A PRELIMINARY INVESTIGATION INTO THE DEVELOPMENT OF HOUSE PRICE INDICES FOR BARBADOS

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ABSTRACT

The developments in Barbados' real estate values and its impact on consumers and the macro economy have received a significant amount of attention is social, economic and political debates. Despite the importance of this issue, no private or public agency has developed any mechanism to monitor or track a house price index for the nation. In this regard, the authors make the first step in outlining the construction of a house price index by estimating a hedonic price index model and a median sales price index. While the latter may be easier to construct, it does not take into account the heterogeneity of properties, unlike the former approach which can account for changes in quality. In addition, questions relating to the impact of structural characteristics, neighbourhood effects and location on real estate values were also addressed. The results indicate that property size, the number of bedrooms and location are the most significant factors that influence the values of property.

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1. Introduction

The perceived escalation in house prices that has occurred over the last two decades has featured prominently in the daily papers. A search of the archives at NationNews.com reveals that since May 2005, 227 articles and commentaries have been written that included the phrase 'high land prices' and 320 that included the phrase 'high housing costs'. The issue of the rising land and house prices also featured prominently in the recently held elections. The October 2007 Nation/CADRES poll, which sought to identify the major issues that trouble Barbadians, identified housing as the most important constituency issue. Due to the link between house price developments and movements in aggregate demand, Girouard and Blöndal (2000) advocate monitoring developments in property markets as a useful input into the setting of economic policy.

Housing and land prices are important since they can have an important impact on access to housing as well as the macroeconomy. High real estate prices can restrict access to some types of properties to certain income groups and lead to social stratification (Conley, 2001). For those individuals that do own homes, an escalation in property values can fuel consumer spending, which could have implications for the financial sector, the external current account balance as well as government's fiscal balance (Case et al, 2000). Real estate prices are also important for better understanding the housing market. Previous research has utilised indices of housing prices to investigate the determinants of house prices (see Smith et al, 1988 for a survey of this literature).

Despite the importance of monitoring house price trends, no private or public agency either monitors or tracks a house price index for the nation. This study provides two possible approaches that can be employed to measure and track trends in house prices: the median house price and hedonic method. The median house price approach derives an index of house prices from the median price of some regularly available database. The hedonic approach, on the other hand, utilises regression techniques to identify whether the characteristics of some 'average' have increased in value over a particular review period.

The structure of the paper is as follows. Following the introduction, Section 2 provides a review of the previous empirical literature in the area. Section 3 outlines the methodological approach and databases employed to generate the house price indices for Barbados, while Section 4 provides the results and highlights the trends in recent house prices on the island. Section 5 concludes with a summary of the empirical research as well as a discussion of the shortcomings of the approaches identified in the study.

2. Literature Review

Since the theoretical application of the hedonic price model to the residential housing market by Rosen (1974), several authors have utilised this technique to construct house price indices and to determine the factors that influence property prices (Butler, 1982; Margo, 1996; Meese and Wallace, 1997; Kiel and Zabel, 2007). The basic interpretation of this theory is that property can be viewed as a bundle of functionally related attributes with no observable prices because they are not traded in open markets. The number of housing attributes can be large and vary from house to house. However, they are usually placed into two categories: structural and neighbourhood. Structural characteristics may consist of the number of rooms, square feet of living space, basement, garage and style of house, while neighbourhood attributes are defined by accessibility to employment areas, schools, parks, and the quality of the environment (Palmquist, 1980; Can, 1990).

In order to gauge the impact of a property's attributes on its value, the traditional approach dictates regressing property values on an OLS equation with its various attributes. The derived coefficients in this equation are estimations of the implicit prices (hedonic prices) of the attributes at the market clearing level, and provide the marginal contribution of each attribute (Can, 1990). This approach makes it possible to isolate changes in house prices from changes in property quality by providing quality-adjusted price indexes, and to investigate the main factors that influence the value of properties within a given dataset.

