MLS® Home Price Index

MLS® Home Price Index Methodology

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Version 2.1

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Introduction

The MLS® HPI is designed to be a reliable, consistent, and timely way of gauging changes in home prices. It is calculated each month and covers 11 major housing markets (Vancouver Island, Victoria, Greater Vancouver, Fraser Valley, Calgary, Regina, Saskatoon, Greater Toronto, Ottawa, Greater Montreal, and Greater Moncton, with additional markets to come). The MLS® HPI is also aggregated for the collection of these markets.

The MLS® HPI tracks price levels at a point in time relative to price levels in a base (reference) period for one- and two-storey single family homes, townhouse/row units, and apartment units. A composite MLS® HPI is also calculated for the collection of these housing categories in each of the 11 housing markets tracked by the index.

Partnership

The MLS® HPI is generated and published under agreements between The Canadian Real Estate Association, Vancouver Island Real Estate Board, Victoria Real Estate Board, Greater Vancouver Real

Estate Board, Fraser Valley Real Estate Board, Calgary Real Estate Board, Association of Regina REALTORS®, Saskatoon Region Association of REALTORS®, Toronto Real Estate Board, Ottawa Real Estate Board, Greater Montreal Real Estate Board, Greater Moncton Real Estate Board, and Altus Group.

The MLS® HPI model was developed by a design team at Altus Group that includes Professor François Des Rosiers, the 2011 recipient of the International Real Estate Society Achievement Award. He has been teaching Urban and Real Estate Management since 1976 within the Faculty of Business Administration of Laval University in Quebec City, Canada.

Representatives from Statistics Canada, Canada Mortgage and Housing Corporation, the Bank of Canada, Finance Canada and Central 1 Credit Union have also reviewed and endorsed the MLS® HPI methodology, and provided valuable contributions in support of its development.

Highlights

MLS® HPI

The MLS® HPI is available for single family homes (which are further split into 1-storey, and 2-storey single family homes), townhouse/row units, and apartment units. These sub-indices are used to calculate a composite or overall MLS® HPI in each market being tracked. The MLS® HPI for each market is also used to calculate an aggregate MLS® HPI for the collection of Metropolitan markets.

MLS® HPI values track relative price levels by comparing price levels at a point in time to price levels in a base (reference) period. Because the base (reference) period has a value of 100, it's possible to quickly infer the extent to which prices have changed relative to the base period. For example, if the base (reference) period for the HPI is the month of January 2005, and the HPI value for Apartment units in September 2011 is 135.1, this indicates that Apartment units in September 2011 were up 35.1% compared to January 2005.

The MLS® HPI is calculated using multivariate regression analysis, a commonly used statistical technique. Using a hybrid modeling approach that merges the Repeat-Sales and Hedonic Price approaches, the MLS® HPI model reflects contributions made by various quantitative and qualitative housing features toward the home price, including:

- Number of rooms above the basement level
- Number of bathrooms & half-bathrooms
- Square footage for main living & basement areas
- Whether it has a fireplace and/or finished basement
- Lot size
- The age of the property
- Parking
- How the home is heated
- Foundation, flooring, siding & roofing types

- Whether the property has waterfront or panoramic view
- Whether the property has been sold previously (newly constructed and previously unsold, or repeat sale)
- Proximity to shopping, schools, hospitals, police stations, churches, sports centres, golf courses, parks, and transportation (including the train station, railways, and airports)

Details on MLS® HPI calculations appear in the *MLS® HPI Methodology* section below.

Benchmark Prices

The MLS® HPI model is used to calculate Benchmark Prices. A "Benchmark home" is one whose attributes are typical of homes traded in the area where it is located, one being generated for each supported sub-area. Benchmark property descriptions are based on median values for quantitative property attributes (e.g. above ground living area in square feet), and the most commonly occurring value (i.e. modal value) for qualitative attributes (e.g. basement is not finished).

Benchmark Prices are available for each housing category tracked by the MLS® HPI in each market. Composite and Aggregate Benchmark Prices are also available, representing an aggregation of Benchmark categories and Metropolitan markets tracked by the Index. This enables Benchmark Prices and their price changes to be compared across areas, and to the overall market.

Details on Aggregate and Composite Benchmark home price calculations appear in the *MLS® HPI Methodology* section below.

Markets

The MLS® HPI, Benchmark Prices, and Relative Benchmark Prices are available for Vancouver Island, Victoria, Greater Vancouver, Fraser Valley, Calgary, Regina, Saskatoon, Greater Toronto, Ottawa, Greater Montreal, and Greater Moncton. It will be expanded to include additional markets.

