Constructing Residential Real Estate Price Indices for Jamaica

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Abstract

This paper presents a framework for the construction of quarterly residential real estate price indices (RREPIs) for Jamaica. In this study, a rolling window hedonic pricing approach is used to create the RREPIs using mortgage transaction and assessment information on dwellings across all 14 parishes of Jamaica collected by the National Housing Trust (NHT). Additionally, two sub-indices are computed for the most active NHT geographic markets, St. Catherine and Kingston & St. Andrew. The RREPIs show that prices have generally been trending upwards over the period December 2008 to March 2016. Furthermore, activity in the two most active geographic markets largely drive the outturn in the index for Jamaica. Overall, these results have important implications for the development of macro-prudential policy tools for the mitigation of asset price volatility in Jamaica.

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1. Introduction

Real estate prices can be prone to large swings or 'boom-bust' cycles. These cycles have a major influence on economic activity and financial stability through their impact on the decisions of households and financial institutions (Kindleberger, 2000; Case *et al.*, 2004). Empirical evidence has shown that asset price booms magnify business cycles and are highly correlated with credit booms (Hofmann, 2001; Borio and Lowe, 2002; Davis and Zhu, 2004). In many industrialized economies, sharp downturns in house prices have been associated with substantial adverse output and inflation effects, which outweigh the impact of busts in other asset prices, such as equities (Helbling and Terrones, 2003; Helbling, 2005).[1] In addition, house price busts generally result in substantial declines in asset quality and profits of financial institutions and, during extreme episodes, directly contribute to financial system instability.

The well-documented links between fluctuations in house prices and macroeconomic and financial instability, underscores the need for an accurate and reliable measure of house price inflation. Specifically, the construction of a hedonic house price index for Jamaica, which can be used as a tool to track the prices of any combination of real estate characteristics, will improve the decision-making capabilities of households, firms and policymakers such as the Central Bank.

Building an accurate measure of house prices depend critically on the reliability and suitability of data sources. A variety of data sources exist including transactions and appraisal or assessment data, building permits, land registry, mortgage records, realtors, appraisors and household surveys. The combination of transactions and assessment data represent the most complete data source for the construction of hedonic prices indices and quality-adjusted repeat-sales indices (Pollakowsky, 1995).

This paper presents a framework for the construction of a house price index for Jamaica. It represents cooperation between two public sector entities - the National Housing Trust

[1] In terms of the Jamaican economy, Mitchell (2005) provide empirical support for the inclusion of some measure of wealth effects, which are related to asset prices such as real estate, in monetary policy analysis.

(NHT) and the Bank of Jamaica (BOJ).[2] The real estate transaction-assessment data set is collated by the NHT and the estimation and compilation of the index is undertaken by the BOJ. Furthermore, given the relatively large size of residential real estate in the asset portfolio of Jamaican households, vulnerabilities within this asset category have the potential to negatively impact Jamaica's business and financial cycles. The resulting RREPIs will provide a measure for assessing real estate price volatility on the Jamaican economy.

2. Alternative Methodological Approaches

The construction of a real estate price index is typically associated with problems arising from measuring temporal changes in the quality and composition of the housing sample. Houses are heterogeneous goods according to location as well as other characteristics which may change over time. For example, the attributes of the existing housing stock may change significantly due to renovation, depreciation or the construction of new houses with improved qualities. In addition, changes in the composition of the sample of houses to be incorporated in the index between periods, as well as the fact that not all house sales will be captured in the index, could introduce some sample selection bias in the computation.

There are various techniques used to construct a price index. The most common methods can be separated into non-parametric and parametric approaches. The non-parametric methods include, the 'simple average' or 'median' price approach and the 'mix-adjustment' or 'weighted average price' approach. Although these non-parametric approaches have the advantage of relatively straightforward data requirements, they typically suffer from major problems associated with inadequate measurement of real estate heterogeneity and temporal compositional changes (Case and Shiller, 1987).

Parametric methods, which include the 'hedonic', 'repeat sales' and 'hybrid' approaches, generally overcome the inherent drawbacks of non-parametric methods. Each of these regression-based approaches standardize quality attributes over time in the measurement

[2] See Buranathanung *et al*. (2004) for a discussion on the construction of residential housing price indexes by Government Housing Bank and the Bank of Thailand.

of price changes which are then used to construct an index of price changes for a constant set of characteristics. Nevertheless, the parametric approaches, depending on the robustness of the specific technique, may still be subject to measurement problems.

Non-parametric Approaches

Simple Average/ Median Price Method

The simple average or median price approach involves the computation of measures of central tendency using a representational distribution of observed real estate prices for each time period. The choice between simple average and median price changes depends directly on the skewness, or existence of outliers, in the distribution of prices in the sample of transactions. If the price distribution was generally heavily skewed, then using the median price index would be preferred (Mark and Goldberg, 1984; Crone and Voith, 1992; Gatzlaff and Ling, 1994; Wang and Zorn, 1997). However, inferences from using either an average or median price index are significantly affected by the failure to control for changes in the quality composition of houses sold over each time period.

