k1,k2}^{1.5} + d} \right) \qquad (4)$$

where δ is a nudge effect, diminishing the correlation whenever the two properties are not identical (hence the logical condition $k1 \neq k2$ is true and return value 1), $\rho > 0$ modulates the speed of decay with the distance *DXY* and $d > 0$ modulates the shape of decay. The value of *d* is chosen such that the correlation coefficient γ declines quickly beyond a short distance, where the correlation is influenced by localized events, but slowly farther out, where the influence of market-wide circumstances becomes more dominant. Figure A1 shows the shape of γ given by Equation (4), with $\delta = 0.05$, $\rho = 0.025$ and $d = 40{,}000$.

For a precise description of the value updating algorithm, the following notations will be used. Let $\mathbf{\Gamma}$ be the symmetric matrix of the correlation coefficients γ for the *N* properties in the SRPI basket. Let $\mathbb{S}(t)$ be the set of $n(t)$ sales in the basket observed in period *t*, $\mathbf{p}(t)$ and $\mathbf{g}(t)$, respectively, the vector of the prices and price growth associated with these sales. Further, let $\mathbf{P}(t)$ be the vector of the *N* mark-to-market values in the basket in period *t*, $\mathbf{P}(t|\mathbb{S}(t))$ the sub-vector corresponding to the properties sold in period *t*, $\mathbf{\Gamma}_{\mathbb{S}(t)}$ the $n(t)$-dimensional symmetric sub-matrix of $\mathbf{\Gamma}$ corresponding to these properties, and $\mathbf{\Gamma}_{k,\mathbb{S}(t)}$ the $n(t)$-dimensional column vector of γ coefficients between property *k* in the basket and those in $\mathbb{S}(t)$.

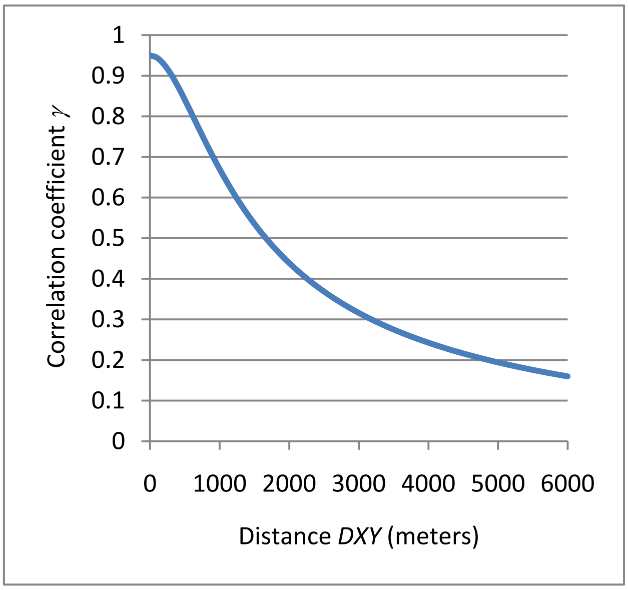


Figure A1. Spatial decay in correlation between price changes given by Equation (4)

The value $\mathbf{P}(t=0)$ for the base period is computed according to the procedure described in section “Base-period valuation” above. In each subsequent period $t > 0$, transaction prices $\mathbf{p}(t)$ are observed, so that the vector of the price growth signals $\mathbf{g}(t)$ can be computed as:

$$\mathbf{g}(t) = \ln(\mathbf{p}(t)) - \ln(\mathbf{P}(t-1 \,|\, \mathrm{S}(t))\ . \qquad (5)$$

$\mathbf{P}(t)$ is updated using the LWR algorithm, which computes the elements of $\mathbf{P}(t)$, $p_k(t)$, for each property *k* in the basket as:

$$p_k(t) = \exp(\hat{g}_k(t)) \cdot p_k(t-1)\,, \qquad (6)$$

with
$$\begin{aligned}\hat{g}_k(t) &= \mu(t) + \boldsymbol{\Gamma}'_{k,\mathrm{S}(t)} \cdot \boldsymbol{\Gamma}^{-1}_{\mathrm{S}(t)} \cdot \left(\mathbf{g}(t) - \mu(t) \cdot \mathbf{E}_{n(t)}\right) \\ &= \mu(t) + \phi_{k,\mathbf{g}}(t) - \mu(t) \cdot \phi_{k,\mathbf{E}}(t)\end{aligned} \tag{7}$$

where $\mathbf{E}_{n(t)}$ is a $n(t)$-dimensional unity vector, $\phi_{k,\mathbf{g}}(t) \equiv \boldsymbol{\Gamma}'_{k,\mathrm{S}(t)} \cdot \boldsymbol{\Gamma}^{-1}_{\mathrm{S}(t)} \cdot \mathbf{g}(t)$ is the weighted sum of the gross price growth signals, and $\phi_{k,\mathbf{E}}(t) \equiv \boldsymbol{\Gamma}'_{k,\mathrm{S}(t)} \cdot \boldsymbol{\Gamma}^{-1}_{\mathrm{S}(t)} \cdot \mathbf{E}_{n(t)}$ is the sum of the weights for the price growth signals with respect to the subject property *k*. Equation (7) states that the imputed price growth for property *k* is the sum of a general price adjustment $\mu(t)$ and a local price adjustment $\phi_{k,\mathbf{g}}(t) - \mu(t) \cdot \phi_{k,\mathbf{E}}(t)$. Since $\phi_{k,\mathbf{E}} < 1$, $\hat{g}_k(t)$ increases in $\mu(t)$. The value of $\mu(t)$ can be determined by letting the average value of the local adjustments equal to zero, in which case,

$$\mu(t) = \frac{\phi_{\mathbf{g}}(t)}{\phi_{\mathbf{E}}(t)}, \tag{8}$$

where $\phi_{\mathbf{g}}(t) \equiv \mathrm{Mean}\left(\phi_{k,\mathbf{g}}(t), \text{ for all } k \text{ in the basket}\right)$ and $\phi_{\mathbf{E}}(t) \equiv \mathrm{Mean}\left(\phi_{k,\mathbf{E}}(t), \text{ for all } k \text{ in the basket}\right)$.

