INTEREST RATE PASS-THROUGH: EMPIRICAL EVIDENCE FOR BARBADOS

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ABSTRACT

Using an error correction model derived from a partial adjustment model, this paper empirically investigates the effectiveness of central bank's interest rate policy (minimum deposit rate) on commercial banks' lending rate behaviour in Barbados for the period 1980 to 2007. The study finds that the reaction of commercial banks' lending rate to changes in the central bank's policy rate is sticky in the short-run, but fully complete or effective in the long-run. On average, it takes almost two quarters for the full effect of changes in the central bank's policy rate to be transmitted to the economy, via adjustments. To make the lending rate fully effective in the short-term, in the first instance, the minimum deposit rate must be increased (decreased) by approximately 300 basis points in order to record an increase (a decrease) of lending rate by 100 basis points. Some of the reasons for the high cost of adjustment have been carefully discussed. Among others, market power, demand elasticity of loans, switching costs and asymmetry in information costs could be the elements to look at to boost the effectiveness of interest rate policy.

Key words: interest rate pass-through, error correction model, partial adjustment model.

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1. Introduction

Any government can use at the very least fiscal policy and/or monetary policy to impact the country's macroeconomic aggregates such as inflation rate, unemployment rate and economic growth. While government taxes and government expenditures are the main tools of fiscal policy, interest rate and money supply are the key instruments of monetary policy. The choice of one policy over another or the policy mix depends on the characteristics of the country under consideration; i.e., exchange rate regime, level of development, and size of the economy.

This paper addresses the issue of interest rate pass-through in the context of a small open economy, Barbados. Precisely, it analyzes the dynamics of Barbados commercial banks' lending rate reactions to changes in Barbados central bank's policy rate (minimum deposit rate); hence, it speaks to the issue of effectiveness of interest rates in affecting the Barbadian economy. Specifically, it focuses on the following questions. First, does the central bank's minimum rate affect the commercial bank lending rate? Second, if yes, what are the sizes of short-tem and long term interest rate pass-through? Third, what is the minimum response time for the central bank's action to impact on commercial banks' average lending rate?

As it is well documented, central banks are at the core of monetary policy through their vital "influence on money market conditions", particularly on money market interest rates. The following quote illustrates well the impact of money market rates on retail or commercial banks interest rates and definitely the economy:

"Changes in money market interest rates, in turn, affect market interest rates with longer maturities and retail bank interest rates, albeit varying degrees. Bank decisions regarding the yields paid on their assets and liabilities have an impact on the expenditure and investment behavior of holders and thus real economic activity. In other words, a quicker and fuller pass-through of official and market interest rates to retail bank interest rates strengthen monetary policy transmission and thus may affect price stability. Furthermore, prices set by banks influence their margins and therefore bank profitability and consequently the soundness of the banking system and thus financial stability." (de Bondt, 2005, 37-38).

Among the various commercial banks' interest rates, the paper focuses on the lending rate channel for monetary policy and is motivated primarily by two reasons. First, the recent comments by the Governor of the Central Bank of Barbados in relation to the Bank's concern about the apparent slow response of commercial banks' lending rates to recent reductions in the minimum deposit rate (see Barbados Business Authority, May 5, 2008, p.1) suggest a need for a quantitative investigation to shed some light on the problem. Second, having an idea about the interest rate pass-through provides useful insight into the transmission mechanism of monetary policy, and should provide policy-makers with a general idea concerning when a particular policy action is expected to have an impact on the real economy.

The study focuses on the lending rate mainly because among the myriad of commercial bank interest rates, it is the main channel through which monetary policy action is transmitted to the real economy to the extent that it serves as an important guide to investment decisions. This view is supported by works of Borio and Fritz (1995,3) and Oliner and Rudebusch (1995,3). For instance, the latter study points out that "the lending rate channel operates when central bank actions affect the supply of loans from depository institutions ("banks") and, in turn, the real spending of bank borrowers."