Mix-adjustment Method

Alternatively, the mix- adjustment approach relies on the simple measures of central tendency for residential price distributions, which are grouped according to separate sets or “cells” of location and other attributes to construct a mix-adjusted index. Unlike the hedonic approach, changes in the quality of houses across time periods will bias this aggregate measure of prices.

Parametric Approaches

Hedonic Price Method

The hedonic price approach is widely utilized to estimate the relationship between real estate prices and their corresponding hedonic characteristics. This approach has its theoretical foundations in Lancaster’s (1966) consumer preference theory and was later extended by using an equilibrium supply and demand framework based on heterogeneous product characteristics (Rosen, 1974). Hedonic price theory assumes the market values of real estate are functions of a set of separate hedonic shadow prices associated with the physical characteristics. These characteristics include location of the property and other attributes, such as, land area, floor area, number of bedrooms, number of bathrooms, number of floors, and existence of a garage and so on.

Many studies have applied hedonic techniques to housing markets (Wigren, 1987; Colwell, 1990; Janssen *et al*., 2001; Buck, 1991; Blomquist *et al.*, 1998; Englund, 1998; Cheshire and Sheppard, 1995; Sivitanidou, 1996; Maurer, Pitzer and Sebastian, 2004; Wen, Jia and Guo, 2005; Gouiéroux and Laferrère, 2006). Assuming that the precise functional form of the hedonic model is known, econometric techniques can be employed to estimate the parameter values associated with each characteristic, revealed from observed prices of heterogeneous houses. These implicit or shadow price estimates are then used to construct the computed average price of a constant-quality stock of residential real estate, consisting of different characteristic compositions.

The three main methods of estimating hedonic models are the time-dummy variable, the characteristics price index and the price imputation methods. A variant form of the time-dummy hedonic model is adopted in this paper. The time-dummy variable method pools all periods of transactions prices, including a set of time-dummy variables to represent the specific transaction period, to estimate a single 'constrained' set of hedonic coefficients. Furthermore, since time coefficients are included in the regression equation, the house price index can be estimated directly from it.

Alternatively, the characteristics price index method does not constrain the intercept or a hedonic coefficient to be constant over time, as the hedonic-price model is applied separately to each period. The primary advantage of the characteristics price index method is, unlike the time-dummy variable method, is that it permits the price index number formula to be determined independent of the hedonic functional form (Diewert, 1976; Triplett, 2004).

The price imputation method involves the use of the specified hedonic function and current data to estimate the imputed market price for a house with the attributes of a reference stock of houses. Then the difference between the value of the reference stock at the base period and the current estimated value of the reference stock gives the 'pure' price change. Further, the value at the base date can also be imputed and then compared with the current period imputed value. This imputation approach enhances the robustness of the hedonic price index as the conditional expected value of the reference stock is used instead of the observed prices, which could include outliers.

There are some limitations associated with the measurement of 'pure' price changes using the hedonic approach. First, the approach is data intensive, relating to not only prices but also detailed information across hedonic characteristics. If relevant characteristics are not included in measurement or change significantly over time, then the shadow prices of characteristics may be unstable resulting in statistically biased estimates of the price index. Second, different functional forms can be used to specify hedonic equations including the 'linear' model, 'log-linear' model' and the 'log-log' ('double-log') model. However, model misspecification produces biased estimates of the price index (Meese and Wallace, 1997). Third, the sample of real estate transactions within a specific period is not random and could vary according to economic conditions if the market is segmented. This could introduce sample selection bias in the computed price index.

Repeat Sales Method

Repeat sales models regress price changes on houses that have been sold more than once to estimate general house price inflation, under the assumption that the hedonic characteristics are unchanged between transactions (Bailey, Muth and Nourse, 1963; Case and Shiller, 1987, 1989; Shiller, 1991, 1993; Goetzmann, 1992; Calhoun, 1996; Englund, Quigley and Redfearn, 1998; Dreiman and Pennington-Cross, 2004; Jansen *et al.*, 2006). By controlling for quality changes in this manner, the change in price of houses between transactions can be expressed as a simple function of the time intervals between transactions.

The obvious advantage of the repeat sales method over the hedonic price approach is that data requirements are much less detailed, in that information on real estate characteristics are not needed to construct the price index. That is, aside from price changes and the transaction dates, confirmation that the characteristics have remained unchanged is all the additional information required.

However, the omission or ‘waste’ of information relating to real estate sold only once during the estimation period is viewed as the main disadvantage of the repeat sales method. Omitting single-transaction price data oftentimes lead to an insufficient number of observations for robust estimation of an index for regions where real estate transaction occur relatively infrequently (Abraham and Schauman, 1991; Clapp, Giacotto, and Tirtiroglu, 1991; Cho, 1996). Similarly, problems of sample selection bias are likely to be more serious using the repeat sales method compared to the hedonic price method (Case, Pollakowski and Wachter, 1991; Cho, 1996; Gatzlaff and Haurin, 1997; Meese and Wallace, 1997; Steele and Goy, 1997). Additionally, similar to the drawback of the hedonic price method, model misspecification due to changes in implicit market prices will lead to an inaccurate price index.

