An analysis of residential land prices and fundamentals in Mauritius

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Abstract
This study dwells on an analysis of how fundamental factors affect residential land prices in Mauritius. A further aim is to depict if the fundamentals have the same effect on land prices at the national level, as well as the regional level. Regional differentiation in terms of urban and rural residential land prices is made, to explain how these regional differences are due to the influence of fundamental factors on land prices. A fixed-effect panel regression technique over the period 2000 – 2019 is used for the case of the Mauritian residential land market. It is found that the variable income is significant at the national level and in all regions, with a more significant influence on land prices in rural regions. Another variable found to be important in explaining land prices at the national level is population. In the urban region, the population was positively significant in explaining land prices unlike in rural regions. The interest rate was also negatively significant in explaining land prices in both urban and rural regions. Whilst supply-side factors were observed to be insignificant in explaining land prices. Thorough knowledge of the factors explaining regional land price differences is deemed important for policymakers.

Introduction
In the land market, land prices are depicted as fluctuating over time. At one point in time, it is noted that land prices also tend to vary in terms of regions. Different factors have been used in past studies to explain the aforementioned land price variations. Land characteristics constitute one category of determinants used to justify the regional land price differences and examples of characteristics used are distance, land topography, or accessibility among others (Hanonen, 2005; Malaitham et al., 2020). Fundamental factors have also been used to explain regional land price differences. Among the fundamental factors deemed important in explaining regional land price differences are population and income. Roos (2006) shows that regional average income or population size can be regarded as important explanatory variables for regional price differences. Other fundamentals commonly included in the real estate pricing model to justify regional price differences are interest rate, unemployment, construction costs, and residential building approvals. These factors would be affecting the demand and supply of land and consequentially land prices. An equilibrium pricing model that assumes equality in terms of demand and supply has been used to find land prices in the market.

Before assessing the factors affecting regional land prices, a regional breakdown is undertaken. An approach similar to Bramley and Leishman (2005) is used, consisting of two regional land classifications, namely urban and rural regions. Subsequently, it is assessed how fundamental factors affect prices and justify land price differences. Land price data is collected in the different regions (regrouped as urban and rural), over the period 2000 – 2019 and a panel data approach is used to find the link between regional land prices and fundamental factors. A fixed-effects model is used to find how fundamentals affect residential land prices in urban and rural regions.

There is a lack of studies on regional price differences and fundamentals (Oikarinen and Engblom, 2015) and this study is believed to be a supplement to the scant literature on regional land price
differences using fundamentals as determinants. Most of the studies on the regional link between real estate prices - fundamentals were undertaken in the US, with relatively fewer researches in other contexts. As such there are no studies on residential land price dynamics in small and island economies. Mauritius remains an interesting study context given that the residential real estate market is characterized by land transactions followed by housing constructions, thus the availability of data on residential land prices. Such data tend to be limited in several contexts where mostly housing transactions are undertaken.

The rest of this work is organized as follows: section 2 reviews both the theoretical underpinnings and the related literature, section 3 discusses the methodology, section 4 discusses the findings and section 5 concludes.

**Related Literature**

*Theoretical review*

A strand of studies (Muth, 1971; Witte, 1975; Manning, 1988; Quigley, 1999; Jud and Winkler, 2002; Jiang et al., 2013) has used the equilibrium-pricing model for representing land prices.

The equilibrium land price for each region at a time $t$ would be as follows:

$$
\text{Land Price}_{t,t} = f (Income_{t,t}, Unemployment_{t,t}, Population\ Size_{t,t}, Interest\ Rate_{t,t}, Residential\ Building\ Permits_{t,t})
$$

Equation 1

The above equilibrium equation illustrates that demand and supply-side fundamental factors are at the basis of the formation of land prices in the market.