Quite a number of papers have documented various degrees of stickiness of lending rates (i.e., Moazzami, 1999; Cottareli and Kourelis, 1994; de Bondt, 2005; Kwapil and Scharler, 2006). The reasons of varying interest rate pass-through may be found, among others, in different degrees of adjustment costs, demand elasticity of loans, implicit contract between the bank and its customers, switching costs, and asymmetric information costs.(see, among others, de Bondt, 2005 and Kwapil and Scharler, 2006). Put rather differently, the degree of stickiness of lending rate depends on the extent to which (1) commercial banks are able to fully insulate their supply of loans in reaction to changes in reserves; (2) the borrowers are able to isolate their spending from alterations in the accessibility of bank loans. (Oliver and Rudebusch,1995,3).

To answer the different questions of the paper, the study uses an error correction model derived from a partial adjustment model. The paper makes three contributions to the literature. First, to the extent that the majority of studies focus on developed countries, this paper, by concentrating

on a small Caribbean economy, adds to the rather sparse body of knowledge on banking sector behaviour in developing countries. Second, this study is also among the very few studies that demonstrate that even though cointegration is not a relevant concept when variables are stationary, a valid error correction model interpretation of results is still possible and that such results are equivalent to those obtained from an autoregressive distributed model. Third, to the best of our knowledge, this study breaks new ground by explicitly showing that autoregressive distributed lag and error (equilibrium) correction models for interest rate pass-through used in the literature can be derived from a partial adjustment model. By so doing, the paper is able to show implicitly that the long-run pass-through really depends on adjustment cost through adjustment coefficient.

The paper is organized as follows. Section 2 briefly introduces the Barbadian economy with emphasis on the central bank and commercial banks interest rate paths. Section 3 contains the literature review. Section 4 focuses on modeling. Section 5 gives the results and interpretations of the exercise. Section 6 contains concluding remarks.

2. Barbados Economy

The Barbadian economy has grown by an average of 3.2% since the last recession in 2001 to become one of the fastest growing countries in the Caribbean. While tourism provides the main impetus for growth in the country, the role of the domestic financial system in the economy has increased significantly with assets rising from 86.4% of nominal GDP in 1980 to 212.2% at the end of 2006. Commercial banks hold a dominant position in the financial system. In 2006, bank assets accounted for well over 65% of total assets, 83.7% of financial sector loans and advances and 94.5% of total financial sector deposits. Being the main source of finance in the economy, the interest rates set by banks strongly impact the investment and consumption decisions of individuals and firms and by extension, cyclical developments and economic growth. This sub-section discusses the data trends on selected interest rates in Barbados over the sample period.

During the 1980's, the banking sector was subjected to a number of restrictions and regulations including programmes geared towards channelling funds to the priority sectors of the economy, with stipulations on saving rate floors as well as ceilings on weighted average lending rates by the Central Bank of Barbados. Around the start of the 1980's, both deposit rates and lending rates were at a fairly low level. However, between 1981 and 1982, the Barbadian economy slumped into recession, registering declines in real GDP of 1.9% and 4.9% in 1981 and 1982, respectively. The recession was accompanied by a deterioration of the current account, which led the central bank to undertake various defensive measures in an effort to protect the balance of payments. Most noteworthy was the increase in the minimum deposit rate to 7% per annum in January 1981, then to 8% in October that year. Meanwhile, the maximum average lending rate was raised twice to reach 15% by October 1981. Reflecting the tightened monetary stance, deposit and lending rates rose. However, with the economy showing signs of recovery in 1983, the Central Bank gradually relaxed its monetary stance and by 1986, both deposit rates and lending rates had returned to pre-1981 levels.