Hybrid Method

The drawbacks of the repeat sales and hedonic approaches inspired the advancement of a hybrid technique which combines the features of both techniques (Palmquist, 1980; Case, Pollakowski, and Wachter, 1991; Case and Quigley, 1991; Quigley, 1995; Knight, Dombrow, and Sirmans, 1995; Meese and Wallace, 1997; Hill, Knight, and Sirmans, 1997; Englund, Quigley, and Redfearn, 1998). The hybrid method was designed specifically to address the bias and inefficiency problems of the hedonic price and repeat sales approaches. Weighted averages of the hedonic and repeat-sales methods are created by jointly estimating the hedonic price and repeat sales models and imposing cross equation restrictions. Nevertheless, problems of model misspecification and sample selection bias are still evident in hybrid measurement. Consequently, no clear evidence exists to support the superiority of hybrid models over the other parametric approaches (Case, Pollakowski, and Wachter, 1991).

3. The Hedonic Model

The hedonic model is used as the appropriate empirical specification for the production of the RREPIs for Jamaica. As discussed in the previous section, this approach is useful given its treatment of the marginal contribution of each household characteristic in constructing the price index which facilitates accounting for the multiplicity of characteristics that contribute to the price of housing units. It is also useful to restate that the approach is based on the premise that the price of a house is determined by its internal and external characteristics. In the context of the housing market, these characteristics refer to aspects of the physical structure as well as the location of the property. The employed econometric models therefore provide price indices that control for changes in the characteristics of the housing stock sold over time.[3,4]

Model Specification

To generate the house price index, it is assumed that the price p_n^t of property *n* in period *t* is a function of a fixed number of *k* characteristics measured by quantities, z_{nk}^t. For T+1 time periods, going from base period 0 to period T, price can be represented as a function:

$$p_n^t = f(z_{n1}^t, \dots, z_{nK}^t, \varepsilon_n^t) \tag{1}$$

Here ε_n^t is a random error term. While there are several possible functional forms for hedonic specifications, selecting an appropriate functional form for the hedonic model is important for minimizing any bias in the estimated coefficients and, by extension, the property price index. To estimate the marginal contributions of the characteristics, equation (1) is first specified as a logarithmic-linear (semi-log) parametric model.

$$\ln p_n^t = \beta_0^t + \sum_{k=1}^{K} \beta_k^t z_{nK}^t + \varepsilon_n^t \tag{2}$$

[3] Shadow prices of property characteristics cannot be independently observed. However, the demand and supply for properties implicitly determine the characteristics' marginal contribution to the prices of the properties. The hedonic regression analysis values these marginal contributions (Eurostat *et al*., 2013).

[4] The methodology employed is largely in keeping with the Handbook on Residential Property Prices Indices (2013) and mirrors the approach used to compute official housing price indices in other jurisdictions such as Ireland, France, Germany, Austria, Norway, Finland and the United Kingdom.

Here β_0^t and β_k^t are the characteristic parameters to be estimated. The parameters β_k^t are allowed to change over time based on the premise that varying housing market conditions determine the marginal contributions of these characteristics. Furthermore, when demand and supply conditions change there is no *a priori* reason to expect that the contributions are constant (Pakes, 2003).

Time Dummy Method – Rolling Window

The time dummy method augments equation (2) by including a set of time dummy variables, D^τ, from which the price index is derived.

$$\ln p_n^t = \beta_0^t + \sum_{k=1}^{K} \beta_k z_{nk}^t + \sum_{t=1}^{T} \delta^\tau D^\tau + \varepsilon_n^t \tag{3}$$

A general shortcoming of the time dummy method is the revisions which occur once the index is updated to include current periods. Constant revisions to index values will ultimately prove undependable, especially in the context of policy decisions related to the residential mortgage market. In this context, a rolling window approach was utilized to compute the indices in order to overcome this shortcoming of the typical time dummy approach. In this paper, equation (3) is estimated using Ordinary Least Squares regression on a rolling sample of four quarters.[5,6] The time dummies represent each quarter over the sample window and the initial quarter of each rolling sample is used as the reference dummy. The coefficients on these time dummies, $\hat{\delta}^t$, form the basis for estimating the price index using this approach. These coefficients estimate the proportionate change in price arising from the progress in time, having controlled for changes in the property characteristics.

The number of periods selected should coincide with expectations of what would yield reasonable results. A four quarter window was chosen for computing the RREPIs in this

[5] For n quarters, n-1 time dummies are created such that time dummy t_i equals 1 if the housing unit belongs to quarter *i* and 0 otherwise. This is also done for the dummy variables representing the dwelling characteristics (see Table A1).