It can be verified that $\hat{g}_k(t) = g_k(t)$ for properties in $\mathbb{S}(t)$. Furthermore, Equation (7) can be re-written as:

$$\hat{g}_k(t) = \mu(t) + \boldsymbol{\Gamma}'_{k,\mathrm{S}(t)} \cdot \mathrm{Diagonal}\left(\boldsymbol{\Gamma}^{-1}_{\mathrm{S}(t)}\right) \cdot \mathbf{h}(t), \tag{9}$$

where $\mathbf{h}(t)$ is the vector of orthogonalized price growth of the transactions in $\mathbb{S}(t)$. The elements of $\mathbf{h}(t)$ are given by

$$h_i(t) \equiv g_i(t) - \tilde{g}_i(t), \tag{10}$$

where $\tilde{g}_i(t)$ is computed the same way as $\hat{g}_i(t)$ in Equation (6) except that property *i* itself is excluded from the set $\mathbb{S}(t)$. $h_i(t)$ represents the price growth of transaction *i* not predicted by the price growth of the other transactions in $\mathbb{S}(t)$.

Equations (6) and (7) define the LWR mark-to-market value-updating algorithm. The LWR algorithm has two key differences from the conventional repeat-sales index method. In the latter, the price growth signals in the transaction sample $\mathbb{S}(t)$ will be assigned equal weights and have the same impact on the imputed value adjustment of the properties across the market represented by the index (as a result of the common-price-trend assumption).[2] According to the SRPI method presented above, (i) the price growth signals in $\mathbb{S}(t)$ that are more independent of the other price growth signals (i.e. have a larger $h_i(t)$ in absolute value) will have greater impact, and (ii) the imputed (predicted) price growth of a property $\hat{g}_i(t)$ is more sensitive to the price growth signals in the more immediate vicinity. Consequently, price growth signals concentrated in one location will have weaker marginal effect on the mark-to-market value updating $\hat{g}_i(t)$ as these signals have a greater correlation coefficient γ with each other.

[2] The weight of each price growth signal may be adjusted according to the error variance of the signal depending on the assumption about the structure of such error.

The LWR mark-to market value-updating algorithm is now fully specified except for the choice of the parameter values δ, ρ, and d in the spatial correlation model described by Equation (4). These values can be selected to minimize the sum of squared orthogonal signals $h_i(t)$ over a historical period, or to maximize the correlation coefficient between $g_i(t)$ and $\tilde{g}_i(t)$ for the properties in $\mathbb{S}(t)$. The values in Figure A1 are so chosen with respect to the 2001.12 basket over the period of 2002.01 to 2003.12; the corresponding correlation coefficient is 0.355, which suggests a substantial amount of independent localized price changes in the short run.

Table 1 provides numerical illustrations of the weights determined by the LWR algorithm according to the spatial pattern of the observed price changes. In example 1, two available signals are in the same location as the subject property and they have equal weights. In this case, $\hat{g}_k = \mu + 0.487 \times (g_{s1} - \mu) + 0.487 \times (g_{s2} - \mu)$ .The sum of the weights is 0.974, which is less than 1 as the correlation is imperfect. In example 2, one of the signals in example 1 is moved 200 meters from the subject property; consequently, the signal nearer to the subject property receives a greater weight but the sum of the weights is a bit smaller. In example 3, the two signals in example 1 remain but a third signal 200 meters away is added; the sum of the weights increases in comparison to that in example 1. Interestingly, when the two signals at the same location as the subject property are replaced by a signal 200 meters away in the opposite direction from the third signal in the last example, the sum of the weights becomes even greater; the two signals in this case are treated as more distinct as they are much more distant from each other, though they are not much more distant from the subject property when compared with the previous examples.

Table 1. Simulated impact of price growth signals on the imputed price change of a subject property (assuming all properties are located along a street)

Observed price growth signals		s1	s2	s3	s4	Total
Example 1	Distance from subject property (m)	0	0			
	Weights	0.487	0.487			0.9744
	Distribution of weights	50%	50%			
Example 2	Distance from subject property (m)	0	200			
	Weights	0.639	0.335			0.9741
	Distribution of weights	66%	34%			
Example 3	Distance from subject property (m)	0	0	200		
	Weights	0.390	0.390	0.204		0.9842
	Distribution of weights	39.6%	39.6%	20.7%		
Example 4	Distance from subject property (m)	-200	200			
	Weights	0.495	0.495			0.9905
	Distribution of weights	50%	50%			

A.2.3 Robustness of the mark-to-market algorithm

There are situations where the observed market transaction signals may be unreliable for the purpose of imputing the price change of other properties in the SRPI basket. The first situation arises in periods of exceptionally low market liquidity, when a small number of transactions could have an undue influence on the mark-to-market value of the whole basket. The second situation arises when extreme outliers exist among the observed transaction signals.

The case of exceptionally low market liquidity

To prevent potentially undue influences that a small number of transactions may have on the index value when the market liquidity is exceptionally low, a dampening mechanism is incorporated in the mark-to-market algorithm to reduce the impact on the average price growth of the basket should the observed signals be too few or too concentrated spatially. This mechanism can be effected by re-defining $\mu(t)$ in Equation (8) such that

$$\mu(t) = \left[1 - \left(1 - \phi_{\mathrm{E}}(t)\right)^3\right] \frac{\phi_{\mathrm{g}}(t)}{\phi_{\mathrm{E}}(t)}, \tag{11}$$

where $\mu(t)$ falls relative to $\phi_{\mathrm{g}}(t)/\phi_{\mathrm{E}}(t)$ when $\phi_{\mathrm{E}}(t)$ falls: this happens when the transactions in $\mathbb{S}(t)$ are few or are more concentrated spatially. The average value of $\hat{g}_k(t)$ is given by

$$\mathrm{Mean}\left(\hat{g}_k(t), \text{ for all } k \text{ in the basket}\right) = \left[1 - \left(1 - \phi_{\mathrm{E}}(t)\right)^4\right] \frac{\phi_{\mathrm{g}}(t)}{\phi_{\mathrm{E}}(t)} > \mu(t). \tag{12}$$

It approaches $4\phi_g(t)$ as $\phi_{\mathrm{E}}(t)$ approaches zero. Since $\phi_g(t)$ approaches zero with $\phi_E(t)$, the average value of $\hat{g}_k(t)$ also approaches zero, as intended by the dampening mechanism.

