



S&P/Case-Shiller[®] Home Price Indices

A Primer

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Understanding Repeat Sales

This document describes the methodology used to calculate the S&P/Case-Shiller® Home Price Indices (S&P/CSIs). S&P/CSIs are based on price changes of individual single-family residences over time; thus, the S&P/CSIs reflect changes in real estate values corresponding to properties that have sold more than once. Fiserv CSW, Inc. ("Fiserv"), the calculation agent for the S&P/CSIs, continuously analyzes and quality-controls residential property data collected from several sources, and uses proprietary software to produce "repeat sales" indexes for real estate markets throughout the United States.

To understand the way that repeat sales, or sale pairs are combined to form an S&P/CSI, consider this simple example, based upon three hypothetical properties and their respective sale transaction histories. Each of the three properties has sold twice within a three-year period as follows:

Year of Sale	1986	1987	1988
Property A	\$100,000	\$120,000	--
Property B	\$ 75,000	--	\$100,000
Property C	--	\$100,000	\$105,000

What can one learn from this data?

1. **Property A** contains information on the rate of appreciation between 1986 and 1987. Based on the information in the data for Property A, our initial inference would be that prices rose 20% between 1986 and 1987.
2. **Property B** contains information on the rate of appreciation between 1986 and 1988. By combining this with what we learned from Property A, we can now make an inference about the appreciation rate between 1987 and 1988. If property B increased in value between 1986 and 1987 at the same rate as Property A, it would have increased 20% or rose from \$75,000 to \$90,000. That would imply that it increased from \$90,000 to \$100,000 between 1987 and 1988, an 11.1% increase. Thus, from the first two properties we would conclude that values rose 20% from 1986 to 1987 and 11.1% from 1987 to 1988.
3. **Property C** gives us a second piece of information on the rate of appreciation between 1987 and 1988. One infers that property values only rose 5% between 1987 and 1988. Thus, our initial inference of 11.1% may be too high. We might take the average of 5% and 11.1% (8%) as our best inference, and at the same time, revise our estimate of the 1986-1987 appreciation rate upwards slightly.

4. Now imagine hundreds or thousands of observations in a particular area: since there are so many independent indicators of market price, it is possible to obtain very accurate measures of overall real estate market price movements. A simultaneous estimation method is used to merge all of these observations into a single home price index.

Index Construction Process

The Case-Shiller home price indexes are based on observed changes in individual home prices. The main variable used for index calculation is the price change between two arms-length sales of the same single-family home. Home price data is gathered after that information becomes publicly available at local deed recording offices across the country. For each home sale transaction, a search is conducted to find information regarding any previous sale for the same house. If an earlier transaction is found, the two transactions are paired and are considered a “sale pair”. Sale pairs are designed to yield the price change for the same house, while holding the quality and size of each house constant.

The Case-Shiller indexes are designed to reflect the *average* change in *market prices* for *constant-quality* homes in a geographic market. The sale pairing process and the weighting used within the Case-Shiller repeat sales index model ensure that the indexes track market trends in home prices by ignoring or down-weighting observed price changes for individual homes that are not market driven and/or occur because of idiosyncratic physical changes to a property or a neighborhood. Sale prices from non-arms-length transactions, where the recorded price is usually below market value, are excluded in the pairing process or are down-weighted in the repeat sales model. Pairs of sales with very short time intervals between transactions are eliminated because observed price changes for these pairs are much less likely to be representative of market trends. Idiosyncratic changes to properties and/or neighborhoods are more likely to have occurred between sales with longer transaction intervals, so these pairs are down-weighted in the repeat sales index model if they are not eliminated during the sale pairing process.

