

## Are Broker Quotes Too Optimistic? Korean Evidence

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We examine the behavior of broker quotes in Korean housing markets by comparing the Kookmin Bank apartment (a condominium in a high-rise residential building) price index, a broker quote based apartment price index, and a repeat sales apartment price index that we built using transaction prices, which have become available since January 2006. Broker quotes may differ from actual prices depending on the housing market conditions. Specifically, we test the hypotheses: (1) price increases shown by the broker quote based apartment price index are greater than those shown by the repeat sales apartment price index in an up market; and (2) the broker quote based price index shows a far less price reduction than the repeat sales price index in a down market. We find that indeed in a down market, the broker quote based price index shows far less price reduction than the repeat sales price index (5.75%-8.07%). However, the broker quote based price index does not distort the prices in an up market, where trading volumes are high. It appears that the price inflation in the broker quotes rises as the

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transaction volume drops. While broker quotes are substantially higher than transaction prices in a down market, the broker sentiment, which is a qualitative assessment of market conditions, appears to be more in line with transaction prices. We have also documented that the broker quote based index reaches its peak about two months after the peak of the repeat sales based index. Finally, broker quotes are smooth in comparison to transaction prices and they are smoothed more in a down market than an up market. Our results suggest that an optimistic view of broker quotes is problematic only in down markets where trading volumes are limited. The price inflation in broker quotes is a risk to the financial system in a market with only a broker quote based index in that it overstates the collateral values underlying mortgage loans in a down market.

## **Keywords**

Broker quotes; Broker quote based apartment price index; Repeat sales apartment price index; House price cycle; Broker sentiment; Korean housing markets

## **1. Introduction**

In many jurisdictions, the actual sale prices of residential units are simply not available in the public domain. In such markets, price discovery is expected to be very difficult for all market participants. Governments would find it difficult to determine the value of residential units which are used to base real estate related taxes. Lenders would find it difficult to value the collaterals of mortgage loans.

However, that is not what we have observed, at least in the Korean residential markets. Even though actual sale prices of residential units were not available in the public domain until January 2006, and the short history of actual sale price data in the public domain means that a repeat sales price index is still not publicly available, price discovery does not appear to be difficult for market participants in Korea. Typically, markets tend to be very liquid and transaction costs very low where transactions are routinely conducted based on broker quotes.<sup>1</sup> The extent of the influence of broker quotes is shown in

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<sup>1</sup> The brokerage fee is between 0.4% and 0.9%, which is separately applicable for both the seller and the buyer, and regulated by the Law on the Real Estate Brokerage Operation and Real Estate Transaction Reporting.

part by the fact that broker quotes are commonly called “market prices” in Korea. The Financial Supervisory Service of Korea, which regulates the loan-to-value (LTV) ratio for mortgage loans, banks and other financial institutions, routinely use broker quotes provided by the Kookmin Bank rather than appraisal values to calculate LTV ratios. In this paper, we attempt to study how broker quotes behave vis-à-vis transaction prices. To the best of our knowledge, a systematic study of the behavior of broker quotes has been essentially non-existent in the literature. Furthermore, the behavior of broker quotes is an important issue given the critical role that brokers play in the real estate markets.

Disincentives to provide transaction prices of residential units must be formidable enough to outweigh all of the problems associated with the lack of transaction prices in the public domain. A well-known disincentive for disclosing transaction prices is real estate related taxes. Buyers and sellers may find it optimal to avoid taxes by refusing to disclose true transaction prices and obtain price information through interactions with local real estate brokers. In addition to the price discovery that brokers provide in the absence of transaction prices, there may be additional incentives for buyers and sellers so that the broker quote system is preferred where brokers maintain orderly market conditions by adjusting broker quotes depending on market conditions. In such markets, local real estate brokers may play dual roles; one is to collect transaction prices (at least recent ones), and the other is to exaggerate prices in an up market and maintain prices in a down market.

In a broker quote system where buyers and sellers depend on the information and advice of real estate brokers (who have become a depository of the bids and asks), deals are made around the broker quotes. Anecdotal evidence suggest that brokers often use asking prices as broker quotes when there are actual asking prices on the properties. On the other hand, brokers use prices which are based on polling the property owners, potential buyers as well as other market participants when there are no active asking prices on the properties.

We briefly describe below, the brokerage system in the Korean residential market. While buyer-brokers and seller-brokers are typically different, the same brokers can represent both buyers and sellers. While most transactions are conducted through brokers, a direct bilateral trade between sellers and buyers is possible and observed occasionally. Brokers are compensated on the basis of the transaction price of the housing units traded. Upon a successful completion of the trade, seller-brokers and buyer-brokers charge brokerage commission to seller and buyers, respectively. The brokerage commission rate is relatively low, ranging from 0.4% to 0.9%, depending on the value of the housing units transacted. Brokers tend to serve areas where their offices are located, with very close ties to the households in the neighborhood, so that the neighbors are able to monitor the house prices quoted by the brokers very

closely. Therefore, brokers tend to be circumspect with prices that they quote in order not to displease the neighbors.

As house price indices based on actual transaction data are not available for Korea as is the case in many other countries, all market participants use the apartment (a condominium unit in a high-rise residential building, which is the largest segment of the housing stock) price index by the Kookmin Bank as the primary house price index.<sup>2</sup> Apartment price information providers, such as Real Estate 114, also provide house price data. Real Estate 114 sells their own apartment price index. The apartment price indices by the Kookmin Bank as well as the Real Estate 114 are not based on actual transaction prices, but on surveys of real estate brokers in the region on current house prices.

Prior to January 2006, transaction prices were not reported to the government. Therefore, there were few real transaction prices to construct a real estate price index for the Korean residential market. In July 2005, the Korean government revised the Law on Brokerage Operation, making it mandatory to report the actual sale prices of real estate transactions from January 1, 2006 onwards, in order to prevent real estate related tax evasion and improve transparency in the real estate markets. The Ministry of Land, Transport and Maritime Affairs discloses the actual sale prices of apartment condominiums monthly on their website.<sup>3</sup>

Since 1986, the Kookmin Bank has published apartment price indices based on surveys of licensed real estate brokers. Brokers included in the surveys are expected to enter the actual sale prices of sampled housing units on the online survey form if trades occur and estimated prices if no trades occur. In practice, polled brokers may quote prices which are different from actual prices and private incentives may influence the difference between their quotes and the actual prices, depending on the housing market conditions.

In order to study the behavior of broker quotes, we have constructed a repeat sales apartment price index using data available from January 2006 to June 2008. We have modified the traditional repeat sales index estimation method to reflect an idiosyncrasy of the Korean apartment markets where apartments on the same floor in the same complex with the same square footage are considered as the “same” apartments. Here, we use very similar apartments rather than the same apartments to construct repeat sales pairs. This results in increasing the repeat sales pairs substantially, enabling us to construct a repeat sales index based on a very limited sample period over which transaction prices are available.

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<sup>2</sup> The Kookmin Bank tabulates the official real estate price indices for the Korean government.

<sup>3</sup> The Ministry filters out questionable data and publishes only sale prices which have passed a series of suitability tests.

We have tested empirically whether broker quotes give an overly optimistic view of house prices. Using the transaction prices collected from January 2006 to June 2008, we construct a repeat sales apartment price index for three districts in the greater Kangnam submarket in Seoul and compare it with the broker quote based price index. We find that in a down market, broker quotes show far less price reduction than transaction prices while price inflations are limited in bullish housing markets where the transaction volumes are high. The difference between broker quotes and the actual prices seems to depend on transaction volume.

We also find that the broker quotes are highly smoothed as shown by the lack of volatility, which is clearly present in the repeat sales indices, and broker quotes lag transaction prices by about two months in registering the market downturn. While we do not find evidence that broker quotes exceed the transaction prices, exacerbating the price upswing in a price run up; however, we find that broker quotes exceed the transaction prices in a down market, overstating the collateral values underlying mortgage loans. We note that broker quotes may facilitate price discovery in a market where transaction data are not widely available and that to the extent broker quotes maintain an orderly fall in the housing prices in a down market, one may argue that a transaction based house price index and broker quote based index complement each other.