Most of the initial studies on the relationship between land prices (or housing prices) and fundamentals were conducted in the US context. In one of the pioneering works, Witte (1975), using the demand-supply equilibrium framework for establishing the factors affecting regional residential land prices in the US, explained that differences in land prices across different urban areas could be caused by differences in demand or differences in supply or the supply of other factors. The main factors found significant in justifying the interurban differences in land prices were the average plot sizes, the level of income and population growth. An analysis of the influence of these main variables over time showed that the coefficients remained significant and almost constant. Ozanne and Thibodeau (1983) subsequently explained regional housing price differences by using data for 54 metropolitan areas in the US. Using a similar theoretical framework and using OLS estimations, they established that the nonelderly single and the price of farmland explained housing price differences while they could not find any impact concerning income and population on housing prices. They further asserted that segmentation of the housing market could improve the results obtained in the study. Studying the US urban land market for 40 regions, Rose (1989) found that interregional differences in land prices could be explained in terms of income, population size, and population growth, with the variables bearing a positive significant link with land prices. Manning (1988) also used a least-squares regression technique to investigate the factors leading to regional land price variations and found that, among the main variables found significant in explaining regional land prices, were population density, population growth, the real high income, construction costs and climate. In the study, it is also suggested that land supply restrictions could be leading to higher land prices.

In a later study, Abraham and Hendershot (1996), using a data set for 30 US regions over 15 years in a linear regression approach, conducted a region-wise analysis to confirm that deviations in the equilibrium real housing prices can be caused by changes in real income, real construction costs and after-tax interest rates. Follow-up work by Potepan (1996) with data collected from 56 regions validated that income and construction costs (positive and significant) were the main factors in explaining regional land price differences. Population change, on the other hand, was also found to have a positive significant link with

1 The authors mentioned that there could have been measurement errors for some variables as the $R^2$ value obtained was relatively low.

2 Represents the income earned by individuals in the higher income range.
house prices. Income was determined as being the variable most significant. Baffoe-Bonnie (1998) used quarterly data from 1973 to 1994 in the US and applied a Vector Autoregressive (VAR) approach to determine how particular macroeconomic variables affected housing prices at both national and regional levels (four main regions). The author observed that at the national level, housing prices were influenced by changes in the mortgage rate and at the regional level housing prices were explained by mortgage rate changes, employment level and inflation in one region. Baffoe-Bonnie (1998) further suggested that the regional housing price differences can also be explained by regional differences in structural conditions and that the increasing housing prices might not be justified by macroeconomic factors only but there could also be speculative bubbles present in the market. Using a wider panel set of 130 metropolitan areas in the US, Jud and Winkler (2002) employed a fixed effect approach to determine that real housing prices were positively and significantly affected particularly by population and real income but also by construction costs, stock price appreciation and after-tax interest rates. Dummy variables were also included in the model to verify if region-specific factors affected housing prices and it is noted that in 69 regions the dummy variables were significant in explaining housing prices. The location-specific factors could include aspects such as land scarcity or regulations on housing constructions (non-measurable/latent variables).

In a more recent study, Pijnenburg (2015) used regional housing data from the US and a spatially fixed effect panel estimation method and concluded yet again that income and unemployment have the same influence on housing prices in the different regions over time. Whereas the relationship of population and building permits with housing prices was heterogeneous when taking into account space and time. The author also explained that real estate price dynamics in coastal regions tended to be different from those in inland regions.

Few other studies focused on other countries. Using regional data on building land prices in Germany, Bischoff (2010) found a significant positive link between income and land prices. Similar to the US case, the author found population as being an important factor justifying regional differences in land prices. As such, structure and tourism were also depicted as having a positive link with land prices. Belke and Keil (2017) subsequently studied how fundamental determinants affected housing prices in different regions in Germany (approximately 125 regions were included in the study sample) using annual data from 1995 to 2010. A positive relationship was obtained between interest rate and housing prices, indicating that it was not the affordability argument that defined the link between housing prices - interest rate but rather how economic activities were affected by higher interest rate leading to more housing demand and higher prices. Housing price increases were mainly justified by considering demand-side factors.