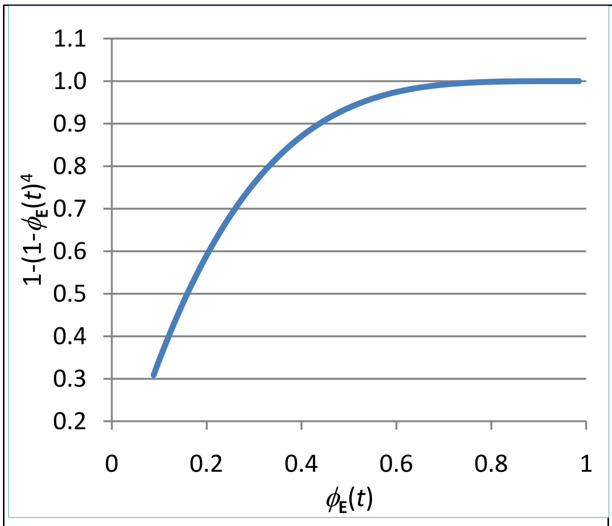


Figure A2. Degree of dampening in mean imputed price change at different values of $\boldsymbol{\phi}_{\mathrm{E}}(t)$

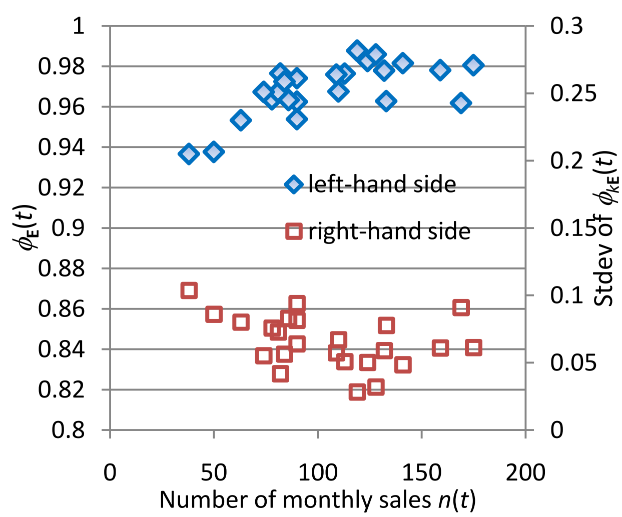


Figure A3. Distribution of mean total weights $\boldsymbol{\phi}_{\mathrm{E}}(t)$ and the standard deviation of total weights $\boldsymbol{\phi}_{k\mathrm{E}}(t)$

The degree of dampening—the ratio of mean $\hat{g}_k(t)$, for all the properties in the basket, over the un-dampened mean $\phi_{\mathrm{g}}(t)/\phi_{\mathrm{E}}(t)$—at different values of $\phi_{\mathrm{E}}(t)$ is demonstrated in Figure A2. Figure A3 shows the distribution of $\phi_{\mathrm{E}}(t)$ as well as the standard deviation of $\phi_{k,\mathrm{E}}(t)$ against the number of sales in $\mathbb{S}(t)$ according to the sales in the 2001.12 base-period basket over the period from Jan 2002 to Dec 2003. The number of sales per month in the 2001.12 basket ranges from 38 to 175. In all these cases, $\phi_{\mathrm{E}}(t)$ is above 0.9 and hence the dampening is negligible.

To assess how the dampening mechanism would work in cases of extremely low market liquidity, we run simulations by randomly taking a sample of 1 to 20 sales from the observed sales in $\mathbb{S}(t)$ in a particular month. Each sample size is simulated 10 times and the basket mean weight $\phi_{\mathrm{E}}(t)$ is computed in each simulation.

Figure A4. Distribution of mean total weights from simulations

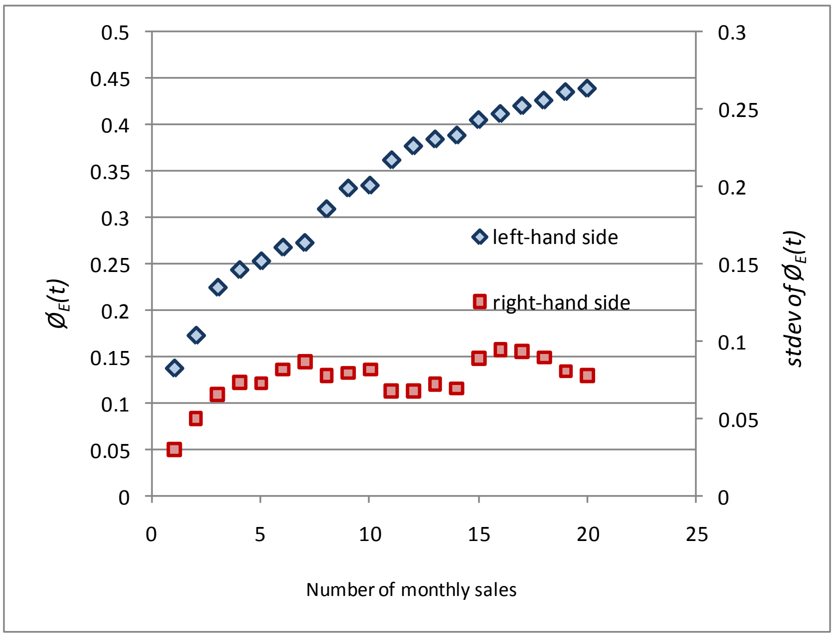


Figure A4 reports the average value as well as the standard deviation of $\phi_{\mathrm{E}}(t)$ from the 10 simulations at each sample size. At a sample size of 5, for example, the average value of $\phi_{\mathrm{E}}(t)$ is 0.2534, which implies a dampening factor of 0.689 according to Figure A2. Thus the dampening of the mean price growth comes into effect when less than 20 transactions are observed.