Despite the wide use of the hedonic price models, several of authors have criticised the traditional method for what they call its shortcomings. These issues were empirical in nature and included questions regarding the choice of housing characteristics to be used, the correct functional form of the hedonic equations, the existence of spatial dependence in the sample selected and specification issues (Can, 1990; Tse, 2002; Hui et al, 2007). As a result, many studies have attempted to resolve these issues leading to a wide variation in the methodology employed using the hedonic price theory.

In the traditional hedonic price function it is assumed that the structural characteristics of properties are fixed in their functional relationships across different neighbourhoods. Moreover, location characteristics are treated independently of housing characteristics, thus implying the same marginal contribution despite a change in geographic location. The assumption of no spatial variability in the price model does not take into account the important differences in value consumers place on the same attribute which can lead to over- or under-estimation of that attribute's implicit price. That is, an attribute in high demand in one part of a geographical space (urban area) would not have the same marginal contribution to property value in another location (rural) with significantly less demand for the same attribute Can (1990). In an attempt to incorporate the consequence of neighbourhood effects on property value, Can's (1990) abandoned the assumption of functional stability and utilised a more flexible approach. By allowing parameters to drift across space and taking into account spatial spillover effects, the author argued that this approach has lead to a more accurate estimation of the changes in urban house prices. One major finding in this study is that house prices in declining neighbourhoods increased by being located close to other high price homes, despite their structural characteristics. This highlights the importance of accounting for the differences in neighbourhood effects related to geographic location.

In addition to spatial variation resulting from differences in geographic locations, the issue of spatial dependence in datasets received a significant amount of attention in the literature (Tse, 2002; Can and Megbolugbe, 1997; Hui et al., 2007). According to Can (1990), spatial dependence is characterised by "the possible occurrence of interdependence among observations that are viewed in a geographic space, and violates the assumption of uncorrelated error terms in

model estimation." He argued that in the presence of spatial dependence, the traditional hedonic framework is of limited use in the analysis of house prices. Following an earlier study done by Can (1990, 1992), Can and Megbolugbe (1997) incorporated what they called adjacency effects into a spatial hedonic function. This effect was identified as spatial spillover effects that resulted from activities such as maintenance or repair that changes the market value of the property and any other change in value that cannot be attributed to house services. This results in spatial dependence or autocorrelation in the hedonic price model. The results suggest that when adjacency effects are accounted for, they were able to derive reliable price indices based on housing age, living space, and land area. Based on the results, this approach can be useful for large datasets with only a few variables – a common trend associated with data collection.

Tse (2002) also addressed the issue of spatial dependence in a stochastic approach. Rather than model autocorrelation through the error terms in the regression equation, this study models it through the constant term. Therefore, it allowed for the separation of location effects from the random disturbance in the model. When confronted with data from Hong Kong this approached reduced the sum-of-squared errors by 7 percent when compared to the traditional OLS technique. While the results are far from conclusive, the writers argued that this approach might be more flexible in the face of spatial dependence.

The use of geographical information systems (GIS) has been incorporated with spatial hedonic equations in an attempt reduce the difficulty associated with identifying the relevant housing attributes to include in the hedonic model. GIS technology allows researchers to position properties on a map based on their geographic location, thus providing a visual representation of the location variables needed for the analysis (Kong et al. 2007). One of the noted immediate benefits of a GIS system is that it provides the fast and efficient identification of explanatory variables critical to the analysis of the effects of location. This approached proved to be useful to the investigation of the impact of urban green spaces on house prices in Jinan City China (Kong et al., 2007). Urban green spaces in this study referred to three categories: parks, plazas and scenic forests. The results obtained in this study showed that higher accessibility to scenery forests, parks and plazas, schools and universities and increasing the number of green spaces in a neighbourhood enhances the value of properties. Similarly, Hui et al. (2007) incorporated a GIS

system with spatial effects to investigate the impact of neighbourhood and environmental effects on house prices. However, unlike previous authors this study focused on the unique setting of a densely populated high-rise environment in Hong Kong. To summarise the results it was found that the consumers in Hong Kong placed high value for various environmental amenities. One important finding in this study was noise level and house prices were positively related. The explanation for this finding is that, in the context of a high-rise environment, peace and quiet may be given up for the sake of convenience.

