

AN ARDL MODEL OF THE DEMAND FOR HOUSING IN BARBADOS

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ABSTRACT

This study provides empirical estimates for the demand for new housing in Barbados using time series data for the period 1965-2004. An Autoregressive Distributed Lag (ARDL) modelling process is employed to capture the effect of prices, income, interest rates and demographic factors on demand. The computed elasticities indicate that income is the most significant variable in explaining the demand for new housing. The price of housing has no measurable impact, which would indicate that the ability to service one's mortgage may be more critical to the householder. The results of the study can be used to guide government policy.

Keywords: Housing demand, Small Island Economies, ARDL
Modelling
JEL classification code: R21, R31, R20

Section I

Housing in Barbados

1.0 Introduction

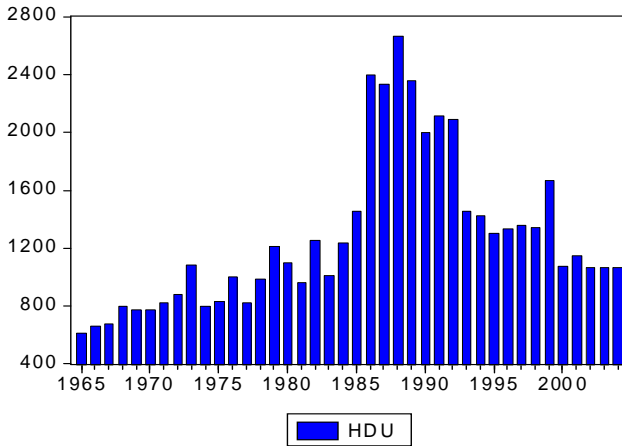
The Government of Barbados – both present and past administrations - has outlined the provision of adequate housing for Barbadians as a key component of its overall development strategy and vision. Indeed, housing is an integral part of a wider development strategy that has to date seen Barbados ranked 30th in the United Nations human development index for all countries and number one among developing countries in 2005. At the same time, Barbados, as a developing country with scarce resources – land, labour and capital – must rationalise the use of these limited resources. In recognition of these constraints and this commitment, a better understanding of housing demand is needed as a basis for sound economic planning and policy. This study therefore seeks to estimate the aggregate housing demand function for Barbados. A preliminary examination of the housing sector in Barbados provides some useful insights as a starting point for a more in depth analysis.

1.1 Background on Housing in Barbados

A preliminary examination of the housing sector data after 1981 shows a significant expansion in private residential building activity (see Figure 1 below). It is noteworthy that the period of greatest change in the housing stock was one of strong macroeconomic performance.

Access to financing may have played an important role in this outcome as well. The enhanced competition in the mortgage market arising from an increase in the number of players, which now includes commercial banks, insurance companies, trust companies and the Barbados Mortgage Finance Company (BMFC)¹, has probably been a contributing factor to the strong growth of the sector.

¹ The National Housing Corporation (NHC), a public institution, was engaged in mortgage lending prior to 1979 but withdrew from the market and specialized

Figure 1: Housing Units completed, 1965-2004

Source: Barbados Economic Report, Government of Barbados Printing Press (1965-2004).

Following rapid growth in the latter half of the decade, growth in mortgage lending and new housing slowed considerably entering the 1990s. The fall-off coincided with the economic recession, which occurred between 1991-1993 and may perhaps have also been related to the policy change by the Central Bank of Barbados. In 1992, the Bank ceased fixing the maximum interest rate chargeable on residential mortgages, which would have allowed market forces to push up mortgage rates to a point where they were comparatively less attractive. Alternatively, the competition for the limited financial resources may have intensified with competing tourism projects being given priority over residential construction. The period 1994-2000 was a period of strong growth in construction activity, mostly tourism-related projects.

The slower growth may also have been reflective of the strong emphasis on the upgrading of existing units, which appears to have taken place at the expense of new construction over the last ten years. This is evidenced in the types of mortgage lending taking place. Total

in the construction of homes for sale and rent. This meant that the BMFC was the sole public lender.

outstanding long-term residential mortgages grew by almost 7000%, far surpassing the 57.6% growth in the overall housing stock. This suggests that not all mortgages were for new properties, although it is highly probable that the extraordinary growth in total mortgages reflects, at least to some extent, higher prices. However, in the absence of data the apparent substitution effect cannot be confirmed.