[6] Stepwise Ordinary Least Squares regression is carried out in Eviews. Using equation (3), all property characteristics are included in the model, however, only those property characteristics that are statistically significant at the 90.0 per cent confidence level are included in the final regression output. Furthermore, the estimated models are subject to the standard robustness checks to ensure reliable estimates are used to generate index values.

paper. The index value for each quarter of the initial sample window, M, is calculated as $100 \times exp(\widehat{\delta^{\tau}})$. After which, the index value representing the last quarter of rolling window M+1 is calculated based on a linking approach to the index value of the last quarter of rolling window M. To do so, the implied rate of price growth for the last two periods of rolling window M+1 is calculated as $\frac{exp(\hat{\delta}^{t}_{M+1})}{exp(\hat{\delta}^{t-1}_{M+1})}$.

This price growth is then applied to the last quarter index value of sample window M. This is done in order to mathematically link the new index value to the previous period index value without the revision of previously estimated index values (Diewert, 2011). Equation (4) illustrates the calculation mathematically while Table 2 provides an alternative view of the procedure.

$$HPI_{M+1,t} = \frac{\exp(\hat{\delta}^{t}_{M+1})}{\exp(\hat{\delta}^{t-1}_{M+1})} \times HPI_{M,t-1} \tag{4}$$

Table 2: Demonstration of the 4-quarter rolling window approach

i) First 4-quarter rolling window, M	Q1	Q2	Q3	Q4	
ii) Derived HPI values using δ coefficients from hedonic regression analysis	**HPI Q1** (Base = 100)	**HPI Q2** ($100 * \delta^{2}$)	**HPI Q3** ($100 * \delta^{3}$)	**HPI Q4** ($100 * \delta^{4}$)	
iii) Second 4-quarter rolling window, M + 1 - Data for Q1 is dropped while data for Q5 is added to the sample	...	Q2	Q3	Q4	Q5
iv) Regression analysis is done using the new sample - Q2 becomes the new reference period time dummy, hence no value for δ^{2} is derived from the regression estimates	...	…	δ^{3}	δ^{4}	δ^{5}
v) Derived HPI value for Q5	**HPI Q1**	**HPI Q2**	**HPI Q3**	**HPI Q4**	**HPI Q5** $[\exp(\delta^{5})/\exp(\delta^{4})]$ * **HPI Q4**

4. Institutional Context & Data Description

The NHT, established in 1976, is the largest provider of residential mortgages in Jamaica with over 50.0 per cent market share. All employed persons in Jamaica that are between the ages of 18 and 65 and that earn above minimum wage are required by law to contribute 2.0 per cent of their wages to the Trust. Employers must also contribute 3.0 per cent of their wage bill. In return for their contributions, the NHT facilitates house purchases at concessionary interest rates. Joint financing facilities with private mortgage providers may also be arranged by contributors.

The initial data set consisted of 13 108 observations, between 2008Q4 and 2016Q1, on residential mortgages for dwellings across Jamaica. This data reflects the overall prices and other primary characteristics for real estate for which NHT is the main mortgage provider. The non-price characteristics covered in the data set are: disbursement date, postcode, lot size (in square meter), floor area (in square meter), year of construction (1930-1959, 1960-1969, 1970-1979, 1980-1989, 1990-1999, 2000-2009, 2010-2015), type of dwelling (detached house, attached house, semi-detached house, townhouse, apartment,), number of floors (1, 2, 3 & over), number of bedrooms (1, 2, 3, 4, 5 & over), number of bathrooms (1, 2, 3, 4 & over), number of laundry rooms (0, 1, 2 & over), number of car ports/garages (0, 1, 2 & over) and existence of a water tank (0, 1 & over). Data related to the price of each housing unit is also presented including market value, forced sale value and transaction price. The data set is divided among 14 parishes, namely, Kingston & St. Andrew, St. Thomas, Portland, St. Mary, St. Catherine, Clarendon, St. Ann, Manchester, St. Elizabeth, Hanover, Westmoreland, St. James and Trelawny.

An initial scrubbing of the data was conducted for statistical use. Estimation of the housing price index for Jamaica requires consistent information on housing characteristics for each mortgage. Therefore, the data was evaluated for missing values in any of the characteristic areas. In addition, outliers and other erroneous data were removed from the final sample given the likely negative impact they posed for the final results. Adjustments were also made for characteristics presented with a range of values; the midpoint between these values was found and used. Further, housing units recorded as having a ½ bath or ½ bedroom were adjusted to full on the assumption that they would intrinsically add to the value of property much like a full bath or full bedroom.