## 2. Literature Review and Hypotheses Development

In jurisdictions where transaction prices are virtually absent, broker quotes are often their closest substitutes. Broker quotes have played an essential role in the Korean residential markets. Hwang, Quigley and Son (2006), and Cho, Kim and Shilling (2007), point out that in Korea, one can readily find neighborhood brokers who can provide daily movements of house prices. They note that these broker quotes are considered to be an accurate reflection of the market and heavily affect the market participants. For example, Hwang, Quigley and Son use the house price data compiled by the Real Estate Bank while Cho, Kim and Shilling use the Kookmin Bank apartment price index time series in their study<sup>4</sup>.

In order to study the behavior of broker quotes, we should compare seller quotes, broker quotes, and transaction prices for each transaction. However, given that this is not possible in practice, we have evaluated the behavior of broker quotes through comparisons of the broker quote based price index with the repeat sales index. The repeat sales house price index was first proposed by Bailey, Muth, and Nourse (1963) and its modified version was popularized

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<sup>4</sup> Real Estate Bank is a private provider of real estate price information

by the work of Case and Shiller (1987). Since the repeat sales index only uses data that involve houses which have been traded twice or more, there is a concern for sampling bias as well the inefficiency of data usage (Clapp and Giaccotto, 1992). This represents a severe constraint for developing a meaningful repeat sales house price index for Korean housing markets in which there has been only a short history of collecting transaction price data and therefore, the count of observations of repeat sales pairs is expected to be low.

A number of authors report that home owners have a tendency to overvalue their own houses. Kish and Lansing (1954) report that home owners overvalue their own houses by 4% compared with appraised values. Robins and West (1977) report that home owners overstate their own houses by 5% compared with appraised values and assessed values. Ihlanfeldt and Martinez-Vazquez (1986) report that home owners overstate by 16% compared with assessed values and sales prices predicted from hedonic regressions. Goodman and Ittner (1992) report that the average U.S. owner overestimates the value of his/her house price by 6%. DiPasquale and Somerville (1995) report that the owner-reported value series are always above the transaction price series. Similarly, Kiel and Zabel (1999) find that owners overvalue their houses by 5.1%. Sellers may influence real estate brokers to overstate the values of their houses just as sellers can influence appraisers. The influencing behavior by sellers is discussed by Levy and Schuck (2005) among others, who report that sellers influence appraisers in overvaluing their houses since sellers are the customers of the appraisers. They suggest that clients possess not only incentives, but also the ability to influence valuation outcomes. The valuation process is governed to a large extent by the client and provides sellers with an opportunity to exert their power over the appraisers.

The foregoing literature on the overvaluation of sellers suggests that home owners have a valuation of their own houses that is higher than those indicated by market prices. The literature on client influence on appraisers implicates that sellers can cause real estate brokers to overstate apartment prices. While there does not appear to be prior research on the behavior of broker quotes, there are some research that report the effect of broker participation on selling prices. For example, Jud and Frew (1986) report that real estate brokers obtain higher prices for the homes that they sell. Violand and Simon (2007) indicate that real estate brokers increase housing prices by 1.3% on average in France while Elder, Zumpano and Baryla (2000) report that brokers of buyers have no effect on home prices. These results are consistent with Hypotheses 1 and 2 that broker quotes exceed the actual sale prices.

A number of authors report that appraisers smooth house valuations. Diaz and Wolverton (1998) report evidence of appraisal smoothing and attribute the reduced variability of real estate return series to appraisers being influenced

by their own previous value estimates. According to Cole (1988), factoring past value estimates into current appraisal judgments as well as the influence of desired client outcome among others may contribute to appraisal smoothing.

Webb (1994) reports that appraisers tend to underestimate value in rising markets and overestimate value in falling markets. He has a view that smoothing arises from appraisers who rationally weigh previous value estimates against subsequent market information. Furthermore, Geltner (1993) develops an approach to recovering the underlying market returns from observable appraisal-based index returns by explicitly correcting for appraisal smoothing.

On the other hand, a few authors have indicated that appraisal smoothing does not generally occur. Chinloy, Cho and Megbolugbe (1997) report that appraisals are systematically about 2% higher than purchase data and large appraisal smoothing does not occur. Lai and Wang (1998) show that the use of appraisal-based data can result in a higher variance than that of true returns.

Clayton, Geltner and Hamilton (2001) suggest that the degree of smoothing implies an average lag of about three quarters at the individual appraisal level. They suggest that this is a rational action by the appraisers since as uncertainty on new information increases, less weight is rationally placed on the new information, and appraisers tend to rely more heavily on older data already used in previous appraisal reports or on such reports directly.

This suggests that as transaction volume decreases and as market uncertainty rises, brokers place a greater weight on past prices, resulting in a smoothed valuation time series. The degree of smoothing is expected to be greater as the uncertainty on new information increases. According to this view, the broker quotes are expected to be smoothed in a down market.

Broker behavior has been examined in a principal agent framework where sellers act as principals and brokers as their agents. Rutherford, Springer and Yavas (2005) report that they find agent-owned houses sell no faster than client-owned houses, but they sell at a price premium of about 4.5%. Levy and Schuck (2005) show that clients influence the valuations of appraisers.

We find support in the literature for using the transaction volume as an indicator of up/down markets in that there is a positive correlation between the house price and the transaction volume. Andrew and Meen (2003), Berkovee and Goodman (1996), Stein (1995), and Clayton, Miller and Peng (2009) among others, show that prices and trading volume move together in the housing market.

There are at least three reasons why broker quotes may overstate the true value of houses. First, since income from broker commission depends both on the transaction price and the overall market activity, brokers have an incentive to post higher quotes in order to turn bullish markets even more bullish and to prevent a sudden collapse of housing markets in a downturn. Furthermore, while brokers may have private incentives to inflate house prices in order to maximize commission income, sellers have private incentives to inflate house prices in order to maximize sale proceeds. The private incentives of brokers and sellers suggest that there may be positive valuation biases in broker quotes. Some even argue that the compensation scheme may matter (among others, see Munneke and Yavas, 2001; Rutherford, Springer and Yavas, 2001 and 2004; Yavas and Colwell, 1999).

The endowment effect as discussed by Kahneman, Knetsch and Thaler (1990, 1991) argues that the value of an object depends on ownership. The endowment effect suggests that sellers have overvaluation biases. In turn, the overvaluation biases of sellers may lead to overvaluation of brokers.

The strategic misrepresentation account, which DePaulo, Lanier and Davis (1983) propose, suggests that participants think that they are making opening offers much like starting positions in a negotiation rather than stating the true valuation of the goods, implying that sellers and brokers may post higher offering prices with a view to offer price concessions which will help close the sale.<sup>5</sup> If the broker agrees with the extent of the overvaluation by the seller, the broker will simply report the seller's quote. If the broker feels that the seller's quote is still too low, then the broker will raise it even further. Finally, if the broker feels that the seller's quote is excessive, the broker will try to convince the seller to reduce the quote. The overall effect is that the resulting broker quotes would tend to overstate the true asset values.

There are at least two reasons why there is price inflation in a broker quote, specifically in a down market. First, if brokers smooth prices over time, putting considerably greater weight on previous prices, the price decrease in broker quotes would tend to be less than the actual prices. Second, if brokers try to maintain prices in their local communities, the price decrease in broker quotes would tend to be less than the actual prices.

The private incentive of brokers, endowment effect of sellers and strategic misrepresentation of sellers suggest that price increases based on broker quotes tend to be exaggerated in up markets (Hypothesis 1). On the other hand, because of price smoothing and price maintenance effects, price drops are understated in broker quotes during down markets (Hypothesis 2).

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<sup>5</sup> For a comprehensive review of various applications of the bargaining theory, see Muthoo (2008).