1.2 Previous Work on Housing Demand in Barbados

Holder (1985) analysed the demand for housing in Barbados using a partial adjustment model that included prices, income and interest rates as the major determinants of demand in which he hypothesized the following:

- The demand for housing depended on the conditions attached to mortgage lending due to the inability of most individuals to build a house without a mortgage. One such condition is the ability to repay the loan, which is assessed based on an individual's income and the price of the housing unit;
- The price of other goods must also be considered since individuals must make choices between satisfying their housing needs and their non-housing needs;
- The terms on which mortgage finance is available – interest rates, the down payment required and the amortization period – determine whether people at certain levels of income can afford a house;
- A growing population requires more sheltered living space, provoking a greater demand for housing;
- The actual demand for housing is only a fraction of the desired demand hence there is a relationship between current housing demand and housing in the previous year.

Holder (1985) concluded that the level of income and the price of all goods except housing were the most powerful influences on the demand for housing in Barbados. This analysis is consistent with the literature as previously discussed and captures all of the salient features of the housing demand market as it relates to the choice of variables. Holder

provides a useful starting point for the current research in selecting from the myriad of seemingly relevant variables.

This paper is organised as follows: Section II provides a brief review of the literature on the demand for housing. Section III outlines the methodology that is employed, while Section IV discusses the econometric results. The final section presents the concluding remarks.

Section II

Previous Literature on Measuring Demand for Housing

2.0 Economic Theory

Megbolugbe et al. (1991) provided a useful review of the theory of housing demand. Housing demand is generally defined as total household expenditure and public investment in housing. In the literature, housing demand has been approached from the perspective of neo-classical consumer theory, which makes certain assumptions about the nature of consumer behaviour, the housing commodity and the housing market:

- the housing market is perfectly competitive;
- household decision-making mirrors consumer decision-making, i.e. the rational consumer optimises utility, subject to income and price constraints or, alternatively, a household chooses between housing and non-housing commodities;
- the object of consumer decision is not a heterogeneous housing commodity but homogeneous housing services, which are unobservable;
- the housing market is part of a tax-free world where asset and capital markets are perfect and in equilibrium.

However, this framework results in a high degree of 'unexplained' variance in housing consumption behaviour. Therefore, housing demand models have generally sought to modify the neoclassical consumer theory to incorporate certain features of the housing market such as consumer attitudes, preferences and perceptions in order to develop an imperfect and non-competitive theory of the housing market.

In such models, the household's attempt to maximize utility with respect to housing and non-housing commodities and the general form of housing demand equation, is defined as:

$$Q = q(Y, P_h, P_o, T) \quad 1$$

where: Q represents housing consumption, Y is household income, P_h is the relative price of housing, P_o is the relative price of other goods and services and T is a vector of taste factors. Sometimes a vector of household demographic characteristics (H) is included, e.g. age, race, marital status, household composition, to capture differences in tastes unrelated to income and price factors. So if $T = t(H)$ then equation (1) is rewritten as follows:

$$Q = q(Y, P_h, P_o, H) \quad 2$$

Therefore, the most commonly used determinants of housing demand are income, price and taste, with household demographics (e.g. total number of households) and housing characteristics used as proxies, since taste is hard to quantify.

However, practical issues exist in the specification of econometric housing models, including the correct measurement of prices, quantities and incomes. Thus, a wide variety of variables has been included in housing demand models:

- Housing consumption – number of owner-occupied dwellings/housing stock, rental stock, mortgage repayments, market values, rates, rents and imputed rents as measurements of housing expenditure;
- Real house prices - consumer expenditure deflator/inflation, interest rates;
- Income - net or gross of taxation, current or permanent, real personal disposable income, personal sector financial wealth, household total debt, mortgages outstanding.

There is also no consensus as to socio-demographic variables to be included e.g. unemployment rate, total population, household size, age of household head, regime-change dummies (e.g. tax reform), seasonal dummies. Similarly, there is no consensus in the choice of empirical methodologies employed.