Macroeconomic developments in the early 1990s was characterised by the turmoil in the global economy, including the Gulf war and recessions in Barbados' main tourism source markets, i.e., North America and the United Kingdom. The Barbados economy experienced a significant fall in real economic activity and persistently high current account deficits resulting in significant losses in the foreign exchange reserves. To combat the foreign exchange deficiency, Government in May 1991 entered an 18-month stabilisation programme with the International Monetary Fund aimed at reducing spending on imports through a reduction in the fiscal deficit and private sector credit. To complement the fiscal measures, monetary policy was tightened; the Central Bank discount rate was raised, the minimum deposit rate climbed to 7% and commercial banks were required to hold a greater proportion of deposits in government securities. Additionally, global credit limits were placed on commercial banks and the ceiling on the average lending rate was removed. With the tightened stance and the liberalisation of the

lending rate, the cost of borrowing rose sharply and the average rate on total loans and selected loans[1] stood at 15.0% and 16.0% in December 1991.

By the latter half of 1992, there had been significant improvement in the balance of payments position, a direct result of earlier measures to dampen aggregate demand. However, real economic activity remained in a depressed state. Given the relative improvement in the external sectors, monetary policy became less restrictive as the central bank aimed to revive economic activity. The average deposit rate fell to 5% by year-end, enabling the average lending rate and the rate on selected loans to fall to 12.1% and 11.1% respectively. The financial sector continued to undergo reform as the Rate of Interest Order was revoked in June 1992, the residential mortgage rate was deregulated by September and all ceilings on credit and credit controls were discontinued by May 1993. Throughout the remainder of the 1990s, there were moderate fluctuations in the deposit rates as monetary policy was geared towards managing the level of liquidity in the financial system. However, lending rates were somewhat stable (fluctuating around 11%.) suggesting a rather low pass-through of changes in deposit rates to lending rates.

From 2000 to 2004, the banking sector was characterised by high levels of liquidity, which emanated from sluggish credit growth. Furthermore, the economy slipped into a recession in 2001. Hence, in an effort to quell excess liquidity and spur lending to the more productive sectors, the central bank continuously relaxed its policy stance. Between 2000 and 2001, the Bank cut its minimum deposit rate four times. Nevertheless, commercial banks' lending rates stagnated. Consequently, the Central Bank once again sought to regulate lending rates, instructing commercial banks to set a ceiling on the weighted average interest rates charged on loans to productive sectors. The indicative weighted average lending rate was periodically lowered from a maximum of 10% in August 2001 to 8.5% by December. Yet, lending rates remained relatively high even as bank continued to cut its minimum deposit rate, which reached an all time low of 2.25% in the first quarter of 2004. Consequently, the central bank

[1] In calculating the weighted average lending rates on selected loans, commercial banks are instructed to exclude rates on consumer installment credit, foreign currency loans, staff loans, mortgage loans and sugar, agricultural and industrial credit fund loans rediscounted with the Central Bank.

reintroduced loan rate ceilings in December 2002, setting the maximum average lending rate on selected loans at 8.0%, which quickly translated into a fall in lending rates. However, by 2003 the regulation of loan rates was abolished.

Four years of relatively easy monetary policy stance spurred a high demand for credit throughout 2005 and 2006, leading to a significant tightening of liquidity in the banking system. In response, the Central Bank aggressively raised the minimum deposit rates from 2.25% at the beginning of 2005 to 5.25% by the end of 2006, prompting a general upward trend in lending rates. From the fourth quarter of 2006, liquidity began to build up in the banking system, largely reflecting significant foreign capital inflows and a slowdown in credit demand. In an effort to reduce the liquidity build up, the Central Bank eased monetary policy, lowering the minimum deposit rate to 4.75% by the end of 2007. In general commercial bank's response to the Central Bank actions was slow, as changes in lending rates were only a fraction of the overall changes in the minimum deposit rates.

3. Literature Review

The literature on interest rate pass-through is quite vast. Without dismissing the role of commercial bank deposit rates[2], this literature review focuses on lending rates. At the methodological level, most studies are of time series nature and use an error correction model as a transformation of an autoregressive distributed lag model to study the effectiveness of interest rate transmission mechanism. Precisely, the typical study starts implicitly with the Cottareli and Kouralis model or its variants:

$$LR_t = c + \alpha_1 LR_{t-1} + \beta_0 DR_t + \beta_1 DR_{t-1} + \beta_2 DR_{t-2} + \cdots + \beta_n DR_{t-n} + u_t \qquad (1)$$

where LR_t is the lending rate; DR_t is the central bank's interest rate, u_t is the error term, and n stands for the optimal lag.