Pairing Sales and Controlling Data Quality

The automated sale pairing process is designed to collect arms-length, repeat sales transactions for existing, single-family homes. This process collects as many qualifying sale prices as possible, ensuring that large, statistically representative samples of observed price changes are used in the Case-Shiller repeat sales model. In an arms-length transaction, both the buyer and seller act in their best economic interest when agreeing upon a price. When they can be identified from a deed record¹, non-arms-length transactions are excluded from the pairing process. The most typical types of non-arms-length transactions are property transfers between family members and transfers of properties from mortgage borrowers to lenders during foreclosure proceedings. Although identified foreclosure transfers are excluded during the pairing process, subsequent sales by mortgage lenders of foreclosed properties are candidates to be included in repeat sale pairs.

¹ A deed record may directly indicate that a transaction is not arms-length. In other cases, it is possible to identify non-arms-length transactions by comparing the surnames of the buyer and seller (transfers between family members) or by checking if the “buyer” is a mortgage lender (foreclosure transfer). Local deed recorders and property data vendors differ in how often and consistently they collect and record information that can be used to identify non-arms-length transactions.

The pairing process is also designed to exclude sales of properties that may have been subject to substantial physical changes immediately preceding or following the transaction. Furthermore, since a property must have two recorded transactions before it can be included as a repeat sale pair, newly constructed homes are excluded from the index calculation process until they have been sold at least twice. Deed records do not usually describe the physical characteristics of properties (other than the size and alignment of land parcels). However, other items listed on the deed record can be used to identify properties that may have been subject to substantial physical changes.² Deeds that have been marked as transfers of land with no improvements (i.e., no structures) are excluded. Transactions where the seller may be a real estate developer (based on the seller's name) are also excluded, since it is likely that this is the sale of a newly constructed home built on a previously vacant or occupied lot or a rebuilt existing home.

Finally, sales that occur less than 6 months after a previous sale are excluded, primarily because single real estate transactions often have duplicate or multiple deed records³ due to the procedures used by local deed recorders and property data vendors. It is also more likely that in cases with a very short intervals between sales that: (1) one of the transactions is non-arms-length (e.g., a transfer between family members before selling a property), (2) the property has undergone substantial physical changes (e.g., a developer has purchased and quickly sold a rebuilt property), or (3) one of the transactions is a fraudulent transaction (a "property flip").

Although the number of excluded transactions will vary from market to market, depending on how much detailed information is available in recorded deeds, usually less than 5% of non-duplicate transaction records are identified as non-arms-length and are removed as possible pairing candidates. Similarly, typically less than 5% of non-duplicate transaction records are preceded by another transaction within the last 6 months. The percentage of properties identified as either new construction or rebuilt existing homes depends on local market conditions, since construction activity is cyclical and related to the strength of the market's economy, the overall age and condition of the existing housing stock, and the balance between housing supply and demand. Depending on these factors and the completeness of deed information, the percentage of sales identified and eliminated from the pairing process because there may have been substantial physical changes to the property usually ranges from 0% to 15%.

² Local deed recorders and property data vendors differ in how often and consistently they collect and record information that can be used to identify properties that have experienced substantial physical changes.

³ The same transaction date may be listed on duplicate deed records, but this is very often not the case. Duplicate records for a single transaction may contain transaction dates that are weeks apart, depending on the recording processes used at local deed offices and the collection procedures used by property data vendors. Requiring transaction dates to be at least 6 months apart prevents these duplicate records from being used as sale pairs.

The Weighting of Sale Pairs

Although non-arms-length transactions and sales of physically altered properties are discarded during the pairing process, it is not possible to identify all of these sales based on the information available from deed records. Furthermore, the price changes observed for individual homes may be the result of non-market, idiosyncratic factors specific to a property (which cannot be identified from the deed information) or a property's neighborhood. For example, a new school may be built, boosting the value of nearby properties relative to the market, or an individual property may have not been well maintained, reducing its value relative to the market. Finally, errors in recorded sale prices may cause a particular sale pair to mismeasure the actual price change of an individual property.