Market Segmentation

To generate consistent indices, markets are divided into areas and sub-areas for which sales in MLS® HPI categories have similar attributes (homogenous). Sub-areas have the same geographical boundaries as those used by Real Estate Boards/Associations, which are well known as neighbourhoods. They are used to set MLS® HPI sub-indices, Benchmark Properties, and Benchmark Home Prices. Each sub-area is tested to confirm that it is small enough to ensure homogeneity and large enough to ensure that there are sufficient sales volumes to model the MLS® HPI throughout housing market cycles.

Details on market segmentation appear in the *MLS® HPI Methodology* section below.

Data inclusions and exclusions

The MLS® HPI includes transactional data for home sales via MLS® Systems at participating Canadian Real Estate Boards and Associations. These data include sale price and additional information that is added to support the MLS® HPI model, including information from a Geographical Information System

(GIS) to capture additional neighbourhood characteristics (proximity factors) relating to schools, main streets, water, and others.

To maintain data consistency, transactional data are filtered to include records above 0.5% and below 99.5% of cumulative normal distributions for Sale price, Age, Living Area, Land Area, number of rooms, and number of bathrooms. Should a transaction record appear to include internally inconsistent data, it is manually reviewed and amended (scrubbed).

Transactions for which data discrepancies cannot be reconciled without a field visit are excluded. The scrubbing process results in exclusion of less than five per cent of transaction records.

Details on data appear in the *MLS® HPI Methodology* section below.

MLS® HPI Methodology

Data

Transactional Data collected and used in the MLS® HPI must first be reformatted, analysed, sorted, and in some cases, amended; this process is commonly referred to as "scrubbing".

Transactional data are reformatted to include additional fields necessary to support the MLS® HPI. These new fields include calculated, estimated or inferred attributes from other available information. For example, *Floor Area Above Main* and *Floor Area Main* are created in the database, and are more useful than a unique *Global Living Area* field. Detailed living areas by floor are aggregated and compared to the Global Living Area in MLS® HPI regressions. For markets where Transactional Data includes detailed Living Area information, it is prioritized over the single Global Living Area in modeling tests.

In keeping with best practices, results are filtered to include records with values above 2.5% and below 97.5% of cumulative Normal distributions; other results are treated as outliers and automatically removed. To mitigate volatility, a moving three-year sample period is used, since the use of a shorter sample horizon may result in an insufficient number of sales over the period and cause index inaccuracies.

Cook's Distance is used to estimate the influence of an observation when doing least squares regressions, and helps detect outliers or identify a sub-area where it would be recommended to have more data points. Cook's Distance is also used to discard outliers that may exert a significantly detrimental impact on the MLS® HPI. When the Cook's Distance for an observation is high, the observation is redirected to the scrubbing process for manual validation. To ensure the full potential to extract knowledge from outliers, observations with a high measurement of Cook's Distance are manually reviewed and validated before being removed.

Market Segmentation

After reviewing the data, sub-areas are tested to ensure they are small enough to be homogenous and large enough to be statistically significant.

Dummy variables are created for each sub-area and introduced in the modeling process. Visual validation using trend maps of residuals, sale price/square foot of living area, and average income per household are used to further validate sub-area delineations. Sub-areas must have a minimum level of sales activity to be statistically significant; accordingly, where sales volumes fall short of the minimum, sub-areas may be grouped into sub-area sets for sampling purposes. These sub-areas are also examined to suggest alternative geographic boundaries when a given attribute among property records lacks sufficient homogeneity. Sub-areas themselves remain intact, with their own individual Benchmark Properties and sub-indices once MLS® HPI models are complete. Sub-areas with insufficient data are excluded from subsequent calculations.

The first validation of sub-area definitions relies on a cartographical analysis of the homogeneity of two demographic characteristics, average income and education levels. Results show that average income is a key contributor with regard to demographic homogeneity.

A visual inspection is performed to identify adjacent sub-areas for which disparate average income and/or education levels for households would preclude grouped statistical processing of their respective transactional data.

Statistical distributions for living areas, age of properties, and sale prices are also analysed to validate sub-area definitions, and to suggest potential sub-area groupings. To reduce the impact of time on distributions, transactional data spanning the years 2009 and 2010 are used.

Sub-areas are further validated by adding each sub-area into a general model. A hedonic regression is performed whereby sale price is modelled as the dependant variable and all sub-areas but one are used as independent variables, with the remaining sub-area serving as a reference or base sub-area. The model then assigns a value to each sub-area. On a cartographical basis, sub-areas are reviewed to determine if sub-areas should be grouped. When running a regression with sub-areas as explanatory variables, the calculated coefficients represent the comparativeness of each sub-area to the base sub-area. To determine which sub-areas can be grouped, results are illustrated cartographically and subject to visual validation to determine if sub-areas with relatively comparable weights are adjacent to one another.

In cases where sub-areas with relatively comparable weights are adjacent to one another, sub-area homogeneity is subjected to further validation, whereby each sub-area is geographically analyzed to determine if it should be grouped or split into smaller sub-areas. Geographical distributions for living areas, property ages and sale prices are visually analyzed. This review includes the use of Google maps

to validate breaks between sub-areas. Using the knowledge gained though each of these validations, markets are segmented for each property type.