<u>The case of extreme outliers</u>

The SRPI LWR algorithm uses the whole sample distribution of the observed transactions in each month to mark-to-market the value of the entire property basket. Extreme outliers in the sample distribution of the observed transaction signals would represent noises to the market demand shock signals. To contain the influences of such noises on the mark-to-market updating, we identify the price growth signals in transaction sample $\mathbb{S}$(t) that falls within the 0.94% of the upper and lower tails of the sample distribution according to the normal distribution as extreme outliers and assign them a large nudge effect (δ) of 0.5 (instead of 0.05 in the normal case) so as to reduce their influence on the mark-to-market value updating.

A.2.4 Treatment of properties on leasehold land

Since some properties in the SRPI basket are of leasehold title and others of freehold title, the price and price change estimates must be standardized to reflect the price movement of the properties of the same legal interest in land. We do so by converting all leasehold prices to their equivalent freehold values according to the relativity of the value of a leasehold title against that of a freehold title of an identical property:

$$p_{kj,\text{leasehold}}(t) / p_{kj,\text{freehold}}(t) = 1 - \exp\left(-\eta \cdot \tau_j(t)\right), \tag{13}$$

where $\tau_j(t)$ is the remaining years to lease maturity for project j (it equals 999999 for freehold properties). η is set to be 2% (per year) which implies that a new 99-year leasehold property trades at about 14% discount from the price of an equal-quality freehold property, consistent with transaction evidence.

Thus we convert all observed sale prices in period t to their freehold equivalent value according to Equation (13) before applying the value-updating algorithm. In other words, $\mathbf{P}(t)$, the vector of the N mark-to-market values in the basket in period t, is always defined in terms of freehold value and SRPI is defined as the price movement of freehold properties.

A.2.5 Computation of price indices

Once $\mathbf{P}(t)$ is estimated for the base period and updated for each of the subsequent periods, SRPI indices can be computed for the overall target market represented by the basket or for sub-markets represented by sub-baskets. A value-weighted version of the SRPI for basket $\mathbb{B}_S$ can be calculated as follows (t=0 denotes the base period):

$$\frac{SRPI\_VW_{\text{Bs}}(t)}{100} \equiv \frac{V_{\text{Bs}}(t)}{V_{\text{Bs}}(0)} = \sum_{k \in \text{Bs}} \frac{p_k(0)}{V_{\text{Bs}}(0)} \frac{p_k(t)}{p_k(0)}, \tag{14}$$

where $V_{\text{Bs}}(0) = \sum_{k \in \text{Bs}} p_k(0)$, whereas an equal-weighted version of SRPI for the same basket is given by:

$$\frac{SRPI\_EW_{\text{Bs}}(t)}{100} \equiv \exp\left(\frac{1}{N_{\text{Bs}}} \sum_{k \in \text{Bs}} \ln \frac{p_k(t)}{p_k(0)} \right), \tag{15}$$

where N_{Bs} is the number of properties in the basket $\mathbb{B}_S$.

A.2.6 Rules for revision

Data for transactions that occur in month t will become available over time. Hence, there is a need to revise the index values for month t as more data gets captured. The following procedures explain how such incremental information is incorporated and how the revised indices are published.

<u>Mark-to-market value revision window</u>

The SRPI adopts a six-month window for the capture of delayed transaction data. This means that a caveat that is lodged six months after month t, the month of the contract date, will not be used in the mark-to-market value updating procedure of the SRPI. Our analysis of the lag between contract date and date of caveat lodgement suggests that only a very small proportion of the transactions for any given month is reported outside the six-month period from the contract date.

Revision procedure

In month t+1, data for month t transactions become available for the first time together with delayed data for sales that occurred in earlier periods. The revision procedure identifies all the data of transactions in month t-5 onwards that become available in month t+1. It then updates the mark-to-market values of all the properties in the basket for month t-5 to incorporate any additional data of transactions that occurred in that month. These newly updated month t-5 mark-to-market values are then used to update the mark-to-market values for month t-4 in turn. This process proceeds forward one month at a time until the market-to-mark values for month t-1 are updated to produce the once revised values for month t-1. The flash mark-to-market values for month t are then computed using the once revised mark-to-market values for month t-1.

Publication of index values

For the purpose of timely public dissemination of the index values, only the flash values and the (once) revised values will be published on the 28th or next business day of each month. The historical comparison of the flash and the (once) revised values is reported in section 3.3.

Revision of the base-period valuation

Once the SRPI basket is reconstituted at a new base period T_0, the base-period values of the properties in the new basket will be computed in T_0+2 in time for the computation of the flash values of the SRPI for month T_0+1. The base-period valuation will be revised once in month T_0+3 to incorporate additional sales data for transactions that occurred in or before month T_0, in time for the computation of the revised values of the SRPI for month T_0+1. Thus, the flash values of the SRPI from month T_0+2 and the revised values of the SRPI from month T_0+1 onwards will reference the revised base-period values computed in month T_0+3.

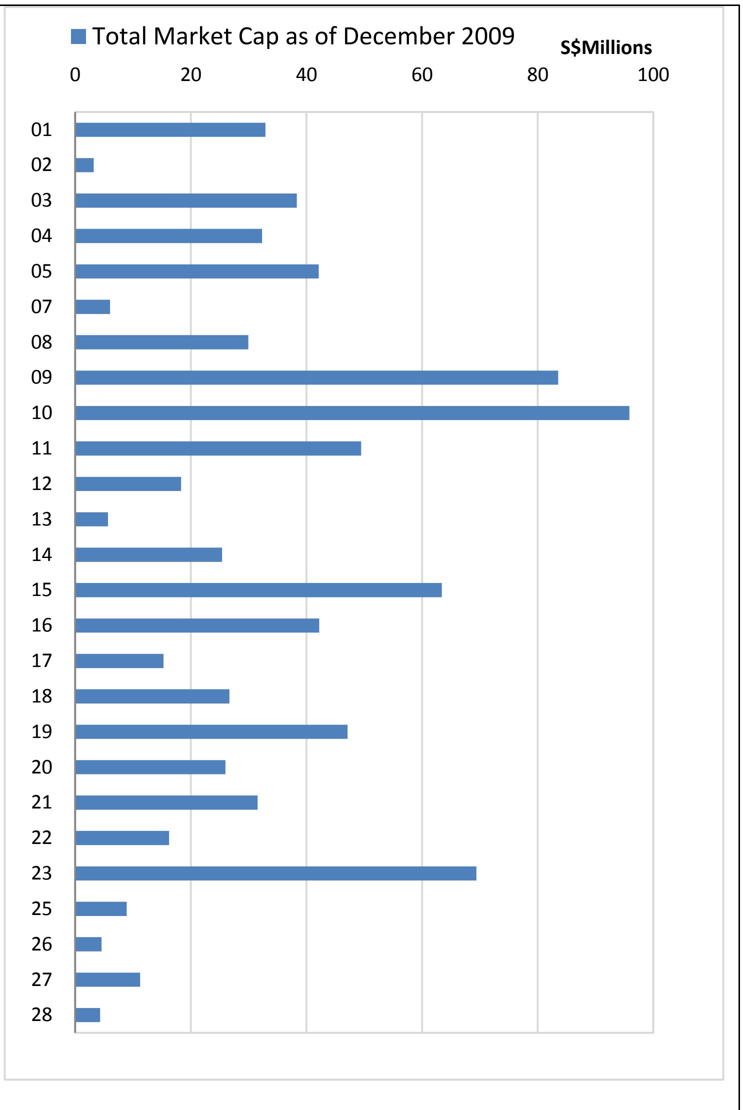
Appendix B. SRPI Property Basket Composition