Broadly, the determinants may be characterized as economic and/or demographic. The standard economic variables can be further decomposed into macroeconomic and housing-related. GDP and interest rates would constitute macroeconomic variables and the housing-related variables would include housing prices, household income and unemployment rate. Demographic variables include population, number of marriages and birth rates. While there is no generally accepted model of the demand for housing, the literature has focused on certain key variables, namely income, prices and one or two demographic variables.

Marcin and Kokus (1975) and McAllister (1967) explored a range of demographic variables in their investigation of the demand for housing in the United States. Similarly, Gagne and Tully (2003) considered the influence of demographic variables that capture household size and household formation on the demand for housing. Marriage and household formation were also examined in a study by Morrison (1977) and Sirmans and Webb (1979). Many of these studies focused on developed countries. In the following section, two of the studies that have focused on developing countries and one that utilized the ARDL approach are examined. A more extensive review of the literature can be found in Malpezzi and Mayo (1987) and Donatos (1995).

2.1 Survey of Empirical Results

Hunaiti (1995), in a study of the relative importance and elasticities of the determinants of housing market behaviour in the urban sector in Jordan, used a loglinear specification and a stepwise multiple regression model. The model estimated was as follows:

$$\ln R = a + b_1 \ln Y + b_2 \ln P + b_3 \ln H + b_4 \ln Ag + b_5 \ln T \quad 3$$

where: R is imputed or explicit monthly housing expenditure, Y is current disposable monthly income, P is the price per unit of housing services and T is the monthly transport cost.

The main finding was that households tried to maintain their level of housing, even if prices increased, by minimising expenditure on other basic needs. Overall, household income and household size were found to be the most important determinants of housing demand.

In a more recent study by Halicioglu (2005), a single cointegration technique is utilized to estimate the demand for housing in Turkey. Halicioglu posited that housing demand is determined by economic and demographic factors. The model used is:

$$\ln HD = a_0 + a_1 \ln Y_t + a_2 \ln HC_t + a_3 \ln UR_t + \varepsilon_t \quad 4$$

where: HD is the total number of private houses completed², Y is the real household disposable income³, HC is the average unit cost of dwellings⁴ and UR is the urbanization rate index⁵. The expected signs of the parameters are: $a_1 > 0, a_2 < 0, a_3 > 0$.

For Halicioglu, the most significant factor in determining the level of housing demand was real income, followed by house prices and level of urbanization. The estimated income and price elasticities were found to be in line with previous empirical studies in the literature. The estimated private housing demand function revealed a stable long-run relationship between independent and dependent variables and a relatively stable housing demand function. Overall, the results indicated the possibility of using the estimated aggregate private housing demand function as a policy tool in implementing housing policy in Turkey.

² Total of housing units constructed by the private sector and granted occupancy permits by the local councils.

³ Real disposable income in millions of Turkish liras at 1990 prices is used as a proxy for permanent income. Nominal household consumption expenditures deflated by CPI=1990

⁴ Average real cost of a unit dwelling in thousands of Turkish liras, used as a proxy for house prices. Nominal cost deflated by CPI=1990

⁵ Ratio of total cities and town population to total population, converted to a 1990=100 base index.

This literature review points to the heterogeneous nature of the housing market, which has resulted in considerable variation in the estimated determinants of housing demand across countries and indeed across different locations within the same country (de Leeuw, 1971; Mayo, 1981; Malpezzi and Mayo, 1987; Fulpen, 1988; Donatos, 1995). This heterogeneity also has implications for the choice of appropriate functional form and methodology. Consequently, modelling the demand for housing requires country or region-specific knowledge (Halicioglu, 2005).