There are two ways to construct a transaction price based house price index; one is based on the hedonic price model, and the other is based on the repeat sales price model. In order to construct a hedonic price model, one must have housing unit characteristics. However, in Korea, only basic housing unit characteristics are disclosed, which include the apartment complex name and the floor level of the unit. Therefore, we are constrained to building a repeat sales index, which we will compare with the two broker quote based apartment price indices; the Kookmin Bank apartment and Real Estate 114 apartment price indices.

### 3. Methodology

We explain below the methodology that we employ to construct the repeat sales apartment price index using data available from January 2006 to June 2008. In the repeat sales index estimation proposed by Bailey et al., time dummies are created for the entire estimation period. These time dummies enter the regression equation as explanatory variables where the dependent variable is the current period price relative to the price on the reference date. For a given pair of repeat sales of a given apartment, we assign to the time dummies, values of -1 for the first sale (or the start date), 1 for the subsequent sale (or the ending date), and 0 for any other period in between. Through regression of the price differences on these time dummies using all repeat sales pairs during the period, we obtain price indices for each period.

In this paper, we have modified the traditional repeat sales index estimation method to reflect an idiosyncrasy of the Korean apartment markets where apartments which are found in the same apartment complex, on the same floor with the same square footage, are considered essentially the same apartments from the pricing perspective. Here, we use very similar apartments rather than the same apartments to construct repeat sales pairs. This results in increasing the repeat sales pairs substantially, enabling us to construct a repeat sales index based on a very limited sample period over which transaction prices are available.

We explain briefly, the standard repeat sales index estimation below while a fuller explanation is found in Appendix B. We regress the natural logarithm of the ratio of the second to the first sale prices of each repeat sales pair on  $D_{i,t}$ , a series of time indicators which equal -1 (when first sale took place), +1 (when the second sale took place) or 0 (any other time).

$$\ln \frac{P_{i,t_2}}{P_{i,t_1}} = \sum_{t=1}^T \beta_t \cdot D_{i,t} + \ln \varepsilon_t \quad (1)$$

The estimated cumulative market return from time 0 to t is thus:

$$\hat{c} r_t = e^{\beta_t} - 1 \quad (2)$$

Finally, setting the index to 100 for time 0, which is January 2006 for our study, the index value for time  $t$  is:

$$P_t = 100 \times e^{\beta t} \quad (3)$$

Depending on the apartment size, the frequency of transactions may not reflect the true stock weight. Generally speaking, small apartments tend to trade more frequently than large apartments. Therefore, the repeat sales index may depend excessively on the price fluctuation of small apartments if size effect is not controlled. To remedy this problem, we weigh the repeat price indices using the stock weight of the medium-sized and the large apartments (larger than 62.8m<sup>2</sup>), and the small apartments (smaller than 62.8m<sup>2</sup>), by region as published by the Office of Statistics in 2005. While the Office of Statistics publishes statistics for the small, medium and large apartments, we group the medium-sized and large apartments together to estimate the apartment price index since there are not enough observations for the large apartments alone. Specifically, we have:

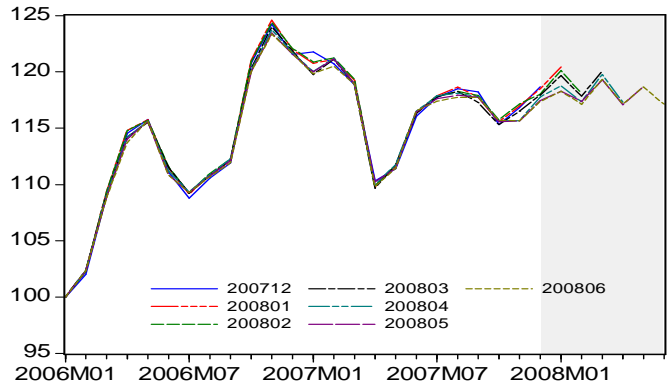
$$I_w = (W_s \times I_s) + (W_l \times I_l) \quad (4)$$

where  $I_w$  is the weighted repeat sales index;  $W_s$  is the proportion of the small apartments;  $I_s$  is the repeat sales index of the small apartment stock;  $W_l$  is the proportion of the large apartment stock, and the repeat sales index of the large apartment stock.

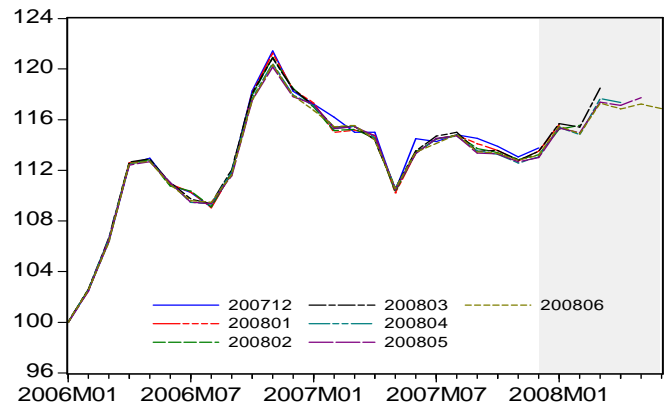
The quality difference of the same housing unit between two subsequent sales is not controlled for in using repeat sales transactions to calculate price changes over time. However, the quality difference of apartments between the two subsequent sales is expected to be limited since the sample period extends only for 30 months.

In the repeat sales house price index estimation method described above, the index values have the potential to change slightly from period to period as new transaction data are added in each period. We investigate the magnitude of the revision by estimating the index values using the data from January 2006 to December 2007, and then, re-estimating the index values every month thereafter until June 2008. As shown in Figure 1, our estimated price indices are stable over time. We find that the index values change very little for our sample as new data are added moving forward in time. The average magnitude of revision is less than 0.6%. This is comparable to the 0.5% reported for the Hong Kong University Real Estate Index Series (Chau, 2006).

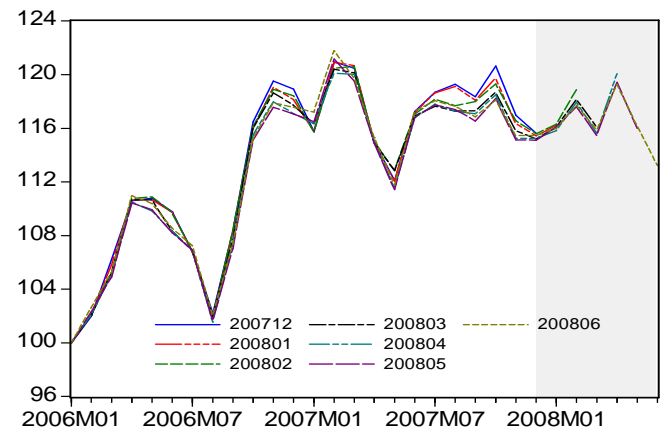
**Figure 1 Recursive Stability Test of Repeat Sales Apartment Price Index**



(a) Kangnam



(b) Seocho



(c) Songpa

We also control for the outliers, which are defined as repeat sales pairs that deviate significantly from the market price trend. In the original residential transaction database of the Korean Ministry of Land, Transport and Maritime Affairs, outliers are likely to be the result of data entry errors and the non-arm's length transactions.<sup>6</sup> Therefore, we detect few outliers in the sample. The price changes of repeat sales pairs range between -0.9 to 1.2. Most of the repeat sales pairs show price changes greater than -0.2 and less than 0.4. Even when we windsorize at 5%, removing observations of the top and bottom 5% of the sample, we find essentially, the same overall results.

#### 4. Data

We use the apartment sale prices, which the Ministry of Land, Transport and Maritime Affairs have began publishing on their website since January 2006, to construct the repeat sales index. Therefore, the study period extends from January 2006 to June 2008, giving 30 monthly observations. To study the broker quote based apartment price index, we use the Kookmin Bank apartment price index, which is the official price index in Korea and often used as the basis of loan collateral valuation. We analyze Kangnam, Seocho, and Songpa, which are three districts of the greater Kangnam submarket located in Seoul to the south of the Han River.<sup>7</sup> In most other submarkets, we have found that there are not enough repeat sales pairs to construct the repeat sales index.