While several studies have tried to enhance the hedonic price model, few have adopted alternative approaches to determining house prices. Since the hedonic price model appears to be the preferred method, the results of these alternative approaches are often compared to the hedonic analysis. Selim (2008) employed an artificial neural network in an attempt to correct questions relating to the correctional form. This approach has the advantage of adapting to arbitrary or unknown functional forms with a certain degree of accuracy, thus, making it a more flexible approach to hedonic regression analysis. When compared to a semi-logarithmic hedonic form, ANN method proves to be more efficient in estimation of house prices. The hedonic analysis indicated that in Turkey the water system, type of house, pool, number of rooms, location characteristics, house size, and type of building are the most important variables that affect property prices. When the values of these variables were compared to the values predicted by the ANN approach, the results indicates that the predictive power of this method was more precise than the semi-logarithmic hedonic model.

Another alternative is the decision tree approach utilised by Gang-Zhi et al. (2006) to assess the relationship between house prices and house attributes in the Singapore real estate market. This non-parametric approach utilises pattern recognition in order to identify and isolate the important variables relative to house price analysis. The authors posited that this approach has the advantage of reducing classification and regression problems, making identification of important variables less difficult and it can be used to analyse linear and non-linear relationships between attributes and prices. In short, the results suggested that the structural attributes had a significant impact on house prices. The model was, however, unable to gauge the impact of location and neighbourhood effects because the limitations associated with sample selection. Despite its noted

advantages, the decision tree approach suffers from a few limitations, such as the inability to capture pure price changes to construct price indices, the difficulty in full analysis of independent variables and without an in-depth knowledge of statistical pattern knowledge makes it difficult to apply this approach.

3. Methodology

The main goal of this study is to outline and implement an approach to constructing house price indices for Barbados. One of the simplest and most popular approaches to constructing house price indices is to employ some measure of central tendency, such as the mean or median price, for the database on house prices (see for example Crone and Voith, 1992; Gatzlaff and Ling, 1994). Unfortunately, the median house price index does not effectively account for the heterogeneity of properties.

To account for the heterogeneity of properties, the study also employs Hedonic multivariate regressions. The hedonic approach attempts to measure how the price of a particular house varies with the attributes it possesses. To derive these estimates, the value for a particular property is regressed on the individual characteristics of the dwelling:

$$V = f(S, N, L, T) \tag{1}$$

where V is the value of the property, S are its structural characteristics, N is neighbourhood characteristics, L is location within the market and T is a dummy variable to indicate the time or period at which the value is observed.

The above expression is usually expressed in log-linear form:

$$\ln V_{it} = \alpha_i + \lambda_t + S_{it}^{'}\beta + N_{it}^{'}\delta + L_{it}^{'}\psi + \nu_{it} \tag{2}$$

where α_i and λ_t are the unobserved individual- and time-specific effects observed for property i and time period t, β, δ and ψ are the hedonic regression coefficients and ν_{it} is a remainder stochastic term. Malpezzi (2002) notes that the log-linear model have five main benefit over other linear or non-linear functional forms: (1) the value-added of each characteristics varies

proportionally with the size and quality of the house; (2) the coefficients have a simple interpretation; (3) it moderates the effects of heteroskedasticity; (4) they are computationally simple, and; (4) it is possible to build specification flexibility into the right-hand side using dummy variable indicators or splines.

The structural variables, S_{it}, used in this model are the number of rooms, area/size and structure type (land, houses, apartment/condos and town house). In addition to these structural characteristics the model also includes parish dummies to capture neighbourhood effects, N_{it}, while the location of the property within the market, L_{it}, is approximated by the realtor used to market the property.