To account for sale pairs that include anomalous prices or that measure idiosyncratic price changes, the repeat sales index model employs a robust weighting procedure. This automated, statistical procedure mitigates the influence of sale pairs with extreme price changes. Each sale pair is assigned a weight of one (no down-weighting) or a weight less than one but greater than zero, based on a comparison between the price change for that pair and the average price change for the entire market. The degree to which sale pairs with extreme price changes are down-weighted depends on the magnitude of the absolute difference between the sale pair price change and the market price change. No sale pair is eliminated by the robust weighting procedure (i.e., no pair is assigned a zero weight), and only sale pairs with extreme price changes are down-weighted. Although the number of sale pairs that are down-weighted depends the statistical distribution of price changes across all of the sale pairs, in large metro area markets, typically 85% to 90% of pairs are assigned a weight of one (no down-weighting), 5% to 8% are assigned a weight between one and one-half, and 5% to 8% are assigned a weight between one-half and zero.

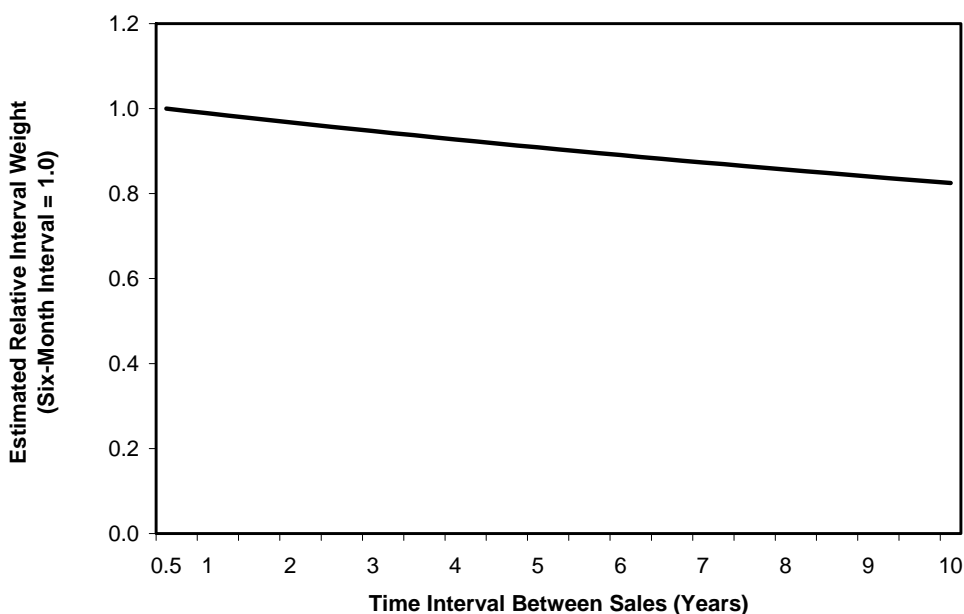
The Case-Shiller repeat sales model also includes an interval weighting procedure that accounts for the increased variation in the price changes measured by sale pairs with longer time intervals between transactions. Over longer time intervals, the price changes for individual homes are more likely to be caused by non-market factors (e.g., physical changes, idiosyncratic neighborhood effects). Consequently, sale pairs with longer intervals between transactions are less likely to accurately represent average price changes for the entire market.

The interval weights are determined by a statistical model within the repeat sales index model that measures the rate at which the variance between index changes and observed sale pair price changes increases as the time interval between transactions increases (time-between-sales variance). It is also assumed that the two sale prices that make up a sale pair are imprecise, because of mispricing decisions made by homebuyers and sellers at the time of a transaction. Mispricing variance occurs because buyers and sellers have imperfect information about the value of a property. Housing is a completely heterogeneous product, whose value

is determined by hundreds of factors specific to individual homes (e.g., unique physical attributes; location relative to jobs, schools, shopping; neighborhood amenities). The difficulty in assigning value to each of these attributes, especially when buyers and sellers may not have complete information about each factor, means that there is significant variation in sale prices, even for homes that appear to be very similar.