B.1 Summary statistics of the projects in the 2009:12 SRPI Basket

The current or 2009:12 SRPI basket comprises 364 projects that represent the private non-landed residential market in Singapore. The details of each of these projects pertaining to its name, location (2-digit postal code), size, and year of TOP are listed in Section B.2 below. Figure B1 shows the number of projects, the total market capitalisation by value [market cap] of the projects and the percentage share of market cap by postal district. It also provides a plot of the distribution of the projects' total market cap by postal district as at December 2009.

Figure B1. The number of projects in the 2009:12 SRPI basket and the distribution of their total market cap and percentage share of market cap by postal district

Postal District	Number of Projects	Total market cap as of Dec 2009 (S$)	Share of market cap (%)
01	2	32,911,868	3.97%
02	3	3,189,760	0.38%
03	9	38,334,438	4.62%
04	5	32,317,066	3.89%
05	17	42,134,061	5.08%
07	3	6,019,431	0.73%
08	11	29,931,780	3.61%
09	31	83,541,887	10.07%
10	55	95,861,567	11.55%
11	30	49,462,877	5.96%
12	20	18,313,827	2.21%
13	4	5,667,640	0.68%
14	22	25,408,146	3.06%
15	37	63,401,849	7.64%
16	16	42,199,017	5.09%
17	9	15,264,860	1.84%
18	7	26,669,164	3.21%
19	21	47,094,276	5.68%
20	8	25,970,508	3.13%
21	14	31,537,001	3.80%
22	3	16,243,647	1.96%
23	23	69,398,957	8.36%
25	4	8,910,181	1.07%
26	2	4,555,354	0.55%
27	6	11,215,684	1.35%
28	2	4,298,601	0.52%
Total	364	829,853,446	100.00%



* Postal districts 6 and 24 are not represented in the current basket as there is either no project that meets the selection criteria or insufficient data.

Figure B2. The distribution of the projects in the 2009:12 SRPI basket by project size (in number of property units)

Size (number of property units)	Number of projects	Share of project number (%)	Total number of property units	Share of property units (%)
40-99	165	45.33%	10354	13.92%
100-199	69	18.96%	9660	12.99%
200-299	43	11.81%	10395	13.98%
300-399	27	7.42%	9499	12.77%
400-499	23	6.32%	10340	13.91%
500-599	16	4.40%	8691	11.69%
600-699	11	3.02%	7130	9.59%
700 and above	10	2.75%	8290	11.15%
Total	364	100.00%	74359	100.00%

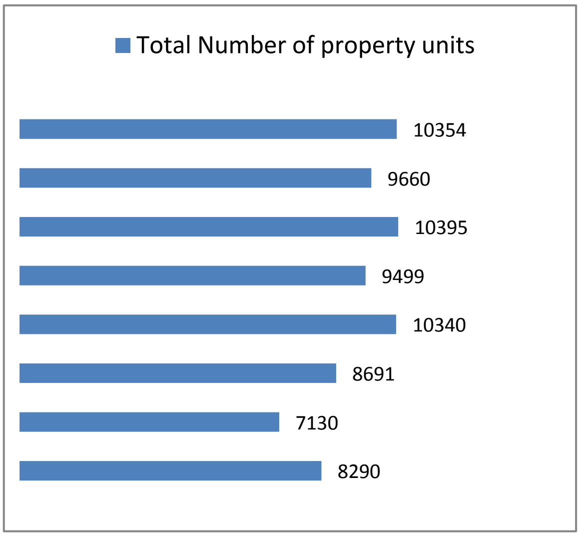
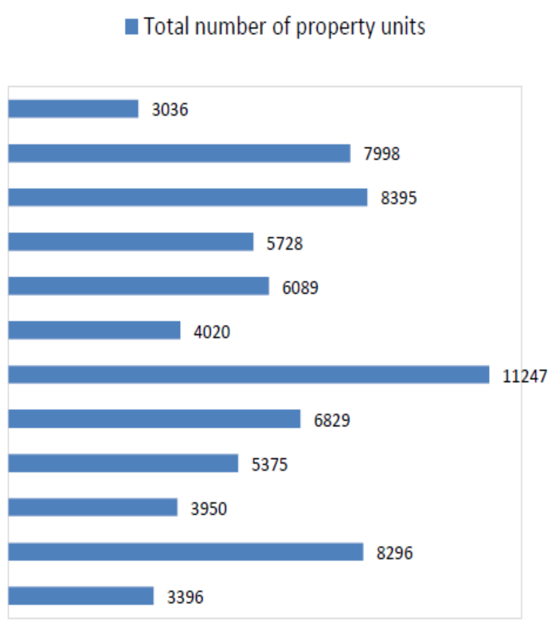


Figure B3. The distribution of the projects in the 2009:12 SRPI basket by TOP year