Studying the Finnish housing market, Oikarinen and Engblom (2015) found that regional house price differences were quite small. It was also highlighted that in different regions the elasticities of housing prices and fundamentals were different. The focus was mainly on the significance of income in explaining housing prices, with a higher elasticity in larger cities. The authors found that in the short term the regional variations tended to be relatively small.

In the Malaysian context, Wong et al., (2018) used a fixed-effects model and pooled mean group (PMG) estimator to find how particular determinants affected housing prices. According to the authors, the main housing price determinants were income and population, while regional housing price differences were principally explained in terms of economic activities, population and income. Other explanatory variables included in the model were foreign real estate investment (FREI) and speculative buying. Interestingly apart from income and population, foreign inflows (FREI) were deemed significant in explaining housing prices but speculation was not a significant factor in explaining the Malaysian housing market.

The latest research by Zhou et al., (2019) in the Chinese housing context used an equilibrium-pricing framework to investigate how fundamentals affected regional housing prices. Using panel data estimation, namely an ordinary least square method (fixed coefficients for different regions) and a geographically and temporally weighted regression approach (GWTR, where the coefficients vary for different regions), to find how the particular explanatory variables affected housing prices in different
regions, the authors found that income and population had a higher influence in some coastal regions. The effect of income on housing prices in different regions seemed to vary over time. The authors also concluded that in regions with higher urbanization levels, population increase had a higher influence on housing prices while the development costs had a positive significant effect in most regions studied.

The above studies illustrate that fundamentals, namely income and population have been commonly used to justify regional land price differences. Most of the above studies are based upon the least square methodology or have used correlation coefficients and some more recent studies have used the fixed-effects model. Only a few studies have used a dynamic approach and less emphasis has been laid upon the short-run effect of fundamentals on land prices on a regional basis.

**Methodology**

**Model Specification**

In past research (see Witte, 1975; Jud and Winkler, 2002 and Wong et al., 2018) common demand-side factors, namely income and population have been used to justify regional land price differences. Other variables included in this model are real interest rate and unemployment, while on the supply-side common explanatory variables included are construction costs and residential building permits (land supply through regulatory authorities).

\[
\ln RLPI_{it} = \alpha + \pi_1 \ln RPCE_{it} + \pi_2 \ln POP_{it} + \pi_3 \ln RIR_{it} + \pi_4 \ln UNEMP_{it} + \pi_5 \ln RBP_{it} + \pi_6 \ln RCCI_{it} + \epsilon_t
\]

Equation 2

Where LNRLPI represents the logarithm of real land price index used as a measure of land price; LNRPCiE is the logarithm of real per capita earnings and used as a measure of income; LNPOP is the logarithm of the population in each region; LNRIR is the logarithm of real interest rate; LNUNEMP is the logarithm of the level of unemployment; LNRBP is the logarithm of residential building permits and LNRCi is the logarithm of real construction cost index.

**Dependent and Independent Variables**

**Land Price (RLPI)**

The data for residential land prices for this chapter is collected from eighteen regions across Mauritius. Subsequently, these regions are classified as urban and rural regions. Within the urban category, there are seven regions and in the rural, there are eleven regions. In each region, the data is collected every year from 2000 to 2019. In each region, the prices for several plots are compared and an average residential land price per square meter per region is estimated.

**Income**

The logarithm of the real per capita of earnings is included in the model as a measure of income. It measures the purchasing power of individuals and as previously mentioned it normally bears a positive relationship with land prices (see Gottlieb, 1965; Witte, 1975; Davis and Heathcote, 2007; Wang, 2007).

**Population**

The population data is collected for each region from the sample of eighteen regions, the figure englobes all the inhabitants within the particular regions. Most past studies have depicted a positive significant link between this demographic variable and real estate prices (See Maisel, 1964; Poterba, 1981; Mankiw and Weil, 1989; Nakamura and Saita, 2007) and specifically for regional studies (Refer to Potepan, 1996; Jud and Winkler, 2002; Pijnenburg, 2015; Wong et al., 2018).