In Barbados, there has been little research on housing demand, apart from the seminal work of Holder (1985), in which he analysed the demand for housing using a partial adjustment model that included prices, income and interest rates as the major determinants of demand over the period 1960-1981. Given the country-specific nature of the demand for housing, the Holder (1985) study provides a useful reference point for the present study, particularly in relation to the choice of variables. However, the Barbadian economy has undergone considerable transformation in the twenty-five years following this initial research, and the field of econometrics has also made significant advances during this time. Therefore, following the recent housing demand literature, the Auto Regressive Distributed Lag (ARDL) approach as proposed by Pesaran et al. (2001) is employed to compute short and long-run elasticities for the main determinants of demand for housing. Furthermore, drawing on the recent literature a demographic variable, marriage, is included as a proxy for new household formation. The choice of demographic variable is influenced by data availability and the performance of other proxies, which were found to be insignificant.

Section III

Research Methodology

3.0 Model

In light of previous research (Holder 1985) and the empirical evidence in other housing demand studies identified in the last section, the following housing demand model is considered and is expressed in natural logarithmic multiple regression form:

$$\ln HDU_t = \alpha_0 + \alpha_1 \ln PH_t + \alpha_2 \ln PO_t + \alpha_3 R_t + \alpha_4 \ln I_t + \alpha_5 \ln M_t + \epsilon_t \quad 5$$

where: HDU is the total units of housing completed per capita; PH is the price of housing; PO is the price of other goods; R is the average lending rate; I is per capita income; and M is the number of marriages per capita. The expected signs of the parameters are as follows: $\alpha_1 < 0$, $\alpha_2 < 0$, $\alpha_3 < 0 < \alpha_3$, $\alpha_4 > 0$, $\alpha_5 > 0$.

The marriage variable serves as a proxy for the demographic factors and was selected based on its performance among the set of demographic variables considered. Its inclusion to account for the impact of the formation of new family units, which is supported by previous research, added to the variable set utilised by Holder (1985). The other variables are standard with the expected signs, except for the interest rate variable. The sign of the interest rate variable is treated as ambiguous. There is a perception that high interest rates would lead to high and rapidly increasing housing cost, which in turn would lead to a substantial decline in the quantity of housing demanded, but this is not necessarily so (see Dhrymes and Taubman, 1969).

The interest rates can feed through two channels with offsetting signs. Firstly, higher interest rates will encourage deposits and can enhance housing demand through its effect on mortgage credit availability. Secondly, higher interest rates will lead to higher borrowing costs and can depress housing demand. Consequently, there is some

ambiguity surrounding how interest rates impact on credit and the demand for housing. It is, therefore, not clear *ex ante* whether the sign of the coefficient of the interest rate should be positive or negative. This was also acknowledged by Holder (1985).

Another departure from Holder's study (1985) is in the choice of estimation technique. Advances in econometrics subsequent to the Holder study have allowed for better estimation techniques. Most economic variables exhibit strong trends, that is, they are non-stationary and are not amenable to the standard least squares estimation which, if used, can give rise to serious errors in the inferences. It has been found that a non-stationary variable might have a long-run relationship with other non-stationary variables and this does not create a spurious regression if the deviation of this long-run relationship is stationary.

While several econometric methods have been proposed for investigating long-run equilibrium (cointegration) among time series variables, including Engle and Granger (1987), Phillips and Hansen (1990), and Johansen (1988), for the purpose of this research the autoregressive distributed lag (ARDL) modelling approach is utilized. Popularized by Pesaran and Pesaran (1997), Pesaran and Smith (1998), and Pesaran et al. (2001), the ARDL modelling approach has several advantages in comparison with other single cointegration procedures. These advantages have been noted by several authors, including Halicioglu (2005), and result from the ability to estimate the long and short-run parameters of the model simultaneously, while avoiding the problems posed by non-stationary time series data. In addition, this approach does not require a prior determination of the order of the integration amongst the variables, unlike other approaches which require that the variables in the time series are integrated of the same order. Another advantage is that the model takes a sufficient number of lags to capture the data generating process in a general-to-specific modelling

framework (Laurenceson and Chai, 2003). An ARDL representation of the housing demand equation is formulated as follows:

$$\begin{aligned} \Delta \ln HDU_t = & \alpha_0 + \sum \alpha_{1i} \Delta \ln HDU_{t-i} + \sum \alpha_{2i} \Delta \ln PH_{t-i} + \\ & \sum \alpha_{3i} \Delta \ln PO_{t-i} + \sum \alpha_{4i} \Delta R_{t-i} + \sum \alpha_{5i} \Delta \ln I_{t-i} + \sum \alpha_{6i} \Delta \ln M_{t-i} + \\ & \alpha_7 \ln HDU_{t-1} + \alpha_8 \ln PH_{t-1} + \alpha_9 \ln PO_{t-1} + \alpha_{10} R_{t-1} + \\ & \alpha_{11} \ln I_{t-1} + \alpha_{12} \ln M_{t-1} + \varepsilon_t \end{aligned} \quad 6$$