[2]It is worth noting that in the European area, de Bondt et al. (2005) showed that the deposit rates are by and large a non predictor of lending rates.

Eq. (1) is an autoregressive distributed lag model of order 1, n: ADL(1,n). The impact multiplier or the short-term multiplier is β_0 and the long-run multiplier is $\beta = \sum_{i=0}^{n} \beta_i \Big/ (1-\alpha_1)$.

A generalized error correction model (ECM) corresponding to Eq. (1) is given by:

$$\Delta LR_t = c + \sum_{i=1}^{n} \alpha_i \Delta LR_{t-i} + \sum_{i=0}^{n} \beta_i \Delta DR_{t-i} + \gamma(LR_{t-1} - \delta DR_{t-1}) + u_t \qquad (2)$$

where β_0 is the short-run multiplier, $\delta = \beta = \sum_{i=0}^{n} \beta_i \Big/ (1-\sum_{i=0}^{n} \alpha_i)$ is the long-run multiplier, γ is the adjustment coefficient, and $M = (1-\beta_0)/\gamma$ is the mean lag adjustment at which the official rate is passed on to lending rates. The completeness of the pass-through is tested with either $\beta_0 = 1$ or $\delta = 1$.

Table 1 to 3 contain the empirical results of the short-run and long-run pass-through for Europe area, USA and Canada and other areas, respectively. Most authors used time series with monthly data. Note that the magnitudes of multipliers are not necessarily comparable since different time periods and different data sources are used.

Table 1: Interest rate pass-through studies: Euro area

Short-term Loans to Firms	Impact	Belgium	France	Germany	Euro Area
Cottarelli and Kourelis (1994)	Short-term	0.67		0.61	0.75
	Long-term	0.87		0.83	0.90
Mojon(2000)	Short-term	1.00	0.71		0.61
	Long-term	1.00	1.00		1.00
Donnay and Degryse (2001)	Short-term	0.85	0.66	0.36	0.58
	Long-term	0.92	0.72	0.42	0.74
Toolsema et al., (2001)	Short-term	0.76	0.53		0.70
	Long-term	1.02	0.62		0.80
Heinemann and Schüller(2002)	Short-term	0.83	0.45		0.75
	Long-term	1.00	1.00		1.00
Angeloni and Ehrman(2003)	Short-term				0.53
	Long-term				1.00
De Bondt (2005)	Short-term				0.19
	Long-term				0.88
Long-term Loans to Firms	Impact	Belgium	France	Germany	Euro Area
Mojon(2000)	Short-term	0.61	0.42		0.37
	Long-term	1.00	1.00		1.00
Donnay and Degryse (2001)	Short-term	0.21	0.23	0.25	0.54
	Long-term	0.10	0.50	0.60	0.67
Toolsema et al. (2001)*	Short-term	0.72	0.08	0.31	
	Long-term	0.90	0.89	0.71	
Angeloni and Ehrmann(2003)	Short-term				0.74
	Long-term				1.30
Kwapil and Schaler (2006)	Short-term				0.79
	Long-term				0.57
Kaufman and Schaler (2006)	Short-term				0.92
	Long-term				1.00
De Bondt (2005)	Short-term				0.55
	Long-term				0.80

Note: (*): 2002 version.