**Real Interest Rate (RIR)**

The logarithm of the real interest rate will be included and is used in the model. Normally when a decrease in interest rate occurs this should entail an increase in real estate demand and also prices. Belke and Keil (2017) consider interest rate changes from the perspective of monetary policy changes and according to the study a positive link exists between interest rate and real estate prices.
Unemployment

The unemployment level prevailing in the country over the period of study is used and it is the same for the different regions. The logarithm of the unemployment figure is included in the model. The few studies (Liu et al., 2016; Gan et al., 2018) on the link between unemployment - housing prices have shown a decrease in unemployment leading to an increase in housing prices. This is justified by the fact that when the unemployment level decreases this entails an increase in real estate demand and hence real estate prices.

Residential Building Permits (RBP)

The RBP measures the number of permits approved for housing construction by regulatory authorities and it indirectly gives an idea of the number of residential plots having been transacted, it, therefore, serves as a measure for housing supply (Lerbs, 2012 uses a similar measure). According to Lerbs (2012), there should be a positive relationship between the number of residential building permits and real estate prices. The logarithm of the RBP is included as an explanatory variable in the model.

Real Construction Cost

The logarithm value of the real construction cost index is included as an explanatory variable in the model. An initial study on the link between construction cost and land prices by Manning (1988) using correlation coefficients and least squares regression found a positive relationship. According to Somerville (1999) and Lerbs (2012), an increase in the construction costs would imply a decrease in housing supply (housing construction activity). According to Belke and Keil (2017), construction costs can either have a positive or negative effect on real estate prices.

Data

The data series spans from 2000 to 2019 and it has been collected every year. The data for land prices have been obtained through several valuation officers. This data is then regrouped in terms of urban and rural regions, with seven main regions within the urban category and eleven regions in the rural category respectively. The data for the explanatory variables were obtained from two main sources. Data relating to population size per region, unemployment level, residential building permits, and construction cost index is obtained from the website of Statistics Mauritius while the data for income (earnings) and the real interest rate was collected from the website of the World Bank.

Data Analysis

A static panel regression technique was chosen to analyze the link between land prices and fundamental factors at the national level and in the two specific regions chosen for the study.

Unit Root Test Results

Following the panel unit root tests, namely the Levin, Lin and Chu test (LLC) and the Im, Pesaran and Shin (IPS) test. For the national data sample, as well as for the two regional samples of panel data under study, it is noted that the data series for the dependent and independent variables is stationary at level. Given that the variables are stationary at level, the panel least squares method can be used for the estimation of equation 2.

Hausman Test

For panel least squares regression, either a fixed-effects or a random-effects model can be used. To choose the appropriate technique, the Hausman test is done. The results indicate that the null hypothesis should be rejected and hence a fixed-effects model is more appropriate to estimate the model. The Hausman test is conducted for the three samples under study and for all three the fixed effect model is chosen.

Fixed Effects Panel Estimation

Several pieces of research (see Schnure, 2005; Oikarinen and Engblom, 2015; Belke and Keil, 2017; Wong et al., 2018) studying the fundamental determinants of regional real estate prices have used fixed-effects model. The econometric specification for the present study is as follows:
The equation 3 represents the different cross-sections or regions in the study and \( t = 1, 2, 3, \ldots T \) denotes the time dimension. \( \alpha_i \) is a variable representing the region-specific fixed effects and it normally captures the influence of region-specific unobservable and heterogeneous factors which do not vary over time.

Descriptive Statistics

The Mauritian context is subdivided into two main regions, namely urban and rural regions, depicting different evolutions in their residential land prices over time. Table 1 gives the descriptive statistics for real land prices in the whole sample and the two main regions. It is observed that the mean and median value for real land prices in urban regions is the highest followed by rural regions. The lowest real land prices occur in rural regions. From the standard deviation figures, it is noted that the regional variation in land prices is highest in urban, followed by rural regions.