In this equation, the terms with the summation signs capture the short-run dynamics of the model, whereas other terms represent the long-run relationship. The ARDL process begins with a test of the presence of a long-run relationship amongst the variables, using the bounds testing procedure of Pesaran et al. (2001). The bounds testing procedure is based on the F-statistics and is a joint significance test of the null hypothesis of no cointegration/long-run relationship (Ho: $\alpha_7 = \alpha_8 = \alpha_9 = \alpha_{10} = \alpha_{11} = \alpha_{12} = 0$). If the F-calculated statistic exceeds the upper critical value tabulated by Pesaran et al. (2001), (the F distribution for this procedure has a non-standard distribution), then the null hypothesis of “no long-run relationship” can be rejected, regardless of the order of integration of the variables. If, however, the test statistics fall within the bounds, then the test becomes inconclusive. A test statistic that is below the lower critical bounds value would suggest that there is no cointegration/long-run relationship.

The ARDL method estimates $(p+1)^k$ regressions in order to obtain optimal lag length for each variable, where p is the maximum number of lags to be used and k is the number of variables in the equation. The appropriate model can be selected using model selection criteria like Schwartz-Bayesian Criteria (SBC) and Akaike’s Information Criteria (AIC). SBC is known as the parsimonious model, selecting the smallest possible lag length, whereas AIC is known for selecting the maximum relevant lag length.

Once a long-run relationship has been established amongst the variables, then the long-run estimates of the ARDL model can be obtained. When there is a long-run relationship between the variables

then there exists an error correction representation. Therefore, in the third step, the error correction model is estimated; it indicates the speed of adjustment back to the long-run equilibrium after a short-run shock.

A general error correction representation of Eq. (6) is formulated as follows:

$$\Delta \ln HDU_t = \alpha_0 + \sum \alpha_{1i} \Delta \ln HDU_{t-i} + \sum \alpha_{2i} \Delta \ln PH_{t-i} + \sum \alpha_{3i} \Delta \ln PO_{t-i} + \sum \alpha_{4i} \Delta R_{t-i} + \sum \alpha_{5i} \Delta \ln I_{t-i} + \sum \alpha_{6i} \Delta \ln M_{t-i} + \lambda EC_{t-1} + u_t \quad 7$$

where λ is the speed-of-adjustment parameter and EC represents the residuals that are obtained from the estimated cointegration model of Eq. (6).

To ascertain the goodness of fit of the ARDL model, the diagnostic and stability tests are conducted. The diagnostic test examines the serial correlation, functional form, normality and heteroscedasticity associated with the model. The stability test of the coefficients of the regression parameters is undertaken using the Brown et al. (1975) stability testing technique, also known as cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ).

3.1 Estimation

Using the Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1979 and 1981) unit root test, all the series are found to contain a unit root in their levels and thus are difference-stationary.

An ARDL cointegration procedure is implemented in estimating Eq. 6, which is expressed in natural logarithmic multiple regression form⁶, using annual data for Barbados over the 1965-2004 period. The optimal lag length based on AIC and SBC was found to be three. The bounds test is employed to ascertain the existence of a long run relationship among the variables (see Table A.1 in Appendix 1).

The total number of regressions estimated following the ARDL method is $(3+1)^6=4096$. The models selected by SBC and AIC are

⁶ The interest rate is taken at the level so the model is semi-log.

(2,3,0,1,0,2) and (2,3,0,1,2,2), respectively. The AIC-based model is selected because its diagnostic results and error-correction model seem to be a relatively better fit than the SBC-based model (see Table A.2 in Appendix 1 for the results of the SBC model). The results of the selected equation, including the diagnostic test statistics and the plot of the stability test results of the model, are outlined below.