Models of emerging communities within sales territories are taken into account from the date that the number of Transactional Data property records achieves a minimum bound (typically ten per month over a period of at least twelve months). Analysis of these sales must also satisfy various diagnostic testing criteria.

In the initial configuration of sub-areas, new communities are identified and modeled accordingly. The treatment of new communities is also taken into account as part of annual review of the MLS® HPI system. As part of the annual review, changes to names and boundaries for market segments in use by the Real Estate Board/Association are also taken into account, together with identification of new sub areas that come into being.

Modeling Approach

The MLS® HPI is based on a hybrid model that merges Repeat-Sales and Hedonic Price approaches. Using multivariate regression analysis, a commonly used statistical technique, the MLS® HPI model reflects the contribution that various housing features make toward the home price, and includes a dummy variable in the hedonic model specification to distinguish single and repeat sales.

The MLS® HPI is conceptually similar to the Consumer Price Index (CPI), which measures the value of a "basket" of common goods and services. Similarly, the HPI measures the contribution toward a home's prices that each attribute or feature makes as part of a "basket" of housing features.

The approach used to construct the MLS® HPI is superior to the Repeat-Sales approach that has gained media attention over the past few years in Canada and the United States:

- The Repeat-Sales approach omits useful information and sample size is reduced because only homes that have been sold at least twice are used.
- The Repeat-Sales approach may be incapable of reliably tracking home prices for sub-areas within a market.
- Price indices calculated using the Repeat-Sales approach may be produced with a considerable time lag due to data collection and availability.
- The Repeat-Sales approach assumes that qualitative and quantitative attributes of homes remain constant; however, the significance of Canadian home renovation expenditure each year makes this assumption unrealistic.

Model Specification

Designing a reliable MLS® HPI requires that the regression model be adequately specified. Model misspecification can arise in a number of ways. A rigorous set of statistical tests is used to identify and resolve potential problems arising from model misspecification.

In a linear regression, one of the main assumptions is that there are no remaining multicollinearity[1] phenomena. Stepwise regression is employed to remove excessive multicollinearity by selecting only those explanatory variables that contribute significantly to explaining price variations. As a diagnostic test, variance inflation factors (VIF) are used to highlight and remove variables with a high degree of multicollinearity.

The Akaike Information Criterion (AIC) allows comparing models that differ with regard to their functional form, variable specification, or both; as such, it can aid in model selection based on how close values predicted by the model are to the real data. The AIC is used to test which of the Linear or Semi-log functional forms provides the best fit. To accommodate nonlinearities, the living area, lot size and age of properties are transformed into non-linear forms. Results of the AIC suggest the use of the semi-log form over the linear form.

Additionally, the Ramsey RESET Test is used to determine if some form of non-linear transformation is required within the model specification (without indicating how to amend the specification).

The RESET test estimates an auxiliary regression using the estimated Yi from the original regression:

$$\hat{Y}_i = \hat{\beta} + \hat{\beta}_1 X_{1i} + \ldots + \hat{\beta}_{ni} X_{ni} + \gamma \hat{Y}_i^2 + \delta \hat{Y}_i^3 + \omega \hat{Y}_i^4 \qquad \text{i=1, 2, … N}$$

where $\hat{Y}_i$ is raised to the 2nd, 3rd and 4th powers and re-inserted in the initial hedonic equation as additional independent variables. The test then compares the original and the auxiliary regressions via F statistic test. The hedonic function is shown to be non-linear if at least one of these $\hat{Y}_i^n$ added terms emerges as statistically significant.

In cases where the equation fails the Ramsey RESET test, the AIC confirms the functional form. That the age of a property cannot be non-linearly transformed may explain the failure at the third and fourth degree for markets where property age is modelled as a binary variable denoting age range.

Demand for one- and two-storey single family homes is significantly different, as reflected in their sales prices. Accordingly, they are modelled separately, with sufficient sales activity to maintain separate and statistically valid categories. Details on how the Single Family Home sub-index is calculated appear in the *Aggregates and Composites* section below.

Single family homes include both attached and detached structures, since analysis shows that the behaviour of a combined 'detached/attached' index tracks congruently with a 'detached' index (configured by extracting sales records of 'attached' homes while maintaining compliance with test

[1] Multicollinearity is a statistical phenomenon in which two or more exogenous variables in a multiple regression model are highly correlated.

criteria). 'Detached' and combined 'detached/attached' indices are monitored to ensure that the congruency of their respective trends supports a combined index.

New communities within a sales territory are considered as part of an annual review of the MLS® HPI system. When accumulation of Transactional Data results in adjustments to market segmentation of a Sales Territory, MLS® HPI models are re-run to take account of geographic revisions while ensuring that homogeneity is maintained for each grouping.