A final data set of 12 139 observations was used to estimate the hedonic model. This represented 92.6 per cent of the initial data set provided by the NHT. This proved to be a favourable outturn given the data intensive nature of the hedonic approach. Table 1 provides a summary of the number of observations available for the estimation of the model after scrubbing.[7]

Table 1: Distribution of data by location

	Number of Observations	Number of Observations after cleaning	Usable Data (%)
Trelawny	1 031	899	87.2
St. James	1 196	1 056	88.3
St. Catherine	6 503	6 173	94.9
Kingston & St. Andrew	3 025	2 840	93.9
Manchester	158	143	90.5
Clarendon	364	318	87.4
Portland	58	51	87.9
St. Thomas	120	90	75.0
St. Ann	233	217	93.1
Hanover	35	26	74.3
Westmoreland	116	92	79.3
St. Mary	132	122	92.4
St. Elizabeth	137	112	81.8
Total	13 108	12 139	92.6

[7] At the sub-index level, the process of cleaning the data was also done given the absence of the postal code identifiers on some housing units. As a result, the total number of observations used at the sub-index level for Kingston & St. Andrew and St. Catherine was 2 790 and 6 132, respectively. Furthermore, Kingston & St. Andrew is divided into 20 postal regions while St. Catherine is divided into 10 postal regions.

Across Jamaica, detached houses accounted for 64.0 per cent of total dwelling types while semi-detached houses, the second most frequent occurring dwelling type, accounted for 18.1 per cent. Other most frequently occurring characteristics include: one floor (90.5 per cent); constructed between 2009 and 2014 (30.3 per cent); two bedrooms (54.7 per cent); one bathroom (65.2 per cent); no carport (78.0 per cent); no laundry area (76.9 per cent); and, no water tank (96.7 per cent). The parishes of St. Catherine, Kingston & St. Andrew and St. James were the most frequently occurring locations, accounting for 50.9 per cent, 23.4 per cent and 8.7 per cent, respectively (see Table A1).

The sample statistics for the final data set across all property types in Jamaica showed an average transaction price of $6.4 million for a housing unit with a standard deviation of $3.1 million and a maximum of $40.9 million (see Table A2). Additionally, the average 'floor area' was found to be 102.6 square meter with a minimum of 10.9 square meter up to a maximum of 8 491.95 square meter.

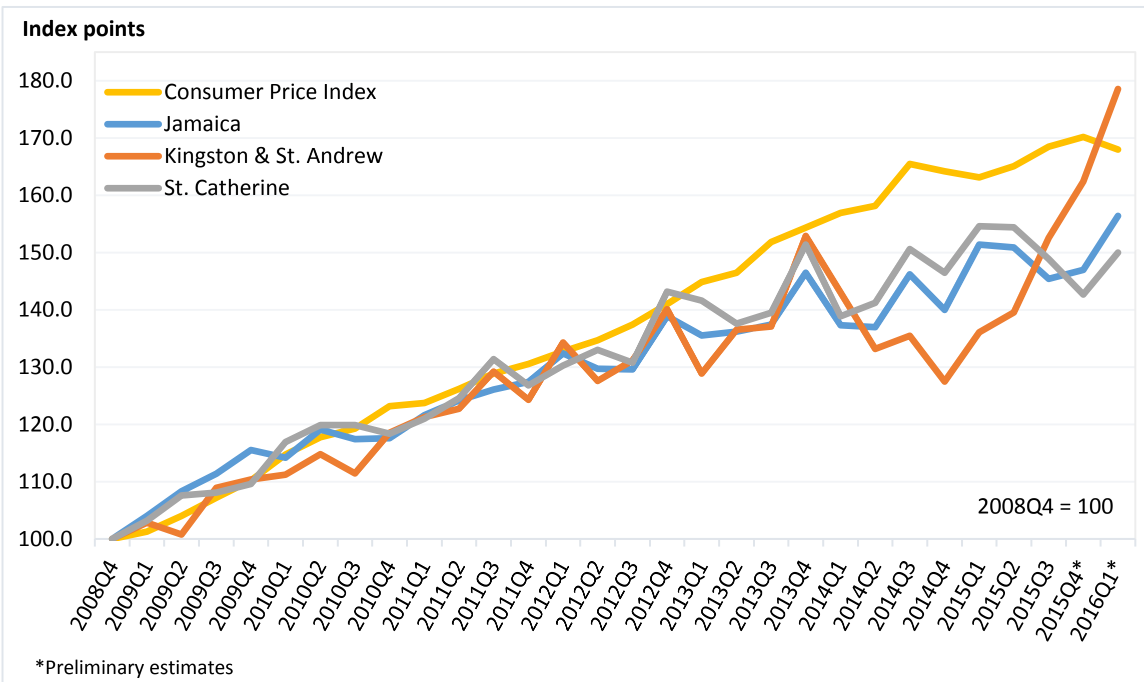
The correlation matrix of selected characteristics showed that transaction price was positively correlated with all characteristics in Jamaica. Among these variables, 'no. of bathrooms' showed the highest positive correlation with 'price' (18.4 per cent), followed by 'no. of floors' (24.4 per cent) and 'no. of a laundry rooms' (20.3 per cent) (see Table A3). 'Floor area' was strongly correlated with 'no. of bathrooms' (33.4 per cent) as well as 'no. of bedrooms' (31.8 per cent). Other notable, positive pair-wise correlations include: 'no. of bedrooms' and 'no. of carports' (37.9 per cent), 'no. of bathrooms' and 'no. of carports' (37.7 per cent) and 'no. of bathrooms' and 'no. of laundry rooms' (37.6 per cent).