Section IV Results

The high R^2 shows that overall goodness of fit of the model is satisfactory. The F-statistics measuring the joint significance of all regressors in the model are statistically significant at the one per cent level. Similarly, the Durbin-Watson statistic is greater than two. The model also passes all the diagnostic tests for correct functional form, normality and the absence of residual autocorrelation or heteroscedasticity.

Table 1
Autoregressive Distributed Lag Estimates
ARDL(2,3,0,1,2,2) selected based on Akaike Information Criterion

Dependent variable is $\ln HDU$ 37 observations used for estimation from 1968 to 2004			
R-Squared	.90868	R-Bar-Squared	.84344
S.E. of Regression	.13331	F-stat. F(15, 21)	
	13.9300[.000]		
Mean of Dependent Variable	-5.3246	S.D. of Dependent Variable	.33691
Residual Sum of Squares	.37319	Equation	
		Log-likelihood	32.5363
DW-statistic	2.2578		
Test Statistics	LM Version	F Version	
A:Serial Correlation	CHSQ(1) = 1.1858[.276]	F(1, 20) = .66219[.425]	
B:Functional Form	CHSQ(1) = 2.4127[.120]	F(1, 20) = 1.3951[.251]	
C:Normality	CHSQ(2) = 2.6957[.260]	Not applicable	
D:Heteroscedasticity	CHSQ(1) = .009911[.921]	F(1, 35) = .009378[.923]	
A:Lagrange multiplier test of residual serial correlation			
B:Ramsey's RESET test using the square of the fitted values			
C:Based on a test of skewness and kurtosis of residuals			
D:Based on the regression of squared residuals on squared fitted values			

Plots of the stability test results (CUSUM and CUSUMSQ) of the model are given below:

Figure 2

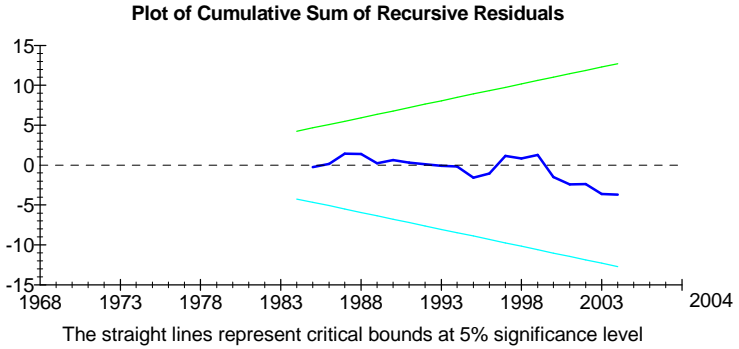
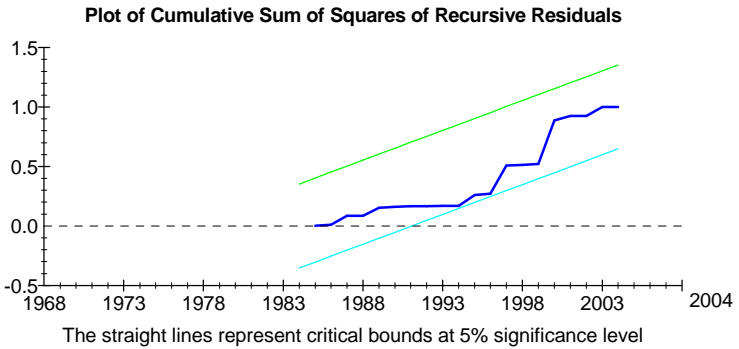


Figure 3



The CUSUM and CUSUMSQ plotted against the critical bound of the five per cent significance level show that the coefficients in the ECM are stable over time.

The long-run results of Equation 6 are reported in Table 2.