The interval weights in the repeat sales model are inversely proportional to total interval variance, which is the sum of the time-between-sale variance and the mispricing variance. A statistical model within the repeat sales model is used to estimate the magnitudes of the two components of total interval variance. The interval weights introduce no bias into the index estimates, but increase the accuracy of the estimated index points.⁴

The following graph shows estimated interval weights for a large, representative metro area market (relative to the weight for a sale pair with a six month interval between transactions):



For large metro area markets, the interval weights for sale pairs with ten-year intervals will be 20% to 45% smaller than for sale pairs with a six-month interval.

⁴ More technically, the interval weights correct for heteroskedastic (non-uniform) error variance in the sale pair data. These corrections for heteroskedasticity reduce the error of the estimated index points, but do not bias the index upwards or downwards. See Case, K.E. and R.J. Shiller (1987) "Prices of Single-Family Homes Since 1970: New Indices for Four Cities" *New England Economic Review*, pp. 45-56 for a discussion of the heteroskedastic error correction model used in the Case-Shiller repeat sales index model.

Index Specifications and Types

S&P/CSIs are generated to accurately gauge price trends of residential real estate markets across the United States.

Base Year

All S&P/CSIs have a base value of 100.00 in January 2000.

S&P/CSIs versus "Standard" CSIs

S&P/CSIs have been created to facilitate the development and growth of housing derivative markets, such as those for the CME Housing Futures and Options contracts, over-the-counter swaps and index-linked notes. Although based upon the very same "repeat sales" technology and underlying data as the "standard" CSIs produced by Fiserv, S&P/CSIs are, with appropriate license, "tradable" indices, and differ from their non-tradable cousins, "standard" CSIs. The fundamental differences are summarized in the table below.

Feature	S&P/CSIs	Standard CSIs
Update Frequency	<i>Monthly⁵</i>	<i>Quarterly</i>
Update Publication	<i>Last Tues every month 9:00am EST⁶</i>	<i>By last business day of calendar quarter-end (and never sooner than the S&P/CSIs)</i>
Lookback or "lag"	<i>2 months (i.e., the March update reflects transactions through the prior January)</i>	<i>3 months (i.e., the March update reflects transactions through the prior December)</i>
Transaction Period Captured	<i>"Rolling Quarters" (i.e., the March update captures Nov/Dec/Jan; the April update captures Dec/Jan/Feb)</i>	<i>"Discrete Quarters" (i.e., the March update captures Oct/Nov/Dec; the June update captures Jan/Feb/Mar)</i>
Composite Index Weighting	<i>"Cap-weighted" by aggregate housing stock value of component markets</i>	<i>n/a</i>

⁵ The S&P/Case-Shiller U.S. National Index is currently updated on a quarterly basis (every February, May, August and November).

⁶ The last Tuesday in December 2007 falls on Christmas Day, a market holiday. The update will be released the following day, December 26th at 9:00am.

S&P/CSI Composition and Update Schedule

Each index update reflects approximately three months of property transactions data. The monthly index calculations use a look-back period of less than two months (e.g., the most recent home sales data incorporated into an April index update will have February transaction dates). Here is an illustration of the composition of a series of monthly S&P/CSI releases:

2007 Index Release	Reflects Data Collected Through	For Months
January 30	January 19	Sep / Oct / Nov
February 27*	February 16	Oct / Nov / Dec
March 27	March 16	Nov / Dec / Jan
April 24	April 13	Dec / Jan / Feb
May 29*	May 18	Jan / Feb / Mar
June 26	June 15	Feb / Mar / Apr
July 31	July 20	Mar / Apr / May
August 28*	August 17	Apr / May / Jun
September 25	September 14	May / Jun / Jul
October 30	October 19	Jun / Jul / Aug
November 27*	November 16	Jul / Aug / Sep
December 26	December 14	Aug / Sep / Oct

*Denotes the four release dates that will include an update to the quarterly S&P/Case-Shiller U.S. National Index

Market Definitions

S&P/CSIs are currently available for the overall United States housing market (a market capitalization-weighted composite of 9 underlying Census Division indices), 20 individual metropolitan markets, and two market capitalization-weighted composite metro-area indices. The weights used for the composite indices reflect the aggregate value of single family housing stock in each of the underlying regions or metropolitan areas. The “Composite – 20” index captures price trends within all twenty of the individual cities currently available (listed below), and the “Composite -10” index captures price trends within ten⁷ of the twenty individual cities.