As it relates to price per square meter for residential properties in Jamaica, median prices by property type indicate that apartments and semi-detached units are generally more expensive than other dwelling types (see Table A4). Attached units were found to be the cheapest property type across Jamaica. Furthermore, the weighted median price per square meter across all property types has been trending upwards in more recent times.

5. Analysis of Results

Quarterly index values for Jamaica and the two largest market segments were computed using the parameters of the semi-log functional form shown in equation (3) and a four-quarter rolling window approach over the period 2008Q4 to 2016Q1 (see Figure 1). While RREPI growth generally mirrored the CPI inflation rate between December 2008 and December 2012, residential prices have since largely appreciated at a slower pace than consumer prices. Nonetheless, all three indices indicated a trend increase in prices over the review period.

Figure 1: Residential Real Estate Price Indices



The RREPIs for Jamaica, Kingston & St. Andrew and St. Catherine showed an overall increase in residential real estate prices of approximately 56.4 per cent, 78.6 per cent and 50.0 per cent, over the review period, respectively. For Jamaica and St. Catherine, the most significant calendar year increase of 9.0 per cent and 12.9 per cent, respectively, occurred during 2012.[8] The most significant increase for the Kingston & St. Andrew area occurred

[8] For 2012, there was a 20.0 per cent decline in the total number of residential mortgages issued nationally, mainly due to a 44.0 per cent reduction in the number of mortgages issued by Credit Unions and Insurance companies. As such, the outturn in RREPIs for Jamaica and St. Catherine may likely be reflecting the supply-driven increase in prices over that period (NHT Annual Report, 2012-2013).

during 2015 and mainly reflected a rally of prices over the slowdown in activity during 2014.

As it relates to the slowdown in prices mentioned above, all three indices mirrored the contraction in the residential mortgage market in Jamaica during 2014. The RREPI for Kingston & St. Andrew was the most impacted with an average quarterly decrease in prices of approximately 4.4 per cent during 2014. For Jamaica and St. Catherine, the average quarterly decline in prices was more subdued at 1.0 per cent and 0.7 per cent, respectively. Furthermore, the slowdown in the housing market during 2014 had a more extended impact on prices for the Kingston & St. Andrew area which did not have a rally of prices as quickly as the St. Catherine area. However, the indices indicated a stronger rebound in prices for the Kingston & St. Andrew area towards the latter part of the review period relative to the outturn in index values for St. Catherine and Jamaica.

6. Concluding Remarks

The hedonic time dummy regression method was used in this paper to construct quality-adjusted residential real estate price indices for Jamaica as well as two market segments, Kingston & St. Andrew and St. Catherine. A rich database including characteristics and price data was obtained from the NHT covering the period 2008Q4 to 2016Q1. The main advantage of this hedonic approach is its simplicity and its inclusion of the marginal contribution of housing characteristics.

The RREPIs largely point to an increase in the residential real estate prices across Jamaica, albeit at a slower pace than consumer prices in more recent times. Notably, the strong influence of the Kingston & St. Andrew and St. Catherine market segments was mirrored in the RREPI outturn for Jamaica. As such, residential real estate price developments in these two key areas must be monitored given the likely impact they may have on the overall RREPI outturn.

Macro-prudential regulators must monitor changes in real estate prices given financial stability consequences arising out of the strong empirical relationship between asset price bubbles and resulting credit booms that further drive these bubbles. Furthermore, from a macro-prudential perspective, the real estate index will facilitate assessing the vulnerability of deposit-taking institutions from large exposures (through direct mortgage loans or collateral for other loans) to real estate and real estate price volatility. This assessment will result in the activation or de-activation of relevant macro-prudential policy tools that can be applied as the dynamics in the residential real estate market develop.

The residential real estate index developed in this paper will be used by the Bank to identify periods in which asset prices are increasing relatively quickly and at a pace not justified by fundamentals. If the appropriate macro-prudential policy response to an asset price boom (a restrictive stance) and bust (an accommodative stance) is applied in a timely manner, then the economic dislocation following the asset price bust will be minimal. For the future, it is envisioned that the data set used for the compilation of RREPIs for Jamaica be extended to include mortgage transactions from other lending institutions to facilitate a more wholesome analysis of real estate price dynamics in Jamaica. It is expected that this development would increase the accuracy and reliability of the RREPIs generated.