We study Kangnam, Seocho, and Songpa, three of the most affluent districts of Seoul to the south of the Han River, in which apartment prices rose dramatically from about 2000 to about the end of 2006, leading to a debate on whether there was a bubble in the apartment prices there. These districts experienced a moderate decline in apartment prices since about 2007. The price run-up followed by a price downturn allows us to investigate the behavior of broker quotes during the up market as well as the down market.

The quality of the repeat sales house price index depends critically on the number of repeat sales pairs used for the regression estimations, which in turn, depends on the number of sales transactions. The analysis of the monthly counts of repeat sales pairs shows a considerable variation. The largest count of repeat sales pairs is 489 in October 2006 in Kangnam while the smallest count is 26 in February 2007 for Songpa. The average monthly count of repeat sales pairs is 119.

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<sup>6</sup> The non-arm's length transactions include the transfer of title as gifts to family members or a third party, or sale of properties to family members or a third party at a substantially discounted price before or after the death of the property owner.

<sup>7</sup> Kangnam, Seocho, and Songpa, are also known as Kangnam or three districts of Kangnam, while Kangnam literally means "to the south of the Han River".

## 5. Results

In order to test the hypotheses that: (1) the broker quotes are inflated over actual prices during an up market, and (2) during the down market, broker quotes overstate actual prices, we must first establish the periods of up markets and down markets. Table 1 shows the peaks and troughs of apartment prices, which are bold-faced and underlined, in accordance to the repeat sales index and the corresponding Kookmin Bank price index for all three districts. According to the repeat sales index, for Kangnam, Seocho and Songpa, the apartment price reaches a peak in November 2006.<sup>8</sup> This is consistent with the government efforts to curb the real estate speculation in these three districts which began to have measurable effects from about the end of 2006.<sup>9</sup>

In contrast, according to the Kookmin Bank apartment price index, the apartment prices in Kangnam, Seocho and Songpa reach their peak in January 2007, which lags the actual peak by two months and falls very modestly thereafter. Using the repeat sales apartment price index rather than the broker quote based apartment price index, we use November 2006 in subsequent analyses to divide the sample period into the subperiod for the up market and the subperiod for the down market for these three districts.

Figure 2 shows the Kookmin Bank, broker quote based, and repeat sales apartment price indices for all three districts. A comparison between the repeat sales and Kookmin Bank apartment price indices as shown in the figure for Kangnam indicates that during the house price run-up, both indices rise more or less together, showing a similar pattern. This result is apparently inconsistent with Hypothesis 1. The result for Kangnam, Seocho and Songpa may be caused by the fact that even when brokers have incentives to post their optimistic views on the market prices, which are likely to be heavily influenced by the offering prices of sellers, their optimism is tempered because of the high level of transactions, which reveal the market prices. On the other hand, during the down market, the Kookmin Bank apartment price index shows very little price changes, hence supporting Hypothesis 2.

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<sup>8</sup> Within the big up market that extended from the January 2006 to November 2006, there is a short trough for three months from June 2006 to August 2006. Even within this small trough, we find that during the down market, broker quotes overstate transaction prices.

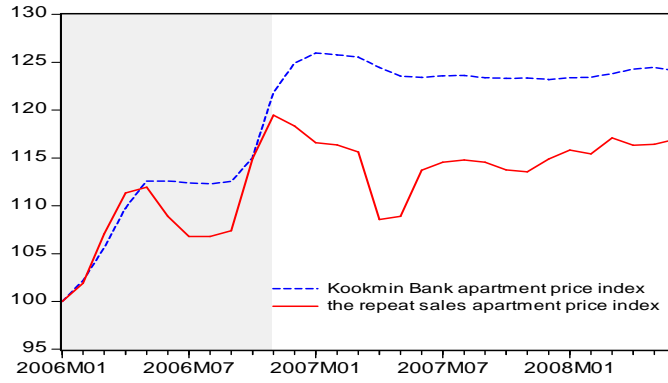
<sup>9</sup> In an attempt to slow down the rapid rise of apartment prices in the greater Kangnam submarket, the Korean government raised the capital gain tax for those owning three or more homes and reduced the loan-to-value ratio in the so-called 'bubble market' in October 2003 and August 2005.

**Table1 Peaks of Apartment Prices for the Three Districts of the Greater Kangnam Submarket**

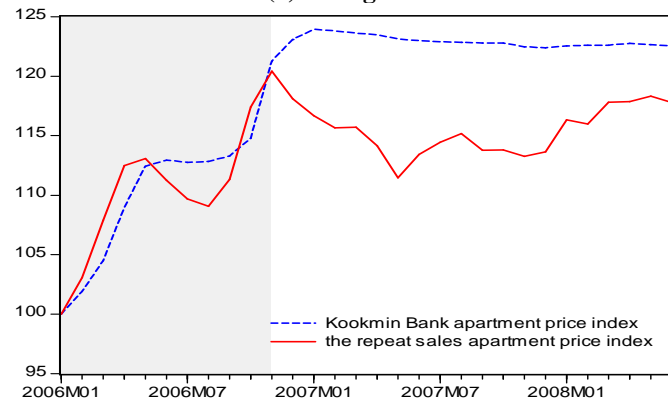
Year : Month	Kangnam		Seocho		Songpa	
	Kookmin Bank index	repeat sales index	Kookmin Bank index	repeat sales index	Kookmin Bank index	repeat sales index
2006:01	100.00	100.00	100.00	100.00	100.00	100.00
2006:02	102.16	101.89	101.90	103.09	101.47	102.59
2006:03	105.60	107.07	104.51	107.90	104.71	105.23
2006:04	109.74	111.34	108.92	112.48	107.36	111.33
2006:05	112.58	111.94	112.44	113.07	109.67	111.36
2006:06	112.60	108.92	112.94	111.25	110.17	109.14
2006:07	112.37	106.80	112.74	109.67	109.99	107.98
2006:08	112.29	106.78	112.82	109.08	109.47	102.21
2006:09	112.54	107.41	113.30	111.32	109.74	107.68
2006:10	115.03	114.96	114.76	117.40	112.36	116.07
2006:11	121.84	<b><u>119.46</u></b>	121.25	<b><u>120.42</u></b>	121.20	<b><u>120.09</u></b>
2006:12	124.93	118.32	123.07	118.10	123.46	118.66
2007:01	<b><u>125.97</u></b>	116.60	<b><u>123.94</u></b>	116.69	<b><u>125.01</u></b>	116.03
2007:02	125.77	116.35	123.80	115.65	124.90	122.82
2007:03	125.54	115.61	123.62	115.71	124.94	120.28
2007:04	124.45	108.57	123.48	114.14	124.37	115.42
2007:05	123.55	108.92	123.11	111.47	123.91	112.21
2007:06	123.40	113.71	122.97	113.42	123.61	116.79
2007:07	123.58	114.58	122.88	114.45	123.72	117.88
2007:08	123.61	114.79	122.82	115.17	123.75	117.01
2007:09	123.38	114.54	122.78	113.78	123.56	116.43
2007:10	123.32	113.76	122.77	113.81	123.19	116.83
2007:11	123.34	113.55	122.46	113.27	122.70	115.17
2007:12	123.20	114.90	122.37	113.64	122.35	115.48
2008:01	123.36	115.84	122.53	116.31	122.20	115.20
2008:02	123.43	115.42	122.58	115.98	122.07	117.73
2008:03	123.79	117.09	122.60	117.80	121.97	115.28
2008:04	124.27	116.34	122.74	117.86	122.05	117.79
2008:05	124.47	116.44	122.64	118.32	121.36	114.35
2008:06	124.08	116.97	122.53	117.79	120.63	111.80