S&P/CS U.S. National Home Price Index

Census Divisions	East North Central East South Central Middle Atlantic Mountain New England Pacific South Atlantic West North Central West South Central
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Individual Metro-Area Indices

Metropolitan Area	State / County Representation
Atlanta	<u>Georgia:</u> Barrow, Bartow, Butts, Carroll, Cherokee, Clayton, Cobb, Coweta, Dawson, De Kalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Haralson, Heard, Henry, Jasper, Lamar, Meriwether, Newton, Paulding, Pickens, Pike, Rockdale, Spalding, Walton
Boston	<u>Massachusetts:</u> Essex, Middlesex, Norfolk, Plymouth, Suffolk <u>New Hampshire:</u> Rockingham, Strafford

⁷ S&P/CSI Composite-10 includes the following metropolitan areas: Boston, Chicago, Denver, Las Vegas, Los Angeles, Miami, New York, San Diego, San Francisco, and Washington, DC.

Charlotte	<p><u>North Carolina:</u> Anson, Cabarrus, Gaston, Mecklenburg, Union</p> <p><u>South Carolina:</u> York</p>
Chicago	<p><u>Illinois:</u> Cook, DeKalb, DuPage, Grundy, Kane, Kendal McHenry, Will</p>
Cleveland	<p><u>Ohio:</u> Cuyahoga, Geauga, Lake, Lorain, Medina</p>
Dallas	<p><u>Texas:</u> Collin, Dallas, Delta, Denton, Ellis, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise</p>
Denver	<p><u>Colorado:</u> Adams, Arapahoe, Broomfield, Clear Creek, Denver, Douglas, Elbert, Gilpin, Jefferson, Park</p>
Detroit	<p><u>Michigan:</u> Lapeer, Livingston, Macomb, Oakland, Saint Clair, Wayne</p>
Las Vegas	<p><u>Nevada:</u> Clark</p>
Los Angeles	<p><u>California:</u> Los Angeles, Orange</p>
Miami	<p><u>Florida:</u> Broward, Miami-Dade, Palm Beach</p>

Minneapolis	<p><u>Minnesota:</u> Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Sherburne, Washington, Wright</p> <p><u>Wisconsin:</u> Pierce, Saint Croix</p>
New York	<p><u>Connecticut:</u> Fairfield, New Haven</p> <p><u>New Jersey:</u> Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union, Warren</p> <p><u>New York:</u> Bronx, Dutchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Westchester</p> <p><u>Pennsylvania:</u> Pike</p>
Phoenix	<p><u>Arizona:</u> Maricopa, Pinal</p>
Portland	<p><u>Oregon:</u> Clackamas, Columbia, Multnomah, Washington, Yamhill</p> <p><u>Washington:</u> Clark, Skamania</p>
San Diego	<p><u>California:</u> San Diego</p>

San Francisco	<u>California:</u> Alameda, Contra Costa, Marin, San Francisco, San Mateo
Seattle	<u>Washington:</u> King, Pierce, Snohomish
Tampa	<u>Florida:</u> Hernando, Hillsborough, Pasco, Pinellas
Washington	<u>District of Columbia</u> <u>Maryland:</u> Calvert, Charles, Frederick, Montgomery, Prince Georges <u>Virginia:</u> Alexandria City Arlington, Clarke, Fairfax, Fairfax City, Falls Church City, Fauquier, Fredericksburg City, Loudoun, Manassas City, Manassas Park City, Prince William, Spotsylvania, Stafford, Warren <u>West Virginia:</u> Jefferson

Composite Weights

The weights used for the composite indices reflect the aggregate value of single family housing stock in each of the underlying regions or metropolitan areas.