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APPENDIX

Table A1: Variable specification

Variables	Description	Proportion (%)
Type of Dwelling		
detached	Used as the reference characteristic	64.0
apartment	= 1, if unit is an apartment; = 0, otherwise	7.8
attached	= 1, if unit is attached; = 0, otherwise	5.4
semi-detached	= 1, if unit is semi-detached; = 0, otherwise	18.1
townhouse	= 1, if unit is a townhouse; = 0, otherwise	4.7
Number of Baths		
1	Used as the reference characteristic	65.2
2	= 1, if unit has two bathrooms; = 0, otherwise	25.9
3	= 1, if unit has three bathrooms; = 0, otherwise	6.7
4 or more	= 1, if unit has four+ bathrooms; = 0, otherwise	2.3
Number of Bedrooms		
1	Used as the reference characteristic	12.1
2	= 1, if unit has two bedrooms; = 0, otherwise	54.7
3	= 1, if unit has three bedrooms; = 0, otherwise	19.0
4	= 1, if unit has four bedrooms; = 0, otherwise	8.2
5 or more	= 1, if unit has five+ bedrooms; = 0, otherwise	6.0
Number of Laundry Areas		
0	= 1, if unit has no laundry room; = 0, otherwise	76.9
1	Used as the reference characteristic	22.5
2 or more	= 1, if unit has two laundry rooms; = 0, otherwise	0.5
Number of Water Tanks		
0	Used as the reference characteristic	96.7
1 or more	= 1, if unit has one or more water tanks; = 0, otherwise	3.3
Number of Carports		
0	Used as the reference characteristic	78.0
1	= 1, if unit has one carport; = 0, otherwise	21.0
2 or more	= 1, if unit has two or more carports; = 0, otherwise	0.9

Table A1: Variable specification (cont'd)

Variables	Description	Proportion (%)
Year of Construction		
< 1959	Used as the reference characteristic	1.0
1960-9	= 1, if unit was constructed between 1960 & 1969; = 0, otherwise. (Note: for any sample with no units built in 1950, 1960 is used as reference)	5.2
1970-9	= 1, if unit was constructed between 1970 & 1979; = 0, otherwise	15.2
1980-9	= 1, if unit was constructed between 1980 & 1989; = 0, otherwise	14.1
1990-9	= 1, if unit was constructed between 1990 & 1999; = 0, otherwise	17.6
2000-9	= 1, if unit was constructed between 2000 & 2009; = 0, otherwise	16.6
2010-5	= 1, if unit was constructed between 2010 & 2015; = 0, otherwise	30.3
Number of Floors		
1	Used as the reference characteristic	90.5
2	= 1, if unit has two floors; = 0, otherwise	9.3
3 or more	= 1, if unit has three or more floors; = 0, otherwise	0.3
Location (Parishes)		
Kingston & St. Andrew	Used as the reference characteristic	23.4
Clarendon	= 1, if unit is located in Clarendon; = 0, otherwise	2.6
Hanover	= 1, if unit is located in Hanover; = 0, otherwise	0.2
Manchester	= 1, if unit is located in Manchester; = 0, otherwise	1.2
Portland	= 1, if unit is located in Portland; = 0, otherwise	0.4
St. Ann	= 1, if unit is located in St. Ann; = 0, otherwise	1.8
St. Catherine	= 1, if unit is located in St. Catherine; = 0, otherwise	50.9
St. Elizabeth	= 1, if unit is located in St. Elizabeth; = 0, otherwise	0.9
St. James	= 1, if unit is located in St. St. James; = 0, otherwise	8.7
St. Mary	= 1, if unit is located in St. Mary; = 0, otherwise	1.0
St. Thomas	= 1, if unit is located in St. Thomas; = 0, otherwise	0.7
Westmoreland	= 1, if unit is located in Westmoreland; = 0, otherwise	0.8
Trelawny	= 1, if unit is located in Trelawny; = 0, otherwise	7.4
Other Variables		
Purchase price	purchase price for housing unit	
Floor area	surface area of a housing unit in square meters	

Table A2: Summary statistics for final data set (12 139 observations)

	Mean	Standard Deviation	Minimum	Maximum
Purchase Price (J$000)	6 364.00	3 102.00	50.00	40 903.20
Floor Area (Sq. ft.)	102.61	164.46	10.88	8,491.95
No. of Bathrooms	1.47	0.77	1.00	10.00
No. of Bedrooms	2.46	1.18	1.00	14.00
No. of Floors	1.10	0.31	1.00	4.00
No. of Laundry Areas	0.24	0.44	0.00	3.00
No. of Carports	0.23	0.46	0.00	4.00
No. of Water Tanks	0.04	0.21	0.00	4.00

Table A3: Correlation Matrix

	Purchase Price	Floor Area	No. of Bathrooms	No. of Bedrooms	No. of Floors	No. of Laundry Areas	No. of Carports	No. of Water Tanks
Purchase Price	1.00							
Floor Area	0.18	1.00						
No. of Bathrooms	0.32	0.33	1.00					
No. of Bedrooms	0.15	0.32	0.74	1.00				
No. of Floors	0.24	0.13	0.27	0.17	1.00			
No. of Laundry Areas	0.20	0.15	0.38	0.28	0.19	1.00		
No. of Carports	0.21	0.20	0.38	0.38	0.03	0.23	1.00	
No. of Water Tanks	0.09	0.08	0.12	0.09	0.07	0.07	0.08	1.00