Table 2
Estimated Long-Run Coefficients using the ARDL Approach
ARDL(2,3,0,1,2,2) selected based on Akaike Information Criterion

Dependent variable is $\ln HDU$

37 observations used for estimation from 1968 to 2004

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$\ln PH$	-.75969	.97803	-.77676[.446]
$\ln PO$	-3.3234	1.3703	-2.4254[.024]**
R	.26617	.067149	3.9638[.001]**
$\ln I$	3.4069	1.1979	2.8440[.010]**
$\ln M$	-.61035	.37706	-1.6187[.120]
Constant	-24.2618	5.0220	-4.8311[.000]**

** Significant at 5% level

The long-run test statistics (Table 2) reveal that most of the variables are statistically significant with the expected signs at the five per cent level. More specifically, income, price of other goods and interest rates are the key determinants of housing demand in Barbados. The coefficient of $\ln PO$ is -3.32 , which suggests that in the long run an increase of one percent in the price of other goods is associated with a decrease in housing demand of 3.32 percentage points. The magnitude of the impact of the price of other goods on housing demand is second only to income, which has a strong positive impact. Interest rates, although statistically significant at the 5% level, have a smaller relative positive impact estimated at 2.37⁷. As previously noted, the sign of the interest rate variable is ambiguous, with the possibility of a positive effect on housing demand. The price of housing and the demographic variable, marriage, are not significant at the five or ten per cent level.

These results are largely consistent with Holder (1985), who found income and the price of other goods to be significant - in other words, individuals' ability to service their mortgage seemed to be the overriding

⁷ The elasticity measure for the interest rate is an average of the coefficient times the interest rate for each year.

determinant of their demand for housing - while the price of housing and interest rates were insignificant. Hunaiti (1995) had similar findings for Jordan. The regulation of mortgage rates over much of the period covered by Holder (1985), which contributed to its lack of variability, might explain the insignificance of this variable in the Holder study.

Table 3
Error Correction Representation for the Selected ARDL Model
ARDL(2,3,0,1,2,2) selected based on Akaike Information Criterion

Dependent variable is $\Delta \ln HDU$

37 observations used for estimation from 1968 to 2004

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$\Delta \ln HDU1$	-.22494	.16296	-1.3804[.180]
$\Delta \ln PH$	.042041	.57957	.072539[.943]
$\Delta \ln PH1$	-1.0561	.40878	-2.5836[.016] **
$\Delta \ln PH 2$	-1.1776	.39634	-2.9712[.006] **
$\Delta \ln PO$	-1.6914	.60622	-2.7901[.010] **
ΔR	-.011383	.037795	-.30119[.766]
$\Delta \ln I$	.79430	.59141	1.3431[.191]
$\Delta \ln I1$	-1.2441	.70876	-1.7553[.091]***
$\Delta \ln M$	.73131	.34820	2.1003[.046] **
$\Delta \ln M1$	.64649	.24851	2.6014[.015] **
Δ Constant	-12.3476	2.6669	-4.6299[.000] **
$ecm(-1)$	-.50893	.12703	-4.0064[.000] **

** Significant at 5% level

*** Significant at 10% level

R-Squared	.69325	R-Bar-Squared	.47415
S.E. of Regression	.13331	F-stat. F(11, 25)	4.3145[.001]
Mean of Dependent Variable	.0080551	S.D. of Dependent Variable	.18383
Residual Sum of Squares	.37319	Equation	
		Log-Likelihood	32.5363
DW-statistic	2.2578		

The short-run dynamics of the model are given in Table 3. It shows that while the coefficient of the price of housing is not statistically significant at the five percent level, the coefficients of ΔPH lagged one and two periods are, implying that while price has no statistically significant long-run impact on housing demand, changes in housing prices lagged one and two periods are associated with a change in housing demand in the short run. Another interesting observation is the significance of the change in marriage variable on change in housing demand. There is a positive short-run impact of marriages on demand for housing. The change in the price of other goods has a statistically significant effect as well. However, the change in income is not statistically significant except lagged one period and at the 10 per cent level.

The coefficient of ECM is found to be relatively large in magnitude and statistically significant and confirms the long-run relationship between the variables. At -0.508 it indicates a relatively rapid adjustment process, with over 50% of the disequilibria of the previous year's shock adjusting back to the long-run equilibrium in the current year. This is well above the figure of 0.295 reported by Halicioglu (2005) for Turkey.