Table 1: Descriptive Statistics for Real Land Price for the whole sample and in the two Regions from 2000 - 2019

<table>
<thead>
<tr>
<th></th>
<th>WHOLE SAMPLE</th>
<th>URBAN</th>
<th>RURAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>7385.88</td>
<td>12883.23</td>
<td>4560.1</td>
</tr>
<tr>
<td>Median</td>
<td>5887.24</td>
<td>11107.27</td>
<td>4854.73</td>
</tr>
<tr>
<td>Maximum</td>
<td>24753.67</td>
<td>24753.67</td>
<td>13692.62</td>
</tr>
<tr>
<td>Minimum</td>
<td>2500</td>
<td>5250</td>
<td>2500</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>4563</td>
<td>5742</td>
<td>2390.41</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.72</td>
<td>0.67</td>
<td>1.74</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>6.11</td>
<td>2.29</td>
<td>5.96</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>430.81</td>
<td>9.63</td>
<td>191.04</td>
</tr>
<tr>
<td>Probability</td>
<td>0</td>
<td>0.008</td>
<td>0</td>
</tr>
<tr>
<td>Sum</td>
<td>3545225</td>
<td>1288323</td>
<td>1201222</td>
</tr>
<tr>
<td>Sum Sq. Dev.</td>
<td>9.98E+09</td>
<td>3.26E+09</td>
<td>1.25E+09</td>
</tr>
<tr>
<td>Observations</td>
<td>480</td>
<td>100</td>
<td>220</td>
</tr>
</tbody>
</table>

A graphical analysis of the average real land prices in the two regions (figures 1 & 2 below) illustrates that the highest land prices prevail in the urban regions and the lowest land prices in the rural regions.

Figure 1. Evolution real residential land prices in Mauritius from 1980 - 2019

Figure 2. Evolution real residential land prices in Mauritius over past four decades
Although the same fundamentals prevail within the country (except for population that varies as per the region), a sustained difference in the land prices of plots situated in urban and rural regions is noted.

**Fixed Effects Panel Estimations**

From Oikarinen and Engblom (2015), the fixed effects model considers the influence of fundamentals on real estate prices as being the same in all regions. Subsequently, through the regression results, it will be assessed if the fixed fundamentals affect the prices to the same extent in all regions. The results obtained from the fixed effects estimation are given in table 2.

<table>
<thead>
<tr>
<th>Table 2. Fixed Effects Panel Estimations residential land prices - fundamentals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanatory Variables</strong></td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Coefficient</td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>Population</td>
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<tr>
<td>Income</td>
</tr>
<tr>
<td>Real Interest Rate</td>
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<tr>
<td>Unemployment</td>
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<tr>
<td>Residential Building Permits</td>
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<tr>
<td>Real Construction Cost Index</td>
</tr>
</tbody>
</table>

### **R**\(^2\) = 0.783  R\(^2\) = 0.819  R\(^2\) = 0.798

***represents significance level at 1%, ** represents significance at 5% and * represents significance at 10%
The variable found to influence land prices in the most significant way is income. For the whole sample, at the national level, income is found to have a positive significant effect on land prices. In the two regions income positively significantly affect land prices, although the influence differs in terms of magnitude. An increase of 1% in income leads to an increase in land prices of around 0.49% and 0.75% in urban and rural regions respectively. A higher influence of income is depicted in rural regions. Some past studies, for example, Malpezzi (1999) and Oikarinen and Engblom (2015) had also depicted a positive link between the two variables. The present study shows that for the same rise in income, a higher is noted in land prices in rural regions as compared to urban regions.