In addition, to providing an assessment of the value-added of particular house characteristics, the hedonic model can also be employed to derive an index of house prices. The coefficients on the time dummies yield a price index for properties sold in Barbados, after controlling for differences in quality. In contrast, to the median house price index described earlier therefore, the house price index obtained from the hedonic regression model, takes explicit account of changes in the quality of properties sold over time.

This paper uses data for Barbados for the period May 2007 – April 2008, with a total number of 4584 properties. The observations were taken from Cariblist.com, which captures over 70 real estate agents in the island that cater to both the high- and low-end of the real estate market.

4. Results

4.1. Median House Price Approach

To provide an initial approach to deriving a house price index for Barbados, the median house price was obtained for each month for the sample period. The data obtained from the online property listing contained extensive information including the property type, real estate agent, the number of bedrooms, the square footage and address of the property as well the price. Table 2 provides the summary statistics for the database over the study period. The monthly mean of

land, house and apartment/condo prices were calculated excluding any extreme outliers that may cause inaccuracies. The monthly median of the three property types were also calculated and compared to the mean estimates since the median is less sensitive to extreme values and could be a better indicator the average prices.

Over the study period, the mean and median list price for houses as well as apartment/condos in the database was about $1.1 million, while the median land price was about $0.4 million. Prices for houses ranged from as low as $85,000 to as high as $96 million; while for land the lowest list price over the period was $52,000 and the highest $5 million. The three-month centred moving average median values for each property type are plotted in Figure 1. The figure suggests that the median list price for houses rose for much of 2007, but has fallen slightly in the first three months of 2008. In contrast, the median price for apartment/condos declined marginally over the sample period, while land prices have been relatively stagnant since May 2007.

A comparison of prices was also done across parishes. Table 1 compares the price of houses, land and apartment/condos in each parish. Statistics indicate over the period under examination, the most expensive houses, land as well as apartment/condos listed were all located in St. Thomas.

4.2 Hedonic Regression Approach

While the median house price approach is relatively simple to calculate and can provide a relatively accurate indication of real estate price trends, it does not take into account differences in the characteristics of properties. For example, suppose in a particular month a larger number of four bedroom houses are listed relative to prior months this could lead to significant jump in the median house price index even though the average prices of other properties, or for that matter four bedroom houses, has not changed significantly. To take account of changes in the characteristics of real estate properties, hedonic regression techniques can be employed.

Utilising the monthly observations on house prices, Equation (2) is estimated and coefficient estimates are reported in Table 2. The table also provides sub-sample regressions for land and

house prices only. The regression results suggest that the size of the property, number of bedrooms and location are the most important determinants of the list price of a house in Barbados. Of the parish location dummies, only those for Christ Church, St. James, St. John, St. Joseph, St. Michael and St. Peter were statistically significant. St. James had the largest location premium: a property located in this parish was estimated to have a list price approximately 52 percent more than that of the average property listed elsewhere in the island.

The model estimated using the full sample of data, however, was only able to explain approximately 14.4 percent of the variation in real estate prices in the island over the sample period. The low explanatory power of the model could possibly be due to heterogeneity in real estate price dynamics. As a result, Table 2 also provides the hedonic regression results for land and house prices. The explanatory power of the hedonic model rises to 83 percent while that for houses climbs to 58 percent. The main findings obtained earlier are, however, largely unchanged: the size and location of the property are the most important determinants of real estate prices, with St. James have the largest average premium for both property types.