Table 2: Interest rate pass-through studies: USA and Canada

	USA		Canada	
Long-term loan rates	**Short-term Impact**	**Long-term Impact**	**Short-term Impact**	**Long-term Impact**
Cottareli and Kourelis(1994)^	0.41	0.97	0.78	0.93
Moazzami ^^ (1999)	0.34	1.05	0.66	0.95
Short-term loan rates				
Moazzami ^^^ (1999)	0.42	1.07	0.52	0.80
Kwapil and Schaler (2006)	0.79	0.57		
Kaufman and Schaler (2006)	0.92	1.00		

Note: (^): there is no clearcut information as to the time length of loans. (^^): Three-Month T-bill rate; (^^^): overnight rate.

Table 3: Interest rate pass-through studies: Other Areas

	Country	Short-term Impact	Long-term Impact
Acheampong(2005)	Ghana	0.26	0.55
Cottareli	Jamaica	0.15	0.92
And Kourelis (1994)			
Cottareli	South Africa	0.61	1.00
And Kourelis (1994)			
Cottareli	Venezuela	0.38	1.48
And Kourelis (1994)			

An examination of these tables reveals that in the majority of cases the short-term impact of interest rate pass through is smaller than the long-term one. Put differently, while the short-term pass-through is often incomplete, the long-term pass-through tends to be more complete. The implication is that monetary policy seems to be potent only in the long-run.

The only study that utilizes a panel data methodology for the Euro Area is Sorensen and Werner (2006). As expected, the study uncovers a large degree of fragmentation of the retail banking sector in the Euro Area. In addition, it finds a greater variation in interest rate pass-through at the

country level as well as uncovers some degree of stickiness in the lending rate reactions to changes in market rates.

Some studies have acknowledged the issue of asymmetric interest rate pass-through; that is, the possibility of lending rates responding differently following an increase or a decrease in market rate interest rate. The results are, however, not conclusive to the extent that some authors have uncovered asymmetry in interest rate pass-through and others, not. (see, among others, Mojon, 2000, Borio and Fritz, 1995 and Acheampong, 2005).

As far as Barbados is concerned, no work has been done explicitly on the topic. However, two papers dealing with a related topic are worth mentioning. Moore and Craigwell (2002) shows that market power is the leading determinant of interest rate spreads in Barbados and the Caribbean. Samuel and Valderama (2006) also find that monetary policy is a key determinant of interest rate spreads for Barbados.

4. The Interest Rate Pass-Through Model

4.1. Some Theoretical Background

Assume that the commercial banks anticipate some change in the central bank's minimum rate. The anticipation most likely results from the state of economy, for example, inflation rate and output gaps, which affects the central bank's minimum rate policy. The anticipation would most likely trigger a change in commercial banks' lending rates or deposit rates or both. For the reasons explained in the introduction, here we concentrate on lending rates.

Let LR_t^* be the desired level of lending rate and DR_t be the central bank's minimum rate. Then the long-run relation between lending rate and minimum deposit rate can be expressed as follows:

$$LR_t^* = \alpha + \beta DR_t + e_t \qquad (3)$$

where "*t*" stands for time, β is the long-run impact of changes in the central bank's minimum rate. The long-run depends on demand elasticity on loans and deposits, the degree of market power, switching costs (cost of acquiring information, search and administrative costs), and asymmetric information costs (adverse selection and moral hazard) (see, among others, de Bondt, 2005, 43-45). To make Eq.(3) operational, the adjustment mechanism needs to be spelled out.

4.2. A Partial Adjustment Interest Rate Pass-Through Model

In Eq.(3) above, let $LR_t^* - LR_t$ represent the desired change of lending rate. One plausible model for this type of adjustment is the partial adjustment which can be expressed as:

$$LR_t - LR_{t-1} = \lambda\left(LR_t^* - LR_{t-1}\right) \tag{4}$$

where $0 \le \lambda \le 1$ is the coefficient of adjustment, $LR_t - LR_{t-1}$ represents the actual change in the lending rate, and $LR_t^* - LR_{t-1}$ is the desired lending rate change. Eq. (4) expresses the actual change in the lending rate between t-1 and t as a fraction of the desired change over the same period. Note that if $\lambda = 1$ then the adjustment is instantaneous and if $\lambda = 0$ there is no adjustment and there is no change in the lending rate as $LR_t = LR_{t-1}$. A high cost of adjustment implies a low coefficient of adjustment and on the contrary, a low cost of adjustment yields a high adjustment coefficient.