Variables

All available information and data that describes land, buildings and location amenities is considered in the MLS® HPI model specification. Socio-demographic attributes (namely, Education Level and Average Income) also contribute to the determination of sub-areas and their grouping for sampling purposes. Additionally, a Geographical Information System (GIS) is used to capture additional neighbourhood characteristics (proximity factors) such as those relating to schools, main streets, water and other factors.

Data are validated before being used in the modeling process. Each variable is analyzed (minimum, maximum, distribution, form), resulting measurements are stored, and key variables are monitored on an ongoing basis.

Variables for Living area, Land area, property characteristics and dummy time variables are included in the model, and key variables (e.g. Living Area, Land Area) are transformed to fit the data (a list of variables used in the MLS® HPI appears in *Appendix A*). To capture the marginal contribution of each variable, tests are performed with the square and the cube of variables, as well as with their respective square and cubic roots. Statistical tests show that the square root and cubic root transformations best capture the marginal contribution of each transformed variable, and have greater statistical significance than the square and the cube of the variables. Accordingly, the square root and cubic root of key variables are used.

To maintain homogeneity, outlier records are filtered out so that data include records above 0.5% and below 99.5% of the cumulative normal distributions of Sale price, Age, Living Area, Land Area, number of rooms, and number of bathrooms.

A random control sample is then created using 10% of the remaining Transactional Data records to run through the same process as the initial model to validate variables.

Regression

Using a stepwise regression procedure, independent variables are successively forced into the model and then removed from the hedonic equation based on their statistical significance via a Student t-test. Variables kept in the model are fully analyzed and interpreted. It is ensured that time dummy variables are included and that key variables satisfy logical rules (e.g. number of rooms cannot be negative). Also, variables with data occurrence greater than 5% within the database are included in the model

specification[2], and a random control sample is confirmed as valid. Afterwards, Cook's Distance is applied to identify and discard outliers that may exert a deleterious impact on hedonic coefficient estimates.

Diagnostic statistical tests (as below) are then performed to determine if assumptions underlying ordinary least square (OLS) regression modelling are violated. If test results indicate that these assumptions are violated, or that the model is mis-specified (e.g. omission of an important variable) or subject to a functional form design flaw, then the results and the sample are analysed, and corrective actions are taken at the data, scrubber, market delineation or functional level as appropriate.

One of the main assumptions for the (OLS) regression method is that errors have the same variance throughout the sample. If true, the model is said to be homoskedastic. If not, the data are said to be heteroskedastic.

As long as the assumption of homoskedasticity is not violated, OLS is considered to be the best linear unbiased estimator (BLUE). When the assumption is violated, OLS regression estimates are deemed inefficient and OLS is not the best regression method.

One or a combination of additional measures and strategies are used to detect heteroskedasticity, and when required, correct for it (e.g. White test, Weighted Least Squares regression technique, additional data transformations).

Moran's Index Test, often referred to as the Moran's I test, is used to measures the degree of spatial dependence among residuals. A model can be considered adequate if its residuals are not related in space. If they are, this is considered to be evidence of spatial autocorrelation. Like heteroskedasticity, the presence of spatial autocorrelation violates the OLS method assumption that residuals are independent from each other.

The presence of spatial autocorrelation is typically marked by unstable regression parameters and unreliable inference tests. Several solutions are available to correct for the presence of spatial autocorrelation, including Casetti's expansion method, spatial autoregressive techniques and Peer effect models.

The Chow Test is also used to determine whether the coefficients in a regression model are the same in separate subsamples. As a test for structural change, it is mainly used in time series analyses where the assumption of homoskedasticity is valid. Test results for break points each month suggest that a structural change occurred in 2008 (likely due to the global financial and economic crisis).

[2] For example, if the number of properties that have parking is greater than 5% but the parameter 'Parking' is not in the model, the parameter is forced into the model.

Benchmark Prices and Sub-Indexes

Following the generation of regression equations, each sub-area's benchmark property attributes are inserted in the equation to calculate their respective benchmark prices. Each property type supported in the said sub-area is attributed a benchmark property, ignoring other property types. These individual benchmark prices are calculated for each month.

Monthly sub-indexes are calculated using the benchmark price of the reference period (January 2005) as the denominator and prices in other periods as numerators to calculate corresponding monthly sub-indexes.

Aggregate and Composite Benchmark Prices

The MLS® HPI System calculates a set of price indexes and sub-indexes, Benchmark Prices and Relative Benchmark Prices.