Note: The peaks of apartment prices are bold-faced, italicized and underlined

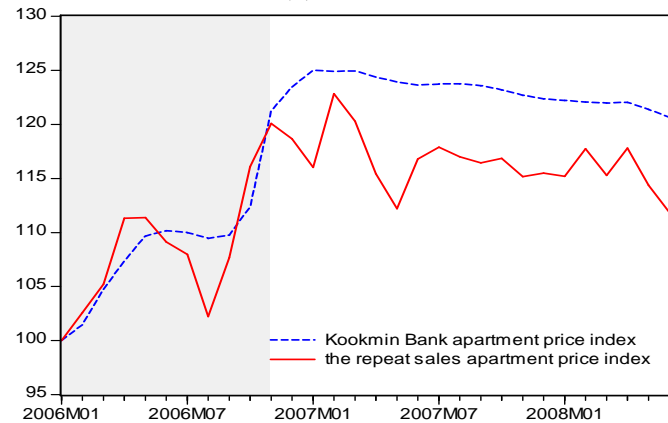
**Figure 2 Broker Quote Based Apartment Price Index and Repeat Sales Apartment Price Index**



**(a) Kangnam**



**(b) Seocho**



**(c) Songpa**

**Dotted line:** Kookmin Bank apartment price index;  
**Solid line:** repeat sales apartment price index.

A considerable degree of variability in apartment prices is found in the repeat sales index and price variability in the broker quote based indices is very limited. The limited price fluctuation observed in the Kookmin Bank price index is puzzling because the variability in apartment prices is expected to be considerable since the price is a result of the pricing process where it is determined by supply and demand, and the negotiation between sellers and buyers. Furthermore, the variability in apartment prices is expected to be larger than that observed for most other goods for which standard or government suggested prices exist.

This observed smoothness in the Kookmin Bank apartment price index is consistent with the smoothing hypothesis discussed for the valuation time series of the appraisers, which holds that appraisers place greater weight on past than current prices, especially when the current price information is less reliable. The smoothing hypothesis, however, does not rule out the possibility that brokers have private incentives to maintain the prices, thus overstating the prices in down markets. This is likely to reflect the fact that during the downturn, transaction prices which actually go down are not fully reflected in the Kookmin apartment price index in which brokers tend to report valuations of sellers in the online survey.

To shed light on the effect of the transaction volume on broker quotes, we examine the transaction volumes in these markets. In Table 2, we show transaction volumes in both up markets and down markets where they are measured by using the monthly counts of transactions. We find that in the three districts, the trading volumes in up markets are much higher than those in down markets. For example, the monthly average transaction volume in Kangnam is 595 in an up market while it is 239 in a down market. The mean difference in the transaction volume is 356, which is statistically significant. Therefore, we conclude that Kangnam, Seocho and Songpa trade more actively in up markets than down markets. This result supports the use of the repeat sales index in identifying down markets and up markets.

The price and volume correlation in the residential market noted above has been reported by a number of studies, including Clayton, Miller and Peng (2008) by using a city level analysis, and Cho, Kim and Shilling (2007) by using aggregate data on the Korean market. Furthermore, using transaction level data, Leung, Lau and Leong (2002), and Leung and Feng (2005) show that in the residential market, the volume leads the transaction prices. Our finding where the trading volume in the “up” market is greater than in the “down” market is consistent with their result.



**Table 2** Average Monthly Transaction Volumes for Both the Down Market and the Up Market

Districts	Mean		Mean Difference
	Up Market	Down Market	
Kangnam	595	239	356(4.31) <sup>a</sup>
Seocho	433	167	266(4.45) <sup>a</sup>
Songpa	576	222	354(4.02) <sup>a</sup>

<sup>a</sup> denotes significance at the 1% level.

**Notes:** The entire sample period is from 2006:01 to 2008:06. The up market is for 2006:01-2006:11 and the down market is for 2006:12-2008:06.

In Table 3, we estimate the percent difference between the broker quotes and the actual apartment prices. As shown in Panel A, we first estimate the difference between the broker quotes and the actual apartment prices on the reference date, which is January 2006. The price differences are not statistically significant. Therefore, both the repeat sales apartment price index, which measures actual prices, and the Kookmin bank apartment price index, which measures broker quotes, start at 100.00 on January 2006. That is, we do not adjust the price indices on the reference date by adding these differences and recalculating the rest of the price indices time series in each subperiod in each submarket. Finally, we calculate the percent difference between the indices in each subperiod in each submarket as shown in Panel B.

We find that during the up market, the differences are modest for any of the three districts. It appears that the upward bias of broker quotes is modest during the up market when trading volumes are high. On the other hand, the differences are substantial for all three districts during the down market; 8.07% for Kangnam, 6.52% for Seocho, and 5.75% for Songpa.

Now, we examine the influence of the market cycle on the gap between the broker quotes and the transaction prices using a regression analysis. Since the transaction volume appears to influence the gap between the broker quotes and the transaction prices, we regress the gap between the broker quotes and the transaction prices on the transaction volume as well as the down market dummy. As expected, we find that the transaction volume has a negative influence on the gap between the broker quotes and the transaction prices. However, we find that overpricing by the brokers is still positive and significant during the down market even after controlling for the transaction volume. Therefore, the upward bias of broker quotes appears to be greater in a down market than in an up market.

**Table 3 Univariate Tests of the Difference between Broker Quotes and Actual Sale Prices**

<b>Panel A.</b> Univariate Tests of the Percent Difference between Broker Quotes and Actual sale prices on the reference date (January, 2006)				
Districts	Observations	Difference (%)	<i>t</i> -statistics	<i>p</i> -value
Kangnam	89	-0.71	-1.082	0.281
Seocho	54	0.60	0.430	0.668
Songpa	59	1.86	0.975	0.334
<b>Panel B.</b> Univariate Tests of the Percent Difference between the Kookmin Bank Index and the Repeat Sales Index				
Districts	Periods	Observations	Difference (%)	<i>t</i> -statistics
Kangnam	up market	11	1.69	2.22 <sup>b</sup>
	down market	19	8.07	16.95 <sup>a</sup>
Seocho	up market	11	0.00	0.00
	down market	19	6.52	15.91 <sup>a</sup>
Songpa	up market	11	0.26	0.24
	down market	19	5.75	13.57 <sup>a</sup>

<sup>a</sup> denotes significance at the 1% level.

<sup>b</sup> denotes significance at the 5% level.

**Notes:** The up market is for 2006:01-2006:11 and the down market is for 2006:12-2008:06. In Panel A, the percent differences are differences between the broker quotes and actual prices divided by actual prices where actual prices are the transaction prices available from the Ministry of Land, Transport and Maritime Affairs and broker quotes are apartment prices reported by brokers polled by the Kookmin Bank as found on the Kookmin Bank website. The null hypothesis is that the difference is zero. In Panel B, the percent differences are differences between the Kookmin Bank index and the repeat sales index divided by the repeat sales index where both indices start at 100.00 on January 2006. In Panel B, the null hypothesis is that the mean percent difference is zero.

One explanation is that brokers attempt to prevent a rapid fall in house prices, which may cause the market to contract drastically, by maintaining prices in a down market. A rapid fall in house prices may cause the residential market to contract drastically, which reduces business opportunities of brokers. That is, brokers do not want to send a negative signal by indicating actual market prices, which are going down. This may be due also to the fact that there is a great deal of pressure from sellers (or the local community) to support the local housing prices in a down market. An alternative explanation that does not involve the broker's role is that the transactions that occur in a down market tend to be distressed sales, which would show 'below market' prices.

**Table 4 Regression of the Gap between the Kookmin Bank Apartment Price Index and the Repeat Sales Apartment Price Index on the Market Cycle and the Transaction Volume**

Variable	Coefficient	t-statistic
constant	16.447	3.172 <sup>a</sup>
down market dummy	4.470	4.266 <sup>a</sup>
log of volume	-2.373	-2.867 <sup>a</sup>
R-squared	0.722	
adjusted R-squared	0.702	

<sup>a</sup> denotes significance at the 1% level.

**Notes:** The dependent variable is the difference between the Kookmin Bank apartment price index and the repeat sales index divided by the repeat sales index. The explanatory variables are the down market dummy and the log of transaction volume. The down market dummy takes the value of 1 for 2006:12-2008:06 and zero, otherwise.