Solving for LR_t^* in Eq. (4) yields:

$$LR_t^* = \frac{1}{\lambda} LR_t - \frac{(1-\lambda)}{\lambda} LR_{t-1} \tag{5}$$

Substituting Eq. (5) into Eq. (3) yields:

$$LR_t = \alpha\lambda + \beta\lambda\, DR_t + (1-\lambda)\, LR_{t-1} + \lambda e_t \tag{6}$$

where $\beta_0 = \beta\lambda$ is the short-run multiplier and $\beta = \frac{\beta_0}{\lambda}$ is the long-run multiplier. As can be seen, both the short-term and the long-run impacts depend on adjustment cost through the

adjustment coefficient. Eq (6) is an autoregressive distributed lag model of order one, zero; that is, an ADL (1,0) or simply an autoregressive process. Eq. (6) is also a parsimonious representation of an infinite distributed lag model:

$$LR_t = c + \sum_{i=0}^{\infty} \beta_i \, DR_{t-i} + e_t \tag{7}$$

4.3 An Interest Rate Pass-Through Error Correction Model

Eq. (6) can alternatively be written, by subtracting LR_{t-1} on both sides, as

$$\Delta LR_t = \alpha\lambda + \beta\lambda \, DR_t - \lambda \, LR_{t-1} + \lambda e_t \tag{8}$$

where Δ stands for the first difference operator.

Eq. (8) can be rewritten, by adding and subtracting $\beta\lambda \, DR_{t-1}$, as

$$\Delta LR_t = \alpha\lambda + \beta\lambda \, \Delta DR_t - \lambda \, (LR_{t-1} - \beta \, DR_{t-1}) + \lambda e_t \tag{9}$$

where $\beta_0 = \beta\lambda$ is the short-run multiplier, β is the long-run multiplier, λ is the coefficient of adjustment, $(1-\lambda)/\lambda$ is the mean adjustment lag and $-\log(2(1-\lambda))/\log(1-\lambda)$ is the median lag.

Eq. (9) is the corresponding error correction model (ECM) to the ADL(1,0) captured by Eq. (6). As can be seen, we do not introduce the theory of cointegration for Eq. (9). It is a truism to point out that the error correction model precedes the theory of cointegration. Basically, if variables are stationary in levels, then both Eq. (6) and Eq. (9) are valid representations of the phenomenon being studied.