Aggregate Benchmark prices for areas in the base (reference) period of January 2005 are based on the weighted[3] contribution of sales activity in constituent sub-areas for each Benchmark category (1-storey single family, 2-storey single family, townhouse/row unit, and apartment unit), whereby the MLS® HPI model calculates Benchmark home prices for each sub-area using applicable Benchmark home attributes in each sub-area.

$$P_{crea} = \sum_{j} W_{i,j} * P_{i,j}$$

where 'P' represents HPI category Benchmark price, 'i' represents Benchmark category, 'j' represents constituent sub-area, and 'w' represents the proportion of Benchmark category activity for the sub-area.

Several levels of Aggregation exist and vary from board to board, depending on their specified requirements. The next level is Area and the level above this is the Sales Territory of the Real Estate Board, followed by Province and then the aggregate of participating boards in Canada.

Aggregate Benchmark prices following the base (reference) period are adjusted by applying corresponding MLS® HPI inflation/deflation. As a result, growth rates for aggregate Benchmark prices are equal to those for their corresponding MLS® HPI. However, since published Benchmark prices are rounded to the nearest $100, growth rates calculated using rounded aggregate Benchmark data may differ slightly from those for corresponding aggregate MLS® HPI indices. For that reason, it is recommended that users rely on percentage changes based on aggregate MLS® HPI indices.

[3] Weights based on proportional values for a three-year period of sales activity.

Composite Benchmark prices in each area in the base (reference) period of January 2005 are based on the weighted contribution of sales activity in constituent sub-areas per benchmark housing category, with the Single Family Benchmark price analogously calculated based on weighted contributions of just 1- and 2-storey sales activity:

$$P_{crea} = \sum_i \sum_j W_{i,j} * P_{i,j}$$

where 'P' represents HPI Composite Benchmark price, 'i' represents Benchmark category, 'j' represents constituent sub-area, and 'w' represents the Benchmark category's proportion of total sales activity for the sub-areas.

Similarly, Metropolitan Composite Benchmark prices in the base (reference) period of January 2005 are based on the weighted contribution of sales activity in constituent sub-areas per benchmark housing category.

Composite prices following the base (reference) period are adjusted by applying corresponding MLS® HPI inflation/deflation. As a result, growth rates for Composite Benchmark prices are equal to those for their corresponding MLS® HPI. However, since published Benchmark prices are rounded to the nearest $100, growth rates calculated using rounded Composite Benchmark data may differ slightly from those for corresponding Composite MLS® HPI indices. For that reason, it is recommended that users rely on percentage changes based on Composite MLS® HPI indices.

Aggregate and Composite Indexes

Since Benchmarks are the only item in the consumer basket, Paasche, Laspeyres index[4] values do not change while calculating sub-indexes per Benchmark category, since quantities cancel themselves out.

$$\Delta P_L = \frac{\sum p_{j,i} q_{0,i}}{\sum p_{0,i} q_{0,i}}$$

$$\Delta P_p = \frac{\sum p_{j,i} q_{j,i}}{\sum p_{0,i} q_{j,i}}$$

[4] Research and Innovative Technology Administration, *'Use of the Chained Fisher Ideal Index to produce the Aggregated Transportation Services Index,* Economics and Finance, http://www.bts.gov/programs/economics_and_finance/transportation_services_index/methodology/pdf/methodology_chained_fisher_ideal_index.pdf

where 'P_L' and 'P_P' represents Laspeyers and Paasche Index respectively, 'i' represents Benchmark category, 'j' represents the subject period, and '0' represents the reference period.

Since the Fisher index 'P_F' is obtained by taking the geometric mean of Laspeyres and Paasche, quantities also cancel themselves out. It is important to understand that this statement is only true on sub-indexes per type;

$$\Delta P_F = \sqrt{\Delta P_L * \Delta P_P}$$

Unlike the Laspeyres Index which overestimates the variation in prices, and the Paasche Index which underestimates it, the Fischer Price Index is more reliable in the estimation of actual price change over time.

The Chained Fisher Index is used to calculate aggregate and composite indexes to conserve the direct month-to-month link that keeps recent sale prices non-obsolete. Accordingly, the results of calculations used in deriving the Metropolitan Composite and Aggregate Composite MLS® HPIs also serve in its calculation:

$$\Delta P_{FC} = \sqrt{\frac{\sum p_{0,i}q_{1,i}}{\sum p_{0,i}q_{0,i}} * \frac{\sum p_{1,i}q_{1,i}}{\sum p_{1,i}q_{0,i}}} * \sqrt{\frac{\sum p_{1,i}q_{2,i}}{\sum p_{1,i}q_{1,i}} * \frac{\sum p_{2,i}q_{2,i}}{\sum p_{2,i}q_{1,i}}} * \ldots * \sqrt{\frac{\sum p_{j-1,i}q_{j,i}}{\sum p_{i-1,j}q_{i-1,j}} * \frac{\sum p_{j,i}q_{j,i}}{\sum p_{j,i}q_{j-1,i}}}$$

where 'P_{FC}' represents the HPI Chained Fisher Index, 'i' represents Benchmark category 'j' represents the subject period, and 'j-1' represents the reference period.