Since broker quotes show only limited falls in prices in a down market, we investigate the responses to survey questions posed to brokers as to their assessment of the current market conditions. First, we use the monthly buyer's market response rate, which is the percentage of responses indicating the buyer's market. The data are from the Real Estate Market Sentiment Survey of the Kookmin Bank, which polls 3,400 real estate brokerages on a weekly and monthly basis. In the market trend study, polled brokers are expected to indicate the market condition either as buyer's markets, seller's markets, or neutral markets. We find that in the three districts of the greater Kangnam submarket, the monthly buyer's market response rate is higher during the down market than during the up market.

**Table 5 Differences in Broker Sentiment between the Up Market and Down Market**

Brokers' Response Rate	Mean		Mean Difference
	Up Market	Down Market	
Buyer's Market	0.35	0.46	-0.10(-2.53) <sup>b</sup>
Slow Market	0.76	0.91	-0.15(-4.09) <sup>a</sup>

<sup>a</sup> denotes significance at the 1% level.

<sup>b</sup> denotes significance at the 5% level.

**Notes:** The up market is for 2006:01-2006:11 and the down market is for 2006:12-2008:06. The null hypothesis is that the mean difference in the two qualitative responses of brokers, which are the buyer's market response rates and the slow market response rates, is zero between the up market and the down market. The buyer's market response rates and the slow market response rates are for the three districts combined. The t-statistics are inside the round brackets.

Next, we use the monthly slow market response rate, which is the percentage of responses indicating that the market is slow, as found in the Real Estate Market Sentiment Survey of the Kookmin Bank. The polled brokers are expected to indicate the market condition as being active, average or slow. We find that in the three districts, the monthly slow market response rate is higher during a down market than an up market. These two results suggest that broker responses to qualitative questions clearly indicate that housing markets are in a down turn while their price quotes tend to indicate prices are holding up. They also support the use of the repeat sales index to identify down markets or up markets as demonstrated in Table 1.

To see if the upward bias of broker quotes is greater in a down market than in an up market, we build regression models of the bias of broker quotes on alternative measures of the down market. The results are shown in Table 6. The bias in the broker quotes, which is the dependent variable of the regression equations, is measured by the difference between the Kookmin Bank apartment price index and the repeat sales index divided by the repeat sales index. We build three regression models where the explanatory variables are one of the three alternative measures of the down market, which are the monthly buyer's market response rate, the monthly slow market response rate and the monthly auction-appraisal ratio. We estimate the regression models where the t-statistics of the estimated coefficients are calculated using the Newey-West heteroskedasticity and the autocorrelation consistent standard error (Newey and West, 1987).

In Model A, we use the monthly buyer's market response rate as a measure of the down market. For all three districts, the coefficients of the monthly buyer's market response rates are positive and significant, which indicate that the positive bias of broker quotes is larger in a down market than in an up market. In Model B, we use the monthly slow market response rate. For Kangnam, Seocho and Songpa, the coefficients of the monthly slow market response rates are positive and significant, which indicate that the positive bias of broker quotes is larger in a down market than in an up market. In Model C, we use the auction-to-appraisal ratio to measure the positive bias of broker quotes. For Seocho and Songpa, the coefficients of the auction-to-appraisal ratios are negative and significant, which indicate that the positive bias of broker quotes is larger in a down market than in an up market. The results in Table 6 confirm the finding that the gap between the broker quotes and the transaction prices is greater in down markets than in up markets.

We also examine whether the broker quotes are smoothed, and if so, the nature of the smoothing. The difference in the coefficient of variation between the Kookmin Bank apartment price index and the repeat sales apartment price index is negligible during an up market while the coefficient of variation of the Kookmin Bank apartment price index is much smaller than that of the repeat sales apartment price index during the down market. Furthermore, the

coefficient of variation of the Kookmin Bank apartment price index is smaller during a down market than during an up market. Therefore, we conclude that broker quotes are more smoothed than transaction prices during a down market and broker quotes are more smoothed in a down market than in an up market.

**Table 6 Regression Models of the Difference between the Kookmin Bank Apartment Price Index and Repeat Sales Apartment Price Index on Market Condition Variables**

Models	Explanatory Variables	Kangnam	Seocho	Songpa
A	Buyer's Market Index	22.04 (2.86) <sup>a</sup>	22.99 (3.05) <sup>a</sup>	19.16 (2.94) <sup>a</sup>
B	Slow Market Index	26.53 (3.34) <sup>a</sup>	28.07 (3.69) <sup>a</sup>	23.09 (4.64) <sup>a</sup>
C	Auction-appraisal Ratio	-2.76 (-0.16)	-24.21 (-3.45) <sup>a</sup>	-10.29 (-2.35) <sup>b</sup>

<sup>a</sup> denotes significance at the 1% level.

<sup>b</sup> denotes significance at the 5% level.

**Notes:** The dependent variable is the difference between the Kookmin Bank apartment price index and the repeat sales apartment price index divided by the repeat sales index. The explanatory variables are the monthly buyer's market response rate, the monthly slow market response rate and the monthly auction-appraisal ratio for Models A through C, respectively. The monthly buyer's market response rate is the percentage of responses indicating the buyer's market. The monthly slow market response rate is the percentage of responses indicating a slow market. The auction-to-appraisal ratio is the ratio of the auction sale price to the appraisal value. The t-statistics are shown in the round brackets, using Newey-West heteroskedasticity and autocorrelation consistent standard errors.

In Table 1, we have already established that the peak in the broker quotes lags behind the transaction prices by about two months. Here, we examine the smoothing effect on broker quotes compared to that on transaction prices by estimating autoregressive models (AR) where broker quotes are regressed on their lagged values. We report the regression estimates on AR (4) models. First, we conduct the augmented Dickey-Fuller unit root tests on the Kookmin Bank and repeat sale apartment price indices. As shown in Table 8, the results show that the Kookmin Bank apartment price indices in all three districts have two unit roots; that is, they are I (2) processes. The fact that even the first difference of the price index time series has a unit root suggests that the Kookmin Bank apartment price index is influenced greatly by previous prices, thus the smoothing effect must be very large. On the other hand, the repeat sales apartment price index in Kangnam and Songpa has one unit root. Furthermore, the repeat sales apartment price index in Seocho does not have a unit root; that is, it is stationary.

**Table 7 Comparison of the Coefficients of Variation in the Kookmin Bank Apartment Price Index and Repeat Sales Price Index**

Index	Up Market(A)	Down Market(B)	Difference(A-B)
<b>Panel A. Kangnam</b>			
Koomin Bank Index(C)	0.055	0.007	0.048
Repeat Sales Index(D)	0.051	0.022	0.029
Difference(C-D)	0.004	-0.015	
<b>Panel B. Seocho</b>			
Koomin Bank Index(C)	0.056	0.004	0.052
Repeat Sales Index(D)	0.052	0.017	0.035
Difference(C-D)	0.004	-0.013	
<b>Panel C. Songpa</b>			
Koomin Bank Index(C)	0.052	0.010	0.042
Repeat Sales Index(D)	0.056	0.022	0.034
Difference(C-D)	-0.004	-0.012	

**Note:** The up market is for 2006:01-2006:11 and down market for 2006:12-2008:06.

**Table 8 Augmented Dickey-Fuller Unit Root Test Results**

Variable	Levels	Difference		Inferred Order of Integration
		First	Second	
<b>Panel A. Koomin Bank Index</b>				
Kangnam	-2.24 (T)	-2.85 (T)	-4.81 (C) <sup>a</sup>	I(2)
Seocho	-2.41 (T)	-3.38 (T)	-5.64 (C) <sup>a</sup>	I(2)
Songpa	-1.70 (T)	-3.39 (T)	-6.01 (C) <sup>a</sup>	I(2)
<b>Panel B. Repeat Sales Index</b>				
Kangnam	-2.73 (T)	-4.63 (C) <sup>a</sup>		I(1)
Seocho	-4.19 (C) <sup>b</sup>			I(0)
Songpa	-2.71 (T)	-4.56 (C) <sup>a</sup>		I(1)

<sup>a</sup> denotes significance at the 1% level.