Table A4: Median purchase price per square meter by property type in Jamaica

	Detached	Apartment	Attached	Semi-detached	Townhouse	Total*
Mar-12	82,402	115,351	57,768	115,385	111,189	93,171
Jun-12	81,800	111,014	60,923	103,334	97,486	88,299
Sep-12	82,381	112,231	61,913	74,816	104,772	83,929
Dec-12	84,082	119,486	56,005	110,208	103,057	91,372
Mar-13	85,462	118,898	59,368	89,686	112,261	89,220
Jun-13	79,822	112,266	77,381	84,684	86,294	83,419
Sep-13	83,810	106,633	63,210	81,115	96,687	84,127
Dec-13	84,429	116,520	64,320	96,333	92,162	87,827
Mar-14	88,841	111,690	70,922	104,371	99,038	92,933
Jun-14	87,847	112,708	63,152	90,631	89,518	88,741
Sep-14	92,267	120,150	62,906	131,116	87,162	103,685
Dec-14	92,512	113,641	64,461	133,419	108,807	104,309
Mar-15	105,328	112,998	73,949	131,107	71,719	108,377
Jun-15	107,812	120,150	69,787	141,909	86,522	114,364
Sep-15	96,267	103,702	66,199	134,114	86,748	102,933
Dec-15	111,792	137,500	52,372	142,951	49,015**	117,055
Mar-16	92,053	150,391	55,990	138,691	-	105,990

*This is calculated as the weighted median of purchase price per square meter across all property types using the stock of each property type as weights.
**Representative of only one housing unit.

Table A5: Residential real estate price indices statistics (December 2008 – March 2016)

	Jamaica			St. Catherine			Kingston & St. Andrew		
	RREPI	Quarterly % change	12 Month* % change	RREPI	Quarterly % change	12 Month* % change	RREPI	Quarterly % change	12 Month* % change
Dec-08	100.00	-	-	100.00	-	-	100.00	-	-
Mar-09	104.00	4.00	-	103.20	3.20	-	102.86	2.86	-
Jun-09	108.30	4.13	-	107.60	4.26	-	100.78	-2.01	-
Sep-09	111.40	2.86	-	108.10	0.46	-	108.90	8.06	-
Dec-09	115.50	3.68	15.50	109.60	1.39	9.60	110.36	1.34	10.36
Mar-10	114.20	-1.13	9.81	116.90	6.66	13.28	111.20	0.76	8.11
Jun-10	119.10	4.29	9.97	119.90	2.57	11.43	114.78	3.22	13.89
Sep-10	117.40	-1.43	5.39	119.90	0.00	10.92	111.42	-2.93	2.31
Dec-10	117.60	0.17	1.82	118.40	-1.25	8.03	118.53	6.38	7.41
Mar-11	121.60	3.40	6.48	121.00	2.20	3.51	121.28	2.31	9.06
Jun-11	124.20	2.14	4.28	124.60	2.98	3.92	122.73	1.20	6.93
Sep-11	126.10	1.53	7.41	131.40	5.46	9.59	129.23	5.29	15.98
Dec-11	127.40	1.03	8.33	126.80	-3.50	7.09	124.30	-3.81	4.87
Mar-12	132.40	3.92	8.88	130.30	2.76	7.69	134.32	8.06	10.76
Jun-12	129.70	-2.04	4.43	133.00	2.07	6.74	127.60	-5.00	3.97
Sep-12	129.60	-0.08	2.78	130.80	-1.65	-0.46	131.19	2.81	1.52
Dec-12	138.90	7.18	9.03	143.20	9.48	12.93	140.09	6.79	12.70
Mar-13	135.50	-2.45	2.34	141.60	-1.12	8.67	128.89	-7.99	-4.04
Jun-13	136.20	0.52	5.01	137.60	-2.82	3.46	136.51	5.91	6.98
Sep-13	137.40	0.88	6.02	139.50	1.38	6.65	137.07	0.41	4.48
Dec-13	146.50	6.62	5.47	151.40	8.53	5.73	152.91	11.56	9.15
Mar-14	137.30	-6.28	1.33	138.90	-8.26	-1.91	143.00	-6.48	10.95
Jun-14	137.00	-0.22	0.59	141.20	1.66	2.62	133.20	-6.85	-2.42
Sep-14	146.20	6.72	6.40	150.60	6.66	7.96	135.44	1.68	-1.18
Dec-14	140.00	-4.24	-4.44	146.50	-2.72	-3.24	127.49	-5.87	-16.62
Mar-15	151.40	8.14	10.27	154.60	5.53	11.30	136.06	6.72	-4.86
Jun-15	150.90	-0.33	10.15	154.40	-0.13	9.35	139.53	2.55	4.75
Sep-15	145.40	-3.64	-0.55	148.90	-3.56	-1.13	152.58	9.35	12.65
Dec-15	147.00	1.10	5.00	142.70	-4.16	-2.59	162.37	6.42	27.36
Mar-16	156.40	6.39	3.30	150.00	5.12	-2.98	178.56	9.97	31.23

December 2008 = 100
*Point to Point