Linking

Introduction

The Consumer Price Index (CPI) and the MLS® Home Price Index (HPI) both track price changes. The CPI tracks price changes for a typical basket of consumer goods and services, and the MLS® HPI tracks home price changes based on a typical basket of housing features.

What people typically purchase changes over time. The CPI and MLS® HPI take similar approaches to account for changes in what people buy so that prices being tracked remain relevant.

To ensure the CPI remains representative of the kinds of things people typically buy, Statistics Canada periodically updates the basket of goods and services tracked by the CPI. Likewise, the MLS® HPI is periodically updated to account for how typical features for Benchmark homes change over time.

Accounting for these changes is important considering that homes being purchased can change over time due to changes in affordability, buyer preferences and the supply of listings. Accounting for how

typical features for Benchmark homes change over time best enables the MLS® HPI to track market trends for home prices.

The CPI and MLS® HPI use identical approaches to ensure that historical and current data remain comparable and non-obsolete after updating what each of them tracks. The approach is known as "Linking". Its mechanics are explained below.

Linking and the MLS® HPI

Linking makes it possible to meaningfully compare prices between two similar but distinct baskets over time. It does so by accounting for how differences between the two baskets affect their prices.

At a single point in time (known as the Linking period), the price for a Benchmark home is calculated based on its old basket of housing features. The price is then recalculated based on its updated basket of housing features. The former price is then divided by the latter price as calculated during the linking period. This quotient is applied to all subsequent HPI calculations, resulting in linked HPI values.

Linked HPI values are applied to Benchmark prices in the base period to yield the linked Benchmark prices as published.

Example:

Assume the Benchmark price for January 2005 (the base period) equals $863,200. Let's say that on January 2014, its Benchmark description is updated and that this date also represents the Linking period. If the January 2014 Benchmark price **before** its description is updated equals $2,498,000 and the Benchmark price **after** its description is updated equals $2,547,960 for January 2014 and the Benchmark price in April 2014 (for example) equals $2,675,358 based on its updated description and before being linked, then:

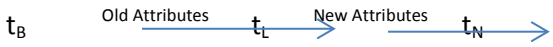
The linked HPI in April 2014 **(as published)** = $2,498,000/$2,547,960 * ($2,675,358/$863,200*100)
= 303.86

The linked Benchmark price in April 2014 **(as published)** = $863,200 * 303.86/100
= $2,622,900

The Mechanics of Linking[5]:

[5] For more information on Linking, please see Statistics Canada's "The Consumer Price Index Reference Paper", Catalogue 62-553 Occasional (available at http://www23.statcan.gc.ca/imdb-bmdi/pub/document/2301_D4_T9_V1_B.pdf).

To compare the price level in the Base period (t_B) to the price level in the New period of interest (t_N) whereby the Benchmark Attributes at t_B are different from the Benchmark Attributes at time N, a Link period (t_L) must be found which is near enough to t_B to be comparable using the old benchmark attributes but also near enough to t_N to be comparable using the new benchmark attributes.



At t_L, Benchmark Prices are calculated using both sets of attributes, yielding $P_{L|old}$ and and $P_{L|new}$

The change in value from $P_{B|old}$ to $P_{L|old}$ and from $P_{L|new}$ to $P_{N|new}$ is then calculated:

Equation 1: $C_{N/L} = P_{N|new} / P_{L|new} * 100$

Equation 2: $C_{L/B} = P_{L|old} / P_{B|old} * 100$

Equation 3: $C_{N/B} = (C_{N/L} * C_{L/B}) / 100$

$P_{N|new}$ is the price level at time N using the New Benchmark Attributes

$P_{L|new}$ is the price level at time L using the New Benchmark Attributes

$P_{L|old}$ is the price level at time L using the Old Benchmark Attributes

$P_{B|old}$ is the price level at time B using the Old Benchmark Attributes

$C_{N/L}$ is the index change in price level from t_L to t_N

$C_{L/B}$ is the index change in price level from t_B to t_L

$C_{N/B}$ is the index change in price level from t_B to time t_N

Index Maintenance

The MLS® HPI System is reviewed annually. The annual review includes re-testing model specifications with a view to potentially strengthening the model. If reviews result in models being re-specified, historical data are revised. Data exclusions are also reviewed and updated as necessary.

Governance

Policy decisions on the use and circulation of MLS® HPI information are the purview of the MLS® HPI Steering Group, which consists of representatives of CREA, Real Estate Boards and Realtor Associations taking part in the MLS® HPI.