TOP Year	Number of Projects	Share of project number (%)	Total number of property units	Share of property units (%)
1998	13	3.57%	3036	4.08%
1999	40	10.99%	7998	10.76%
2000	37	10.16%	8395	11.29%
2001	24	6.59%	5728	7.70%
2002	31	8.52%	6089	8.19%
2003	27	7.42%	4020	5.41%
2004	46	12.64%	11247	15.13%
2005	34	9.34%	6829	9.18%
2006	30	8.24%	5375	7.23%
2007	26	7.14%	3950	5.31%
2008	37	10.16%	8296	11.16%
2009	19	5.22%	3396	4.57%
Total	364	100.00%	74359	100.00%



B.2 List of the projects in the 2009:12 SRPI Basket

(sorted by Postal District and TOP year)

No	Project_name	Postal District	TOP Year	Size (number of units)
1	THE SAIL @ MARINA BAY	01	2008	1113
2	EMERALD GARDEN	01	1999	269
3	CRAIG PLACE	02	2000	61
4	THE ARRIS	02	2002	63
5	THE BEACON	02	2008	124
6	RIVER PLACE	03	2000	509
7	TANGLIN VIEW	03	2001	384
8	QUEENS	03	2002	722
9	ALESSANDREA	03	2003	105
10	MERAPRIME	03	2006	213
11	TWIN REGENCY	03	2007	234
12	DOMAIN 21	03	2007	141
13	REGENCY SUITES	03	2008	84
14	THE METROPOLITAN CONDO	03	2009	382
15	CARIBBEAN AT KEPPEL BAY	04	2004	969
16	THE PEARL @ MOUNT FABER	04	2005	192
17	THE BERTH BY THE COVE	04	2006	200
18	THE AZURE	04	2008	116
19	THE COAST AT SENTOSA COVE	04	2009	249
20	HERITAGE VIEW	05	2000	618
21	FABER CREST	05	2001	360
22	THE SPECTRUM	05	2005	72
23	MONTEREY PARK CONDO	05	2005	280
24	BLUE HORIZON	05	2005	616
25	TREASURE PLACE	05	2006	54
26	THE GRANDHILL	05	2006	53
27	THE FOLIAGE	05	2008	88
28	VARSITY PARK CONDO	05	2008	530
29	THE MAYLEA	05	2008	88
30	MURANO	05	2008	50
31	THE INFINITI	05	2008	315
32	THE STELLAR	05	2008	162
33	CARABELLE	05	2009	338
34	ONE-NORTH RESIDENCES	05	2009	416
35	LE HILL CONDO	05	1999	97
36	PALM GREEN	05	1999	40
37	SUNSHINE PLAZA	07	2001	160
38	BURLINGTON SQUARE	07	1998	179
39	THE BENCOOLEN	07	1999	122
40	KERRISDALE	08	2005	481
41	CITYLIGHTS	08	2007	601
42	SOHO 188	08	2008	52
43	MERA SPRINGS	08	2008	129
44	CITY SQUARE RESIDENCES	08	2008	471
45	PRISTINE HEIGHTS	08	2009	60
46	THE MERLOT	08	2009	42
47	CITY SQUARE RESIDENCES	08	2009	440
48	TYRWHITT 139	08	2009	48
49	KENTISH GREEN	08	1999	122
50	KENTISH COURT	08	1999	77
51	CLAREMONT	09	2000	67
52	RIVERSIDE 48	09	2000	73
53	THE EDGE ON CAIRNHILL	09	2002	46
54	CAIRNHILL CREST	09	2004	248
55	THE LIGHT @ CAIRNHILL	09	2004	121
56	THE PATERSON	09	2004	88
57	ROBERTSON 100	09	2004	186
58	RESIDENCES AT 338A	09	2004	46

No	Project_name	Postal District	TOP Year	Size (number of units)
59	LEONIE HILL RESIDENCES	09	2005	80
60	2 RVG	09	2006	60
61	THE BOTANIC ON LLOYD	09	2006	65
62	THE IMPERIAL	09	2006	187
63	LEONIE STUDIO	09	2006	97
64	THE PIER AT ROBERTSON	09	2006	201
65	8 @ MOUNT SOPHIA	09	2007	313
66	THE METZ	09	2007	169
67	URBANA	09	2007	126
68	VISIONCREST	09	2007	265
69	PARC EMILY	09	2008	295
70	WATERMARK ROBERTSON QUAY	09	2008	206
71	THE COSMOPOLITAN	09	2008	228
72	ROBERTSON EDGE	09	2008	70
73	THE SUITES AT CENTRAL	09	2009	157
74	RIVERGATE	09	2009	545
75	SCOTTS HIGHPARK	09	2009	73
76	MACKENZIE 88	09	2009	55
77	SCOTTS 28	09	1998	136
78	THE PATERSON EDGE	09	1999	61
79	THE BAYRON	09	1999	74
80	SAM KIANG MANSIONS	09	1999	53
81	KIM YAM HEIGHTS	09	1999	130
82	MELROSE PARK	10	2000	170
83	SEVEN HOLT ROAD	10	2000	45
84	MUTIARA VIEW	10	2000	64
85	JERVOIS JADE APARTMENTS	10	2000	45
86	HOLT RESIDENCES	10	2000	46
87	ROBIN REGALIA	10	2000	48
88	CHELSEA GARDENS	10	2000	40
89	PARC STEVENS	10	2000	48
90	THE HORIZON	10	2001	80
91	CHARLESTON	10	2001	48
92	ST MARTIN RESIDENCE	10	2001	82
93	THE EQUATORIAL	10	2001	95
94	BALMORAL RESIDENCES	10	2001	65
95	ARDMORE PARK	10	2001	330
96	THE MONTANA	10	2002	108
97	THE ASTON	10	2002	80
98	CUSCADEN RESIDENCES	10	2002	150
99	THE LOFT	10	2002	77
100	THE LADYHILL	10	2002	55
101	SHEARES VILLE	10	2003	65
102	BALMORAL 8	10	2003	40
103	THE TESSARINA	10	2003	443
104	MILL POINT	10	2004	108
105	GRANGE RESIDENCES	10	2004	164
106	BELMOND GREEN	10	2004	211
107	BALMORAL HEIGHTS	10	2004	44
108	THE LEVELZ	10	2004	126
109	THE SERENADE @ HOLLAND	10	2004	89
110	STUDIO 3	10	2005	66
111	PROXIMO	10	2005	49
112	DRAYCOTT EIGHT	10	2005	136
113	TANGLIN RESIDENCES	10	2005	43
114	CASABELLA	10	2005	81
115	THE CORNWALL	10	2005	99
116	DUCHESS MANOR	10	2005	52
117	THE MARBELLA	10	2005	239
118	GLENTREES	10	2005	176
119	NATHAN PLACE	10	2006	46
120	THE TRESOR	10	2007	62