Section V

Conclusions

Given the importance of housing for the construction industry, the financial system, labour market and wider economy, monetary and general economic policy must take into account their potential impact on housing demand.

The results of this study indicate that income, the price of non-housing items and interest rates largely explain the pattern of demand for housing in Barbados, with interest rates apparently having a positive impact on the demand for housing through their effect on mortgage credit availability. This indicates the primacy of individuals' ability to service their mortgage in their housing decisions. Indeed, it appears from the statistical insignificance of the price variable in the long run, that not

even escalating housing prices have been a deterrent to potential homeowners. However, the short-run impact of the price variable suggests that rapid, uncontrolled house price inflation could still pose a risk. These findings indicate where policymakers should focus their attention in a bid to achieve their desired outcome. Clearly, based on these results, what is relevant for policy is that income grows commensurate with housing prices.

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APPENDIX

Variables, Data Sources and Additional Test Results

The definitions of variables and data sources are as follows:

HDU is the total number of housing units constructed by the private sector and approved by Town and Country Planning per capita.

Sources: Various issues of the Government of Barbados, Economic Report 1964-2005.

PH is the housing price index taken from the Retail Price Index. This index covers rents, insurance, taxes and the cost of building materials, repairs and maintenance. To the extent that the type of housing captured by the index may be related to low-income and not fully representative of the market, then this proxy for housing prices might not be reliable, which might explain the results.

Sources: Various issues of the Central Bank of Barbados, Annual Statistical Digest, 1964-2005. *PO* is the Retail Price Index excluding housing prices.

Sources: Various issues of the Central Bank of Barbados, Annual Statistical Digest 1974-2005. *R* is the mortgage rate.

Sources: Various issues of the Central Bank of Barbados, Annual Statistical Digest 1974-2005. *I* is Per Capita GDP.

Sources: Various issues of the Central Bank of Barbados, Annual Statistical Digest 1974-2005. Demographic factors are captured by the number of marriages *M* per capita.

Sources: Various issues of the Government of Barbados, Economic Report 1964-2005.

Key Regression Statistics

Table A.1
Variable Deletion Test (ARDL Case)

Dependent variable is $\ln HDU$

List of the variables deleted from the regression:

$\ln HDU (-1)$	$\ln PH$	$\ln PO$	R	$\ln I$
$\ln M$				

37 observations used for estimation from 1968 to 2004

Joint test of zero restrictions on the coefficients of deleted variables:

Lagrange Multiplier Statistic	CHSQ(6) = 17.9854[.006]
Likelihood Ratio Statistic	CHSQ(6) = 24.6313[.000]
F Statistic	F(6, 21) = 3.3106[.019]

Notes: The relevant critical value bounds are obtained from Table CI(iii) (with an unrestricted intercept and no trend; with five regressors) in Pesaran et al. (2001). These are 2.26-3.335 at 90%, and 2.62-3.79 at 95 %. Inconclusive but given the significance of the ECM term it can be concluded that a long-run relationship exists.

Table: A.2
Autogressive Distributed Lag Estimates
ARDL(2,3,0,1,0,2) Selected Based on Schwarz Bayesian Criterion

Dependent variable is $\ln HDU$

37 observations used for estimation from 1968 to 2004

R-Squared	.89088	R-Bar-Squared	.82921
S.E. of Regression	.13924	F-stat. F(13, 23)	14.4447[.000]
Mean of Dependent Variable	-5.3246	S.D. of Dependent Variable	.33691
Residual Sum of Squares	.44590	Equation Log-likelihood	29.2430
DW-statistic	2.2067		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(1)= .94152[.332]	F(1, 22)= .57444[.457]
B:Functional Form	CHSQ(1)= 5.1184[.024]	F(1, 22)= 3.5320[.074]
C:Normality	CHSQ(2)= .0037437[.998]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .38793[.533]	F(1, 35)= .37085[.546]*

A:Lagrange multiplier test of residual serial correlation

B:Ramsey's RESET test using the square of the fitted values

C:Based on a test of skewness and kurtosis of residuals

D:Based on the regression of squared residuals on squared fitted values