HPI Contact Information

For technical enquiries, or enquires about index operations or business development regarding the MLS® HPI, please contact Gregory Klump, CREA's Chief Economist at gklump@crea.ca

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Disclaimer

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Appendix A

Variables used in the Model

Parking access
Tangible or intangible benefits that increase attractiveness or value
Property is serviced by municipal aqueduct
Property is near a shopping mall
Method of heating
Source of energy for heating
Flooring type
Foundation material
Property is equipped with a fireplace
Garage has two parking spaces
Property is equipped with geothermal energy
Property building is semi-detached
Land size in square feet
Property siding material
Property has undergone major renovations
Only a part of Property is renovated
Property is equipped with a roughed-in fireplace
Basement is finished
Parking lot has a shelter or carport
Garage is located below main floor
Roofing material
Property has a crawlspace
Property has a view of water
Property has a panoramic view
Number of bathrooms
Number of half-bathrooms
Property is in proximity to an elementary school or a high school
Hydro line neighbours Property lot
Property has a view of power lines
Property is in proximity to a train station
Property is in proximity to a church
Property is in proximity to an airport
Property is in proximity to a boulevard
Property is adjacent to a boulevard
Property in proximity to a sports center
Property is in proximity to a railroad
Property is in proximity to a hospital
Property is in proximity to a police station
Property is in proximity to a prison
Property is in proximity to a golf course
Property is in proximity to a park
Property is adjacent to a park
Basement living area in square feet

Time dummy variable month and year
Number of rooms above basement level
Main living area in square feet
Number of rooms at basement level
Age of property

Appendix B

Property Types Considered in MLS® HPI Models

A table for all property types considered in MLS® HPI models for each participating board may be found here.

Appendix C

Benchmark Home Definitions

Benchmark homes are representative of standardized homes for specific sub areas. Their physical characteristics remain fixed over time. Benchmark property attributes are formulated for each sub area for Benchmark housing categories that have a significant presence in a sub-area.
The following describes general characteristics for each Benchmark housing category and for selected composites of categories:
NOTE: MLS® HPI data published by CREA for one- and two-storey single family homes (and for the single family composite) include detached and attached properties. By comparison, MLS® HPI data for single family homes published by Greater Vancouver and Fraser Valley real estate boards in their local market areas include only detached properties. Differences in property coverage may result in MLS® data variances for single family homes as published by CREA and the aforementioned real estate boards.

One-storey single family homes:

A property with one floor above ground. This type of property is characterized by the bedrooms, kitchen and dining rooms being on the same floor; the utility room and laundry room are generally located below ground. Special attention is made to raised bungalows, where the basement is partially above ground and where the room distribution provides criteria for its assignment to the appropriate Benchmark housing category. This includes Property Styles submitted by participating Real Estate Boards labeled as: Back Split, Bi-Level, Bungalow, Hillside Bungalow, Hillside Split, 2 Storey Split and 3 Level Split. This type of property does not differentiate between attached and detached homes.

Two-storey single family homes:

A property with two, or more, above ground floors. This type of property is characterized by the distribution of bedrooms on the upper floor and a kitchen, living room and other day-to-day rooms on the main floor. This category includes Property Styles submitted by Participating Boards labeled as: 4 Level Split, 5 Level Split, One-and-a-Half Storey, Two- Storey, Two-and-a-Half Storey, and Three-Storey. This type of property does not differentiate between attached and detached homes.

Single Family homes:

Benchmarks and indices for “Single family homes” are generated as a composite of One- and Two-storey single family homes described above.

One-Storey attached single family homes:

A property with one floor above ground sharing at least one wall (or part of a wall) with another home. In addition to sharing a wall, this type of single family home is characterized by the bedrooms, kitchen and dining rooms being on the same floor; the utility room and laundry room are generally located below ground. Special attention is made to raised bungalows, where the basement is partially above ground and where the room distribution provides criteria for its assignment to the appropriate Benchmark housing category. This includes Property Styles submitted by participating Real Estate Boards labeled as: Back Split, Bi-Level, Bungalow, Hillside Bungalow, Hillside Split, 2 Storey Split and 3 Level Split. This type of attached home is distinct from units such as a townhouses, apartments or

condos which typically share more than one wall with another home being within multi-family dwellings and where the ownership and maintenance costs of exterior walls, land and entrances may be shared. Benchmarks and Indices for this particular Property Type are generated for TREB and GMRGM under arrangement with these boards.

Two-Storey attached single family homes:

This category includes properties with two or more above ground floors sharing at least one wall (or part of a wall) with another home. In addition to sharing a wall, this type of home houses one family and is characterized by the distribution of bedrooms on the upper floor and a kitchen, living room and other day-to-day rooms on the main floor. This category includes Property Styles submitted by Participating Boards labeled as: 4 Level Split, 5 Level Split, One-and-a-Half Storey, Two- Storey, Two-and-a-Half Storey, and Three-Storey. This type of attached home is distinct from units such as a townhouses, apartments or condos which typically share more than one wall with another home being within multi-family dwellings and where the ownership and maintenance costs of exterior walls, land and entrances may be shared.
Benchmarks and Indices for this particular Property Type are generated for TREB and GMRGM under arrangement with these boards.