The hedonic regression model was them employed to derive a house price index for the period May 2007 to April 2008. In an attempt to control for quality, mean log house prices were calculated using fixed values to represent a 5000 sq ft, 3-bedroom house of fixed location. Another point worth noting is that not all property-type coefficient estimates were available for each month. This paper addressed that issue by using the previous month's property-type coefficient estimate. The main assumption is that the estimated change in the property coefficient from the previous month would not be enough to have a significant influence on the results. Figure 2 plots the mean log price over the period of study. Similar to the results from the median house price index approach, Figure 2 suggests that mean listed house prices exhibited were relatively flat over the sample period. Beginning at a log price of 14.97 in June 2007, house prices fell to 13.92 by the end of December 2007, ending April 2008 at 13.97.

5. Conclusions

House price trends have been one of the most important issues to both policymakers and the average Barbadian in recent years. House price trends can impact on the cost of living, aggregate demand as well as income inequality. This study provides two possible approaches to measure and track trends in house prices. The median house price approach derives an index of house prices from the median house price of cariblist.com while the hedonic regression framework utilises regression techniques to identify whether the characteristics of some 'average' have increased in value over the particular review period.

Using the median house price approach, list prices for houses rose for much of 2007, but have fallen slightly in the first three months of 2008. In contrast, the median price for apartment/condos declined marginally over the sample period, while land prices have been relatively stagnant since May 2007. While the median house price approach is relatively simple to calculate and can provide a relatively accurate indication of real estate price trends, it does not take into account differences in the characteristics of properties. Utilising the monthly observations on house prices, the hedonic regression model suggest that the size of the property, number of bedrooms and location are the most important determinants of the list price of a house in Barbados. The hedonic regression model was them employed to derive a house price index for the period May 2007 to April 2008. Similar to the results from the median house price index approach, the mean listed house prices exhibited were relatively flat over the sample period.

The main purpose of this study was to explore the possibility of developing real estate price indices for Barbados. In conducting the study the authors encountered a number of challenges. One of the main challenges was that only a limited amount of information was collected on the characteristics of listed properties. Factors such as age, proximity to schools, shopping areas and the beach could all have a significant impact on real estate prices, but were not available. The regular collection of these and other characteristics of listed properties could greatly improve the accuracy and utility of the approaches highlighted in the paper. Unfortunately, data was only available for a relatively short time span. It would be interesting to see how the approaches track real estate price movements over a relatively longer period of time.

References

Crone, T.M. and Voith, R.P. (1992) "Estimating House Price Appreciation: A Comparison of Methods", *Journal of Housing Economics* 2: 339-357.

Butler, R.V. (1982) "The Specification of Hedonic Indexes for Urban Housing", *Journal of Land Economics* 58: 96-108.

Can, A. (1990) "The Measurement of Neighbourhood Dynamics in Urban House Prices", *Journal of Economic Geography* 66: 254-272.

Can, A. (1992) "Specification and Estimation of Hedonic Housing Price Models", *Regional Science and Urban Economics* 22: 453-474.

Can, A. and Megbolugbe, I. (1997) "Spatial Dependence and House Price Index Construction' *Journal of Real Estate Finance and Economics* 14: 203-222.

Fan, G., Ong, S.E. and Koh, H.C. (2006) "Determinants of House Price: A Decision Tree Approach", *Journal of Urban Studies* 43: 2301-2315.

Gatzlaff, D.H. and Ling, D.C. (1994) "Measuring Changes in Local House Prices: An Empirical Investigation of Alternative Methodologies", *Journal of Urban Economics* 35: 221-224.

Hui, E.C.M, Lilian Pun, C.C.K and Law, M.Y. (2007) "Measuring the Neighbourhood and Environmental Effects on Residential Property Value: Using Spatial Weighting Matrix' *Building and Environment* 42: 2333-2343.

Kiel, K.A. and Zabel, J.E. (2008) "Location, Location, Location: The 3L Approach to House Price Determination", *Journal of Housing Economics* xxx: xxx-xxx.

Kong, F., Yin, H. and Nakagoshi, N. (2007) “Using GIS and Landscape Metrics in the Hedonic Price Modeling of the Amenity Value of Urban Green Space: A Case Study in Jinan City, China”, *Landscape and Urban Planning* 79: 240-252.