At the national level, the population is depicted as having a positive significant effect on land prices. Although for the regional breakdown, it is found that the population is significant and positive only in urban regions and not in the rural regions. The Mauritian population consists of around 1.2 million individuals and the number of inhabitants in the urban regions is approximately equal to 500000 (all the urban regions in Mauritius have been included in the sample) and the remaining individuals live in rural (around 163000 for the selected regions). Given that roughly around half of the inhabitants stay in urban regions, this could justify the positive significant bearing that the variable has on land prices in urban regions. Using a fixed-effects approach Oikarinen and Engblom (2015) concluded that population and income were insignificant in regional real estate price differences.

Unemployment bears a positive significant link with land prices at the national level, as well as in urban and rural regions. A positive relationship had also been obtained by Belke and Keil (2017) when studying housing prices in Germany. Normally categorized as a demand-side factor, as unemployment increases land demand and prices should decrease. In the main residential zones in Mauritius, that is urban and rural regions, the opposite is noted. Unemployment could be affecting the supply of real estate, mainly housing as this is quite a labor-dependent industry. A decreasing supply of housing and hence land supply could entail price increases. Coastal regions are not affected by the unemployment level.

The real interest rate is found to have a negative significant relationship with real land prices in the three samples, namely national, urban and rural. This suggests that a lower interest rate would encourage borrowing and consequently increase land demand and prices. In the Mauritian context, the majority of individuals have their primary houses in the urban and rural regions. These are normally financed with savings and borrowings, justifying the higher demand at low-interest rates. Using a similar approach to explain regional housing price differences, Oikarinen and Engblom (2015) found a negative link between interest rate-housing prices. Among the supply-side factors, namely residential building permits and real construction costs, in most of the regions the variables are insignificant in explaining residential land prices. The fixed effects panel model demonstrates that fluctuations in land prices mainly occur as a consequence of changes in the demand-side factors.

**Conclusion**

The objective of the present study was to establish if regional land price differences can be explained by their link with fundamental factors. More so to depict if the same fundamentals can have different influences on land prices depending upon the region where the land plot is situated. The regional categorization is done by using urban and rural distinctions, with the fundamental factors categorized as demand and supply-side factors.

Using a panel data estimation method, namely a fixed-effects panel model, the regional relationships between the fundamentals and real residential land prices were estimated. The fixed-effects model, a static model assumes that the fundamentals’ influence on regional residential land prices is the same across the different regions. The population is found to be positively significant in explaining residential land prices and it is in the urban regions that this influence is most significant. Income has a positive significant effect on real land prices in all regions, which is more pronounced in rural regions. In urban and rural regions, which contain most of the residential real estate properties, interest rate has a negative significant link with land prices. Whilst the supply-side factors are mostly insignificant in explaining land prices.

**Implications**
In the Mauritian context, over the study period, it is noted that some supply-side factors are not influencing land prices. The regulators and other parties operating in the land market should be focusing more on the demand-side fundamental factors, as these represent the factors determining land prices. Although in rural areas land availability is higher and restrictions on the use of land tend to be lower and according to Jud and Winkler (2002), these two aspects are important in justifying regional land price differences. In the rural regions of Mauritius with a higher supply, the residential land prices are relatively lower as compared to urban regions.

The influence of some variables, such as population size should be assessed more on a regional basis, rather than at the national level. The analysis of the results at the national level illustrates that population is significant in explaining land prices, although in rural regions it is insignificant.

Limitations

The analysis is not without its limitations. Data availability has restricted the study period from 2000 to 2019, for example, data for the construction costs index is available from the year 2000. An analysis over a longer period might have provided a better definition of the links fundamentals-land prices in the regions. Given the lack of studies on land prices and fundamentals in similar contexts, direct comparisons could not be made in terms of the results obtained. Latent variables such as land-use restrictions will normally have a regional bearing on residential land prices and the fact that there is no quantifiable measure available for this variable, its effect on land prices could not be studied. Another component not included in this study due to lack of data is regional taxes where inhabitants of urban regions pay a municipal tax in contrast to those living in rural regions and this could partly explain land price differences.

References