Attached single family homes:

Benchmarks and indices for the category **"Attached single family homes"** are calculated as a composite of One-and Two-storey attached single family homes described above. The term "attached" describes a home that is part of a larger multi-family building.
Benchmarks and Indices for this particular Property Type are generated for TREB and GMRGM under arrangement with these boards.

One-Storey detached single family homes:

A **"One-Storey detached single family home"** is built with one above ground floor on land that exceeds the footprint of the building on each of its sides. Ownership of the surrounding land (typically less than 40,000 square foot yard), entrance and associated lesser structures is an integral and inseparable part of the home.
The generation of indices for this particular category of homes is generated for GMRGM, TREB, FVREB and REBGV.

Two-Storey detached single family homes:

A **"Two-storey detached single family home"** is built with two or more above ground floors on land that exceeds the footprint of the building on each of its sides. Ownership of the surrounding land (typically less than 40,000 square foot yard), entrance and associated lesser structures is an integral and inseparable part of the home.
The generation of indices for this particular category of homes is generated for GMRGM, TREB, FVREB and REBGV.

Detached single family homes:

Benchmarks and indices for **"Detached single family homes"** are generated as a composite of One- and Two-storey detached single family homes. As described above, these homes are independent structures

that are typically built on land that exceeds the footprint of the building on each of its sides. Ownership of the surrounding land (typically less than 40,000 square foot yard), entrance and associated lesser structures is an integral and inseparable part of the home.
The generation of indices for this particular composite category of homes is generated for GMRGM, TREB, FVREB and REBGV.

Townhouse/row units:

Townhouses have configurations which lay between apartment units and freehold non strata buildings, such as bungalows and two-storey houses. Owners typically pay co-ownership fees for maintenance and enjoy exclusive access to a part of the lot. This category includes Property Styles submitted by Participating Boards labeled as any of the submitted Styles, with a note that the property is a Townhouse.

Attached townhouse:

Attached townhouses have configurations which lay between apartment units and freehold non strata buildings, such as bungalows and two-storey houses. Owners typically pay co-ownership fees for maintenance and enjoy exclusive access to a part of the lot. This category includes Property Styles submitted by Participating Boards labeled as any of the submitted Styles, with a note that the property is a Townhouse. Additionally, the townhouse must be either a semi-detached or an attached property. Benchmarks and Indices for this particular Property Type are generated for CREB under arrangement with this board. Detached townhouses exist in a limited number of communities, but their scarceness on the territory did not allow for detached time series.

Apartment units:

Apartment units are characterized by being part of a multi-unit building. Occupants of apartment units may or may not have direct access to the lot from their units. There are also no parts of the lot whereby access is reserved for only one of the co-owners or apartment occupants. Several type of homes within this category had originally been duplexes and triplexes and are now treated as condos or apartments according to a formal declaration of co-property.
This category includes Property Styles submitted by Participating Boards labeled as: Single Level Apartment, Multi-Level Apartment, Loft, Penthouse, Duplex, Triplex and Studio Suite.

Attached single family homes:

Benchmarks and indices for the category **“Attached single family homes”** are calculated as a composite of One-and Two-storey attached single family homes described above. The term “attached” describes a home that is part of a larger multi-family building.
Benchmarks and Indices for this particular Property Type are generated for TREB and GMRGM under arrangement with these boards.

Attached category:

Benchmarks and indices for the category **“Attached category”** are calculated as a composite of One-, Two-storey attached single family homes and attached townhouses as described above. The term “attached” describes a home that is part of a larger multi-family building.

Benchmarks and Indices for this particular Property Type are generated for CREB under arrangement with this board.

Detached category:

Benchmarks and indices for **"Detached category"** are generated as a composite of One- and Two-storey detached single family homes. As described above, these homes are independent structures that are typically built on land that exceeds the footprint of the building on each of its sides. Benchmarks and Indices for this particular Property Type are generated for CREB under arrangement with this board.

Semi-detached category:

Benchmarks and indices for the category **"Semi-detached category"** are calculated as a composite of One-, Two-storey semi-detached single family homes and semi-detached townhouses as described above. The term "semi-detached" describes a home that is part of a two units multi-family building. Benchmarks and Indices for this particular Property Type are generated for CREB under arrangement with this board.

Row category:

Benchmarks and indices for the category **"Row category"** are calculated as a composite of One-, Two-storey row single family homes and row townhouses as described above. The term "row" describes a home that is part of a multi-family building with at least three units physically linked. Benchmarks and Indices for this particular Property Type are generated for CREB under arrangement with this board.

Composite:

Benchmarks and indices within the "Composite" category represents all homes used in models, including One- and Two-storey single family homes, Townhouses and Apartments. Accordingly, the Composite index includes both attached and detached homes within One- and Two-storey single family homes.