Malpezzi, S. (2002) “Hedonic Pricing Models: A Selective and Applied Review”, in Gibb, K. and O’Sullivan, A. (eds), *Housing Economics: Essays in Honour of Duncan Maclennan,* Blackwell Publishing, UK: 67-89.

Margo, R.A. (1996) “The Rental Price of Housing in New York City”, *The Journal of Economic History* 56: 605-625.

Meese, R.A. and Wallace, N.E. (1997) “The Construction of Residential Housing Price Indices: A Comparison of Repeat Sales, Hedonic-Regression, and Hybrid Approaches’ *Journal of Real Estate Finance and Economics* 14: 51-73.

Palmquist, R.B. (1980) “Alternative Techniques for Developing Real Estate Indexes’ *The Review of Economics and Statistics* 62: 442-448.

Rosen, S. (1974) “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition”, *Journal of Political Economy* 82: 34-55.

Selim, H. (2008) “Determinants of House Prices in Turkey: Hedonic Regression versus Artificial Neural Network”, *Expert Systems with Applications*.

Tse, R.Y.C (2002) “Estimating Neighbourhood Effects in House Prices: Towards a New Hedonic Model Approach”, *Journal of Urban Studies* 39: 1165-xxx.

Table 1: Descriptive Statistics for Each Parish

	Ch. Ch.	St. Andrew	St. George	St. James	St. John	St. Joseph	St. Lucy	St. Michael	St. Peter	St. Philip	St. Thomas
Land											
Mean	170,672	220,145	383,489	425,790	641,460	707,842	540,727	687,629	1,167,580	1,768,038	8,388,382
Median	165,000	220,145	290,000	346,608	390,000	550,000	482,750	584,110	804,000	1,063,396	7,000,000
Maximum	215,000	286,125	950,000	1,200,000	2,600,000	1,400,000	1,100,000	1,585,000	3,100,000	6,250,000	28,000,000
Minimum	130,000	166,455	200,000	240,181	260,000	360,000	270,000	300,000	350,000	165,000	435,000
House											
Mean	673,109	766,667	800,208	1,251,042	1,597,000	1,408,611	1,198,750	1,731,250	2,295,909	3,323,542	6,716,818
Median	605,000	758,333	765,000	1,200,000	1,548,500	1,404,306	1,198,750	1,700,000	2,158,750	3,323,542	7,000,000
Maximum	1,240,000	875,000	1,050,000	2,000,000	2,200,000	2,325,000	1,400,000	2,600,000	3,650,000	9,000,000	10,250,000
Minimum	475,000	675,000	450,000	825,000	1,000,000	550,000	997,500	600,000	1,300,000	567,500	900,000
Apartment/ Condo											
Mean	890,680	n.a.	939,950	1,756,656	n.a.	n.a.	n.a.	2,280,000	4,062,091	5,100,000	8,333,333
Median	881,250	n.a.	939,950	1,837,500	n.a.	n.a.	n.a.	2,400,000	4,600,000	3,000,000	7,400,000
Max	1,217,160	n.a.	1,550,000	2,800,000	n.a.	n.a.	n.a.	3,600,000	7,500,000	10,000,000	16,000,000
Min	600,000	n.a.	329,900	500,000	n.a.	n.a.	n.a.	860,000	1,168,000	2,300,000	1,600,000