The S&P/Case-Shiller® U.S. National Home Price Index

Region	Weight
East North Central	0.15770404
East South Central	0.04632221
Middle Atlantic	0.13653163
Mountain	0.06804488
New England	0.06381155
Pacific	0.22095966
South Atlantic	0.17460979
West North Central	0.05969073
West South Central	0.07232552

The S&P/Case-Shiller® Composite-10 Home Price Index

Metropolitan Area	Weight
Boston	0.07412188
Chicago	0.08886762
Denver	0.03682453
Las Vegas	0.01480245
Los Angeles	0.21161961
Miami	0.04986164
New York	0.27239040
San Diego	0.05513356
San Francisco	0.11787881
Washington, DC	0.07849949

The S&P/Case-Shiller® Composite-20 Home Price Index

Metropolitan Area	Weight
Atlanta	0.03929074
Boston	0.05279478
Charlotte	0.01314212
Chicago	0.06329774
Cleveland	0.01730555
Dallas	0.03952123
Denver	0.02622900
Detroit	0.04834563
Las Vegas	0.01054334
Los Angeles	0.15073029
Miami	0.03551495
Minneapolis	0.02794756
New York	0.19401550
Phoenix	0.02917885
Portland	0.01927497
San Diego	0.03926998
San Francisco	0.08396154
Seattle	0.03889872
Tampa	0.01482467
Washington, DC	0.05591283

Index Revision

Similar to other macroeconomic indicators and statistical measures, the S&P/CSIs are subject to revisions. For a period of up to two years, when any new sales data pertaining to a time period covered by a previous S&P/CSI release is reported and new, valid sale pairs can be created, this information is added to the database, and can result in revision.

Revisions to previously released index estimates can occur because:

- For certain recently-sold properties, data that would serve as ingredients (e.g., sale price, transaction date, property type) for new, valid sale pairs are sometimes incomplete, erroneous or simply unavailable (e.g., as a result of operational delays at public record data recording offices) at the time an index is calculated.
- As illustrated in the preceding section, the S&P/CSIs are calculated using a statistical estimation method that infers overall price movements from thousands of sales pairs spanning multiple time periods (between the first and second transaction dates for each sales pair). Accordingly, in the example above, addition of sales pairs spanning 1987-88 can lead to revisions of the index representing price changes in 1986-87.

In addition to sales data availability and timeliness, revision magnitude and volatility can also be a function of market conditions. For example, in relative terms, revisions will tend to be larger for markets experiencing extreme (either negative or positive) price changes or low sales volume.

Historically, in the vast majority of cases, Case-Shiller® Index revisions have tended to be modest (e.g., more than 90% of revisions to estimates of quarter-to-quarter percent changes are less than 1.0%; 86% of revisions to the index level are less than one index point). The table on the following page summarizes revision history for a large sample of “standard” CSIs from Q1 2001 through Q2 2005⁸.

⁸ Note that these revision statistics are based upon historical experience, and reflect revisions associated with “standard” CSIs calculated by Fiserv using their standard methods (discrete calendar quarter updates with three-month look-back) and historical market definitions. S&P/CSIs use the same repeat-sales methodology and underlying data as standard CSIs. However, the S&P/CSIs are updated monthly using a rolling-quarters approach and a two-month look-back, and reflect geographic definitions that are based upon the most recent OMB standards. As new data series, there is little revision history pertaining to the S&P/CSIs.

Revisions to Initial Estimate of Index Level		Revisions to Initial Estimate of Period-to-Period Percent Change	
Index Points	Number of Initial Estimates	Percentage Points	Number of Initial Estimates
No Change	557	No Change	560
0 to 0.25	826	0% to 0.25%	1,012
0.25 to 0.50	214	0.25% to 0.50%	260
0.50 to 0.75	177	0.50% to 0.75%	113
0.75 to 1.00	90	0.75% to 1.00%	69
1.00 to 1.50	93	1.00% to 1.50%	79
1.50 to 2.00	53	1.50% to 2.00%	29
2.00 to 3.00	76	2.00% to 3.00%	21
3.00 to 4.00	32	3.00% to 4.00%	10
More than 4.00	38	More than 4.00%	3