<sup>b</sup> denotes significance at the 5% level.

**Notes:** The augmented Dickey-Fuller test statistics are shown in the null hypothesis in the table. The series are not stationary. T indicates the test regression includes a time trend and a constant, and C indicates the test regression includes only a constant.

In order to compare the smoothing effects of the two price indices, we estimate the AR (4) models of the first difference of each price index. As shown in Table 9, the coefficient of AR (1) of the Kookmin Bank apartment index is highly significant, with 0.70 in Kangnam, 0.41 in Seocho and 0.51 in Songpa, which are very large indeed. However, the coefficient of the AR

terms of the repeat sales apartment index is not statistically significant and their absolute values are small as well. There is even an indication of reversal in the first difference of the repeat sales apartment price index in Kangnam with the coefficients of AR (2) and AR (4) being negative and significant. We conclude that broker quotes are far more smoothed compared to transaction prices. This result is consistent with the observation that in a down market, broker quotes show far less price reduction than transaction prices. It is also consistent with the observation made in Table 1 that the broker quotes reach a turning point by about two months later than the transaction prices.

**Table 9 Auto-Regressive (AR) Regression Model Estimation of the Kookmin Bank Index and Repeat Sales Index**

Districts	Variables	Kookmin Bank Index		Repeat Sales Index	
		Coefficient	<i>t</i> -statistic	Coefficient	<i>t</i> -statistic
Kangnam	AR(1)	0.70	(3.14) <sup>a</sup>	0.35	(1.70)
	AR(2)	-0.18	(-0.66)	-0.56	(-2.58) <sup>a</sup>
	AR(3)	-0.12	(-0.44)	0.13	(0.62)
	AR(4)	0.03	(0.12)	-0.37	(-1.93) <sup>b</sup>
	Constant	0.72	(1.43)	0.33	(1.02)
	Log likelihood	-41.18		-54.13	
Seocho	AR(1)	0.41	(1.88) <sup>c</sup>	0.29	(1.28)
	AR(2)	-0.04	(-0.18)	-0.22	(-1.01)
	AR(3)	-0.11	(-0.50)	-0.24	(-1.12)
	AR(4)	-0.03	(-0.16)	-0.08	(-0.40)
	Constant	0.43	(1.16)	0.32	(1.11)
	Log likelihood	-40.17		-47.13	
Songpa	AR(1)	0.51	(2.28) <sup>b</sup>	0.02	(0.08)
	AR(2)	0.01	(0.04)	-0.29	(-1.34)
	AR(3)	-0.22	(-0.91)	-0.24	(-1.14)
	AR(4)	0.03	(0.16)	0.02	(0.11)
	Constant	0.44	(0.78)	0.18	(0.36)
	Log likelihood	-47.71		-64.88	

<sup>a</sup> denotes significance at the 1% level.

<sup>b</sup> denotes significance at the 5% level.

<sup>c</sup> denotes significance at the 10% level.

Finally, we use the apartment price index which is compiled by Real Estate 114. We find that the Real Estate 114 apartment price index behaves qualitatively similar to the Kookmin Bank apartment price index. While unreported as a table, we document that the upward bias of broker quotes exhibited by the Real Estate 114 apartment price index is even greater than

that shown by the Kookmin Bank. It also shows a greater upward bias during a down market than during an up market.

## 6. Conclusion

We have examined the behavior of broker quotes in Korean housing markets. Even though the actual transaction prices has only become publicly available since January 2006 and a repeat sales house price index is still not available in Korea, price discovery does not appear to be difficult for housing market participants in Korea where transactions are routinely conducted based on broker quotes. Typically, markets tend to be liquid and transaction costs tend to be low.

Broker quotes may differ from actual prices depending on the housing market conditions. Specifically, we have tested the following hypotheses: (1) price changes will be exaggerated when measured by using broker quotes in bullish housing markets; and (2) in a down market, broker quotes show far less price reduction than transaction prices. Using the transaction prices collected from January 2006 to June 2008, we have constructed repeat sales apartment price indices for three districts in Seoul and compared them with the broker quote based price indices.

In this paper, we have modified the traditional repeat sales index estimation method to reflect an idiosyncrasy of the Korean apartment markets where apartments in the same apartment complex, on the same floor with the same square footage, are very similar so that they are practically the “same” apartments. Here we use ‘very similar’ apartments rather than the same apartments to construct repeat sales pairs. The substantial increase in repeat sales pairs enables us to construct a repeat sales index based on a very limited sample period over which transaction prices are available.

We have documented only a modest price inflation in broker quotes during the up market in the greater Kangnam submarket. The price inflation in up markets has the potential to exacerbate speculation and bubble price formation, which can lead to a greater market disruption in its aftermath. It appears that the actual price inflation appears to be moderated by market transparency that results from high transaction volume in an up market.

We find that indeed in a down market, the broker quote based price index shows far less price reduction than the repeat sales price index (5.75%-8.07%). It appears that in a down market, brokers have a strong incentive to use asking prices of sellers as their market quotes, which are likely to be well above the actual transaction prices in an attempt to induce an “orderly” drop in the market prices. We have documented this type of distortion of the market prices induced by broker quotes in the greater Kangnam submarket, an



affluent submarket in Seoul where a rapid price escalation from 1998 to 2006 was followed by a drop in prices from about the end of 2006. Furthermore, the gap between the broker quotes and the transaction prices is greater during a down market than during an up market even after controlling for the negative effect of the transaction volume on price inflation in broker quotes.

We find that while broker quotes suggest that the market has not entered into a down turn, broker sentiment measures show that brokers believe that the market has indeed entered a downturn. We have also documented that the broker quote based index reaches its peak about two months after the peak of the repeat sales based index. Finally, broker quotes are smoothed compared to transaction prices and smoothed more in a down market than in an up market.

In summary, we find that: (1) the price inflation in broker quotes is modest at most in an up market where transaction volumes are high; and (2) in a down market, broker quotes show far less price reduction than transaction prices. Our findings are consistent with the hypotheses on broker commission maximization, seller endowment effect, seller strategic misrepresentation and broker quote smoothing.

The optimism in broker quotes that is shown as an upward bias has the potential to distort apartment prices in down markets. The price inflation of broker quotes during a down market documented in this study points to a potential systemic risk of the financial markets in that it leads to the overvaluation of housing assets underlying mortgage loans. On the other hand, a potential benefit of broker quotes is to maintain the orderly fall in the house prices in a down market. We also note that broker quotes may facilitate price discovery in a market where transaction data are not publicly available. In this sense, the transaction based house price index and the broker quoted based index may complement each other.

Cho, Kim and Shilling (2007) emphasize that the behaviors of the submarkets are different across the Han River. Our study limits itself to the empirical investigation of Kangnam, Seocho and Songpa, three affluent districts to the south of the Han River, because it is only in these districts that we find a large enough number of repeat sales pairs to be able to estimate the repeat sales price index. The other reason is that it is only in these three districts that we observe a well defined up market followed by a well defined down market. However, in future studies, a careful examination of broker quotes in other submarkets, including those to the north of the Han River, would provide further details on the issue of broker quote "optimism".

Our study uses a post-2006 period when transaction price data are made available. As a result, from a time series econometric standpoint, our study is based on a rather short period and could suffer from small sample bias (Hsiao, 2003). Finally, if we could repeat our analysis on office markets or

commercial real estate in general, we could compare our analysis with the series by Leung, Lau and Leong (2002), and Leung and Feng (2005), and see whether a difference exists between residential and commercial properties. Unfortunately, the transaction price data for the Korean office markets as well as commercial real-estates are typically not publicly available. Therefore, these extensions are left for future studies.

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## Appendix A: Computational Methodology of the Kookmin Bank Apartment Price Index

Up until now, participants in the Korean residential markets have depended on the indices based on the Lasperyes formula where the apartment price index is a value weighted average of the price appreciation ratios of sampled apartments at the time of measurement. The computational method is identical to that of the standard composite stock price index, i.e., the Korean Composite Stock Price Index (KOSPI).