Table 2: Hedonic Regression Results

Dependent Variable = log(house price)	Full Sample	Land	Houses
Area (sq. ft.)	1.73e-07 (2.54e-08)**	1.03e-07 (2.27e-08)**	2.90e-07 (9.26e-08)**
Bedrooms	0.041 (0.006)**	- 	0.056 (0.007)**
Agent	-0.001 (0.001)*	0.000 (0.001)	-0.002 (0.001)**
Christ Church	0.146 (0.045)**	0.192 (0.061)**	0.171 (0.068)**
St. Andrew	0.029 (0.186)	0.334 (0.218)	-0.098 (0.321)
St. George	0.042 (0.057)	0.137 (0.074)*	-0.016 (0.089)
St. James	0.521 (0.048)**	0.574 (0.073)**	0.471 (0.071)**
St. John	0.110 (0.091)	0.202 (0.114)*	0.360 (0.149)*
St. Joseph	0.314 (0.100)**	0.621 (0.160)**	0.096 (0.134)
St. Lucy	0.065 (0.097)	0.089 (0.100)	0.349 (0.324)
St. Michael	0.100 (0.051)**	0.232 (0.071)**	0.051 (0.077)
St. Peter	0.245 (0.056)**	0.148 (0.083)*	0.301 (0.081)**
St. Philip	0.041 (0.050)	0.267 (0.065)**	0.075 (0.078)
Adjusted R-squared	0.144	0.830	0.582
s.e. regression	0.537	0.474	0.544

Figure 1: Median House Prices

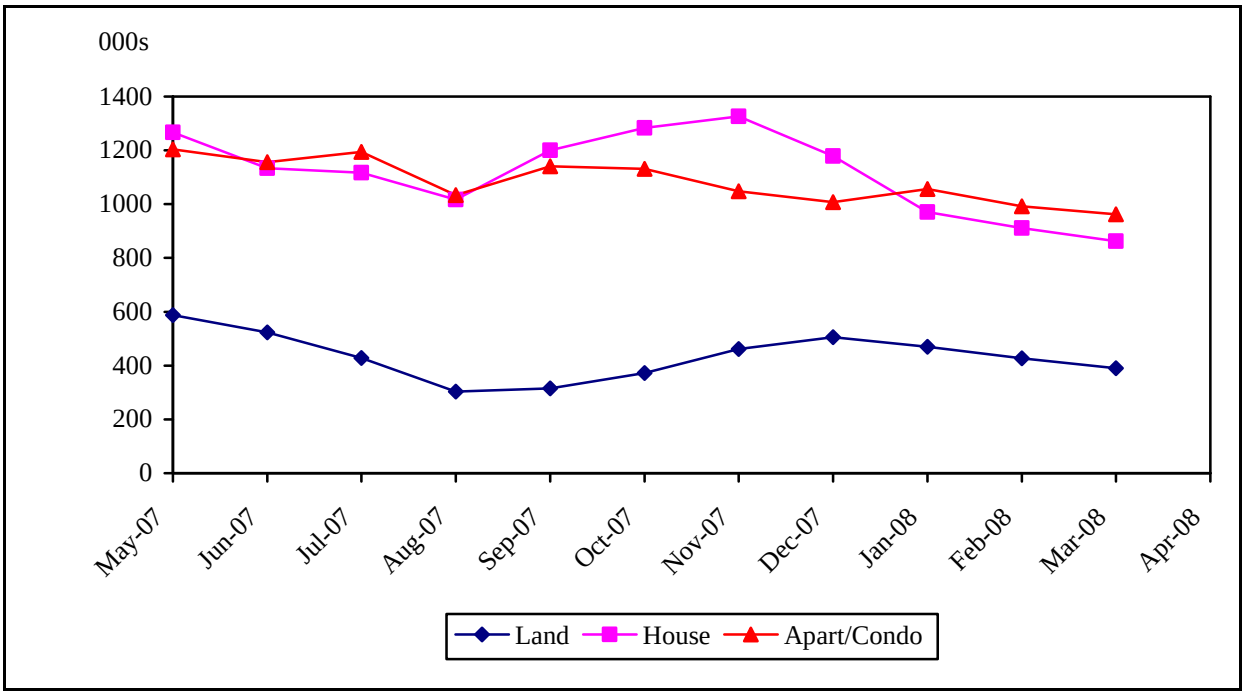

Figure 2: Mean House Price Index derived from Hedonic Regression Model