No	Project_name	Postal District	TOP Year	Size (number of units)
121	SHANGHAI ONE	10	2007	52
122	MONTVIEW	10	2008	115
123	THE GRANGE	10	2008	95
124	VIZ AT HOLLAND	10	2008	165
125	ORION	10	2008	46
126	ONE TREE HILL RESIDENCE	10	2008	48
127	THE ARC AT DRAYCOTT	10	2008	58
128	ST REGIS RESIDENCES SINGAPORE	10	2008	173
129	QUINTERRA	10	2009	55
130	THE FORD @ HOLLAND	10	2009	83
131	DUCHESS CREST	10	1998	247
132	KASTURINA LODGE	10	1999	60
133	GARDENVILLE	10	1999	56
134	AVALON	10	1999	82
135	SIXTH AVENUE VILLE	10	1999	49
136	VILLA AZURA	10	1999	53
137	THE HUNTINGTON	11	2000	42
138	THE TREVOSE	11	2001	142
139	THE ARMADALE	11	2001	43
140	THOMSON EURO-ASIA	11	2002	136
141	NEWTON 18	11	2002	81
142	THE SPRINGS	11	2003	62
143	THE LINCOLN MODERN	11	2003	56
144	1 MOULMEIN RISE	11	2003	50
145	ADAM PARK CONDO	11	2004	118
146	MANDALE HEIGHTS	11	2004	96
147	NOVENA SUITES	11	2004	92
148	AMARYLLIS VILLE	11	2004	311
149	NEWTON EURO-ASIA	11	2004	69
150	THE ANSLEY	11	2004	100
151	THE SHELFORD	11	2005	215
152	AMANINDA	11	2005	70
153	THE LINC	11	2006	51
154	STRATA	11	2006	100
155	CITY EDGE	11	2007	49
156	RESIDENCES @ EVELYN	11	2007	208
157	MEDGE	11	2007	44
158	NEWTON SUITES	11	2007	118
159	SUFFOLK PREMIER	11	2007	41
160	PARK INFINIA AT WEE NAM	11	2008	486
161	BUCKLEY 18	11	2009	49
162	NEWTON ONE	11	2009	91
163	PAVILION 11	11	2009	180
164	THOMSON 800	11	1999	390
165	GLOUCESTER MANSIONS	11	1999	61
166	NOVENA LODGE	11	1999	66
167	TRELLIS TOWERS	12	2000	384
168	GLOBAL VILLE	12	2000	48
169	MOONSTONE VIEW	12	2000	76
170	ST MICHAEL'S CONDO	12	2002	60
171	THE BELLEFORTE	12	2003	74
172	PAPILLON	12	2003	73
173	DE PARADISO	12	2004	54
174	CALARASI	12	2004	99
175	MOONSTONE RESIDENCES	12	2004	76
176	PARC HAVEN	12	2004	137
177	RIO GARDENS	12	2005	54
178	SUNVILLE	12	2005	147
179	SCENIC HEIGHTS	12	2005	50
180	THE CALLISTA	12	2005	87
181	THE ELYSIA	12	2005	40
182	DE ROYALE	12	2006	204

No	Project_name	Postal District	TOP Year	Size (number of units)
183	PINNACLE 16	12	2006	73
184	D'LOTUS	12	2008	83
185	THE CITRINE	12	2008	54
186	TWIN HEIGHTS	12	1999	132
187	PLATINUM EDGE	13	2007	51
188	BLOSSOMS @ WOODLEIGH	13	2007	240
189	ONE LEICESTER	13	2008	194
190	THE ACACIAS	13	2009	65
191	GRANDLINK SQUARE	14	2000	71
192	CENTRAL GROVE	14	2001	262
193	SIMS RESIDENCES	14	2002	112
194	NICOLE GREEN	14	2002	44
195	VISTAYA VIEW	14	2002	117
196	SIMS GREEN	14	2003	108
197	THE CHAMPAGNE	14	2003	46
198	THE HELICONIA	14	2003	103
199	THE ALCOVE	14	2004	102
200	REGAL 35	14	2005	40
201	THE WATERINA	14	2005	398
202	THE TRUMPS	14	2005	189
203	LE CRESCENDO	14	2006	228
204	STARVILLE	14	2006	250
205	GROSVENOR VIEW	14	2006	93
206	ASTOR	14	2006	55
207	DENG FU VILLE	14	2007	44
208	MERA EAST	14	2007	55
209	LE REVE	14	2007	62
210	ATRIUM RESIDENCES	14	2008	142
211	SIMSVILLE	14	1998	522
212	CASA SARINA	14	1998	138
213	VILLA MARTIA	15	2000	58
214	CAMELOT	15	2000	99
215	CHELSEA LODGE	15	2000	78
216	DUNMAN PLACE	15	2001	69
217	THE PALLADIUM	15	2002	43
218	PARADISE PALMS	15	2002	58
219	D'ECOSIA	15	2003	73
220	EMERY POINT	15	2003	51
221	FORTUNE JADE	15	2003	85
222	LEGENDA AT JOO CHIAT	15	2004	100
223	MALVERN SPRINGS	15	2004	75
224	SUNNY PALMS	15	2004	56
225	HAIG COURT	15	2004	360
226	11 AMBER ROAD	15	2004	40
227	WATER PLACE	15	2004	437
228	BUTTERWORTH 8	15	2004	216
229	SANCTUARY GREEN	15	2004	522
230	DUNMAN VIEW	15	2004	148
231	COTE D'AZUR	15	2004	612
232	EAST PALM	15	2004	42
233	THE CARPMAELINA	15	2005	52
234	ONE FORT	15	2005	79
235	THE GERANIUM	15	2006	62
236	SPRING @ KATONG	15	2006	52
237	ARTHUR 118	15	2006	55
238	COASTARINA	15	2006	56
239	THE BELVEDERE	15	2007	167
240	THE SEA VIEW	15	2008	546
241	RIVEREDGE	15	2008	135
242	PALM OASIS	15	2008	56
243	THE ESTA	15	2008	400
244	POSHGROVE EAST	15	2008	76