Prices are based on broker quotes and not sale prices because there is a lack of sale price information until January 2006. The most representative broker quote based apartment price index is that of the Kookmin Bank, which is based on price quotes from 15,672 brokers. In order to reflect the change in the composition of the apartment stocks, it is adjusted every 5 years following the population and housing census published every five years by the Office of Statistics. While the standard composite stock price index method is relatively easy to implement and readily applicable to a variety of submarkets and regions, it can produce a misleading index if it is not adjusted for the quality change of the housing stock between the reference date and the date of valuation. Since it is value weighted, the price changes of the more expensive apartments have a greater influence on the apartment price index than those of less expensive apartments. Specifically, Kookmin Bank follows the following weighting processes to arrive at the index. The computation of the index of the submarket market  $h$  and the apartment type  $I$  is as follows:

$$\hat{\theta}_{hi} = \frac{\sum_{j=1}^{n_{hij}} d_{hij} r_{hij}}{\sum_{j=1}^{n_{hi}} d_{hij}} \quad (\text{A-1})$$

where  $r_{hij}$  the ratio of the house price at time  $t$  to the house price at reference time of the sampled housing unit  $j$  in the submarket  $h$  and the housing type  $i$ ;  $d_{hij}$  is the value weight of the sampled housing unit  $j$  in the submarket  $h$  and the housing type  $i$  at time  $t$ ; and  $n_{hij}$  is the number of the sampled housing units in the submarket  $h$  and the housing type  $i$  at time  $t$ . Next, the computation of the index of the submarket market  $h$  is as follows:

$$\hat{\theta}_h = \sum_{i=1}^{\delta} W_{hi} \hat{\theta}_{hi} \quad (\text{A-2})$$

where  $\delta = 1, 2$  and  $3$  depending on whether the housing type is a detached house, a housing unit in a low-rise apartment complex or an apartment, which is a housing unit in a high-rise apartment complex.

### Appendix B: Computational Methodology of the Repeat Sales Apartment Price Index

We explain briefly the standard repeat sales index estimation method. Let  $r_t$  be the single period return of a portfolio of property assets from time  $t-1$  to  $t$  ( $t=0, \dots, T$ ) and  $P_t$  be the portfolio price at time  $t$ . By definition, the gross return,  $1+r_t$ , is the ratio of portfolio prices in two consecutive periods:

$$\frac{P_1}{P_0} = 1 + r_1, \frac{P_2}{P_1} = 1 + r_2, \dots, \frac{P_t}{P_{t-1}} = 1 + r_t \quad (\text{B-1})$$

The return defined here captures price changes before the deduction of any transaction cost.

For multiple periods, the price ratio from time 0 to  $t$  can be written as the product of a series of gross returns:

$$\frac{P_t}{P_0} = (1 + r_1)(1 + r_2) \dots (1 + r_t) \quad (\text{B-2})$$

Or simply: 
$$\frac{P_t}{P_0} = 1 + cr_t \quad (\text{B-3})$$

where  $cr_t$  is the cumulative return of the property portfolio from time 0 to  $t$ , with  $cr_0 = 0$ . It follows from (B-1) that for any two periods,  $t_1$  and  $t_2$  (where  $T \geq t_2 > t_1 \geq 0$ ), the gross cumulative return is:

$$\frac{P_{t_2}}{P_{t_1}} = \frac{1 + cr_{t_2}}{1 + cr_{t_1}} \quad (\text{B-4})$$

Subtracting 1 from both sides of the equation gives the cumulative return from  $t_1$  to  $t_2$ .

To estimate a property price index, we implement a regression-based approach as proposed by Bailey et al., where we use information embedded in returns of varying holding periods. Suppose that there are  $N$  properties, each of which is transacted twice between time 0 and  $T$ . Let  $t_1$  be the time of first sale and  $t_2$  the time of the second sale. The properties are neither restricted to have the same holding period nor the same transaction dates as in (B-4). Assume for any property  $i$  ( $i = 1, \dots, N$ ), the cumulative return between its first and second sales is made up of two multiplicative, uncorrelated components: the property market return and the idiosyncratic return,  $\varepsilon_i$ :

$$\frac{P_{i,t_2}}{P_{i,t_1}} = \frac{1 + cr_{t_2}}{1 + cr_{t_1}} \times \varepsilon_i \quad (\text{B-5})$$

If the repeat transactions span the whole period from time 0 to T, (B-5) can be expressed more generally in terms of a series of gross cumulative returns:

$$\frac{P_{i,t_2}}{P_{i,t_1}} = (1 + cr_1)^{D_{i,1}} (1 + cr_2)^{D_{i,2}} \dots (1 + cr_t)^{D_{i,t}} \varepsilon_i \quad (\text{B-6})$$

where  $D_{i,t}$  is a time indicator which equals  $-1$  if  $t$  is equal to  $t_1$ ,  $+1$  if  $t_2$ , and  $0$  otherwise. Taking the natural logarithm of both sides and making the assumption that  $\ln \varepsilon_i$  is a random noise with zero mean and constant variance, (B-6) becomes a linear regression model, which can be estimated using the ordinary least squares method:

$$\ln \frac{P_{i,t_2}}{P_{i,t_1}} = \sum_{t=1}^T \ln(1 + cr_t) \cdot D_{i,t} + \ln \varepsilon_i \quad (\text{B-7})$$

where the dependent variable is the natural logarithm of the ratio of the second to the first sale prices of each repeat sales pair. The independent variable,  $D_{i,t}$ , is a series of time indicators which equal  $-1$  (when first sale took place),  $+1$  (when the second sale took place) or  $0$  (any other time).

We can rewrite Equation (B-7) as follows:

$$\ln \frac{P_{i,t_2}}{P_{i,t_1}} = \sum_{t=1}^T \beta_t \cdot D_{i,t} + \ln \varepsilon_i \quad (\text{B-8})$$

Equation (B-8) is the repeat sales model developed by Bailey et al. Given N pairs of transaction prices and dates, the coefficients of the time dummies can be estimated. The estimated cumulative market return from time 0 to  $t$  is thus:

$$\hat{c} r_t = e^{\beta_t} - 1 \quad (\text{B-9})$$

Finally, setting the index to 100 for time 0, which is January 2006 for our study, the index value for time  $t$  is:

$$P_t = 100 \times e^{\beta_t} \quad (\text{B-10})$$



**Appendix C: Data Descriptions and Sources**

<b>Variables</b>	<b>Explanations</b>	<b>Sources</b>
Kookmin Bank index	apartment price index published by Kookmin Bank	Kookmin Bank website ( <a href="http://est.kbstar.com/">http://est.kbstar.com/</a> )
Real Estate 114 index	apartment price index compiled by Real Estate 114	Real Estate 114
broker house price quotes from Kookmin Bank	house prices quoted by the real estate brokers polled by Kookmin Bank	Kookmin Bank website ( <a href="http://est.kbstar.com/">http://est.kbstar.com/</a> )
actual sale prices	used for the repeat sale index as well as comparison with the broker quotes	Ministry of Land Transport and Maritime Affairs website ( <a href="http://rt.mltm.go.kr/">http://rt.mltm.go.kr/</a> )
buyer's market index	monthly buyer's market response rate	Kookmin Bank website ( <a href="http://est.kbstar.com/">http://est.kbstar.com/</a> )
slow market index	monthly slow market response rate	Kookmin Bank website ( <a href="http://est.kbstar.com/">http://est.kbstar.com/</a> )
auction-to-appraisal ratio	auction price to appraisal value ratio	Good Auction website ( <a href="http://www.goodauction.co.kr/">http://www.goodauction.co.kr/</a> )
transaction volume	the monthly counts of transactions	Ministry of Land, Transport and Maritime Affairs website ( <a href="http://rt.mltm.go.kr/">http://rt.mltm.go.kr/</a> )