No	Project_name	Postal District	TOP Year	Size (number of units)
245	MEYER RESIDENCE	15	2009	68
246	EMERALD EAST	15	1999	52
247	BUTTERWORTH VIEW	15	1999	49
248	CRYSTAL RHU	15	1999	45
249	VILLA MARINA	15	1999	432
250	FAIRMOUNT CONDO	16	2000	64
251	LAGUNA 88	16	2000	88
252	THE CLEARWATER	16	2001	420
253	AQUARIUS BY THE PARK	16	2001	720
254	EAST MEADOWS	16	2002	482
255	SUNHAVEN	16	2002	296
256	COUNTRY PARK CONDO	16	2003	160
257	COSTA DEL SOL	16	2004	906
258	TANAMERA CREST	16	2004	288
259	VENEZIO	16	2006	40
260	BAYWATER	16	2006	232
261	RIVIERA RESIDENCES	16	2007	138
262	THE DAFFODIL	16	1998	66
263	STRATFORD COURT	16	1998	268
264	CASAFINA	16	1999	224
265	PALMWOODS	16	1999	87
266	BALLOTA PARK CONDO	17	2000	365
267	CARISSA PARK CONDO	17	2001	528
268	SANDY PALM	17	2002	48
269	THE EDGEWATER	17	2003	53
270	DAHLIA PARK CONDO	17	2003	299
271	LIGHTHOUSE	17	2004	51
272	EDELWEISS PARK CONDO	17	2006	517
273	BLUWATERS	17	2007	45
274	ESTELLA GARDENS	17	1999	350
275	THE TROPICA	18	2000	537
276	MODENA	18	2001	230
277	TROPICAL SPRING	18	2002	242
278	CHANGI RISE CONDO	18	2004	598
279	RIS GRANDEUR	18	2005	453
280	SAVANNAH CONDOPARK	18	2005	648
281	EASTPOINT GREEN	18	1999	646
282	CASA ROSA	19	2001	96
283	THE SUNNYDALE	19	2001	70
284	CENTRAL VIEW	19	2002	104
285	COMPASS HEIGHTS	19	2002	536
286	PALM HAVEN	19	2002	48
287	PALM GROVE CONDO	19	2002	111
288	RIVERVALE CREST	19	2002	490
289	THE SUNSHINE	19	2003	45
290	GOLDEN HEIGHTS	19	2003	53
291	SUNGLADE	19	2003	475
292	CHERRY GARDENS	19	2004	48
293	RIO VISTA	19	2004	716
294	AMARANDA GARDENS	19	2004	189
295	THE YARDLEY	19	2005	55
296	KOVAN MELODY	19	2006	778
297	TANGERINE GROVE	19	2007	125
298	THE CHUAN	19	2007	106
299	REGENTVILLE	19	1999	580
300	8 EDEN GROVE	19	1999	41
301	EVERGREEN PARK	19	1999	394
302	THE SPRINGBLOOM	19	1999	372
303	BISHAN 8	20	2000	200
304	SEASONS VIEW	20	2000	224
305	RAFFLESIA CONDO	20	2003	230
306	BOONVIEW	20	2003	121

No	Project_name	Postal District	TOP Year	Size (number of units)
307	GOLDENHILL PARK CONDO	20	2004	390
308	THE GARDENS AT BISHAN	20	2004	756
309	GRANDEUR 8	20	2005	579
310	BISHAN POINT	20	2005	164
311	LE WOOD	21	2000	58
312	THE STERLING	21	2000	232
313	THE HILLSIDE	21	2001	340
314	SUMMERHILL	21	2002	406
315	FREESIA WOODS	21	2003	129
316	MEADOWLODGE	21	2004	64
317	THE NEXUS	21	2006	242
318	GARDENVISTA	21	2006	318
319	THE RAINTREE	21	2008	316
320	HILLVIEW GREEN	21	1998	210
321	SOUTHAVEN II	21	1999	340
322	ENG KONG GREEN	21	1999	64
323	PARC PALAIS	21	1999	517
324	HIGH OAK CONDO	21	1999	192
325	THE MAYFAIR	22	2000	452
326	LAKEHOLMZ	22	2005	369
327	THE LAKESHORE	22	2008	848
328	GUILIN VIEW	23	2000	655
329	GLENDALE PARK	23	2000	448
330	HAZEL PARK CONDO	23	2000	696
331	PALM GARDENS	23	2000	694
332	REGENT GROVE	23	2000	553
333	HILLTOP GROVE	23	2001	192
334	HILLINGTON GREEN	23	2002	480
335	HILLVIEW 128	23	2002	90
336	HILLVIEW RESIDENCE	23	2002	98
337	THE PETALS	23	2002	270
338	THE MADEIRA	23	2003	456
339	THE JADE	23	2004	280
340	THE WARREN	23	2004	699
341	HILLVIEW REGENCY	23	2006	572
342	THE LINEAR	23	2006	221
343	YEWTEE RESIDENCES	23	2008	139
344	CHANTILLY RISE	23	1998	120
345	CENTURY MANSIONS	23	1998	64
346	NORTHVALE	23	1998	762
347	REGENT HEIGHTS	23	1999	645
348	HILLBROOKS	23	1999	299
349	MONTROSA	23	1999	122
350	MERAWOODS	23	1999	305
351	ROSEWOOD	25	2003	437
352	CASABLANCA	25	2005	478
353	THE WOODGROVE	25	1998	72
354	WOODGROVE CONDO	25	1999	248
355	FOREST HILLS CONDO	26	2003	128
356	THE CALROSE	26	2007	421
357	SUN PLAZA	27	2000	76
358	EUPHONY GARDENS	27	2001	304
359	SELETARIS	27	2001	328
360	YISHUN SAPPHIRE	27	2001	380
361	YISHUN EMERALD	27	2002	436
362	THE SENSORIA	27	2007	73
363	SELETAR SPRINGS CONDO	28	2000	363
364	SUNRISE GARDENS	28	1998	252