4.4. Method of Estimation

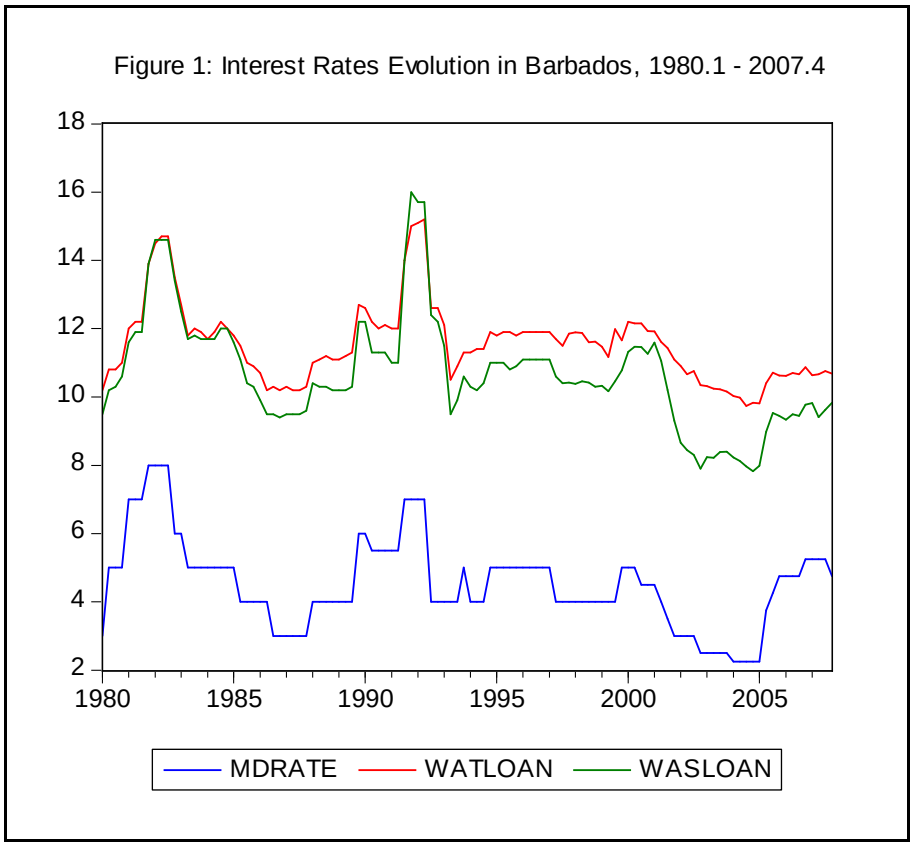
Eq.(6) and Eq. (9) are both equivalent equations as just pointed out. Both are highly non linear in parameters. Hence, some nonlinear algorithms are required to estimate them. In addition, particular attention must be paid to the issue of autocorrelation.

To recall, the objectives of the model estimation are to derive the short-term interest rate pass-through, $\beta_0 = \beta\lambda$, the long-run interest rate pass-through, β, and the mean lag, $(1-\lambda)/\lambda$. In addition, for reasons explained in Hendry (1995, 216,257) a median lag is also derived.

5. Empirical Results

The data of interest are the following: Barbados central bank's minimum rate (mdrate), weighted average rate on total loan (watloan) and weighted average rate on selected loans (wasloan).

Quarterly data for the period 1980 to 2007 have been utilized for the analysis. We start by examining the time series properties of these variables. The quarterly mean stands at 4.54%, 11.55% and 10.68% for mdrate, watloan and wasloan, respectively. The median rate amounts to 4.50%, 11.50% and 10.41% for mdrate, watloan and wasloan, respectively. Figure 1 provides us with the evolution of each series. There is a high degree of synchronization between the series. The latter synchronization is well captured by a high correlation between the series: 0.828 between mdrate and watloan; 0.854 between mdrate and wasloan and 0.963 between watloan and wasloan. In addition, each series looks stationary as it often reverts to its mean. To reinforce this point, we resort to formal unit root (stationary) tests, specifically, the ADF test and the KPSS test. Since these tests are now common knowledge, they are not explained here.



Note: mdrate: Central bank's minimum rate; watloan: average rate on total loans; wasloan: average rate on selected loans. All interest rates are in %.
Source: Economic and Financial Statistics, Central bank of Barbados, various issues.

Table 4 reveals that, at the 10% level of significance, wasloan is a stationary variable. The tests give, however, conflicting results for mdrate and watloan. Indeed, while the ADF test indicates that mdrate and watloan are each integrated of order one, the KPSS points out that the two series are each stationary. An AR(1) fitting of each series points to stationarity.

Table 4: ADF and KPSS Test Results

Variables	ADF(level)	ADF(1st difference)	KPSS(level)	KPSS(level)
Mdrate	-3.137 (c,t)	-10.756(c)	0.056 (c,t)	0.073 (c)
Watloan	-2.992 (c,t)	-8.720 (c)	0.095(c,t)	0.068 (c)
Wasloan	-3.750 (c,t)	-7.790 (c)	0.085(c,t)	0.054 (c)

Note: (c,t): with a constant and a trend; (c): with a constant only: The null hypothesis for the ADF test is the data has unit root; The null hypothesis for KPSS is that the series is stationary. Critical values are: ADF (c, trend): -4.043, -3.451, and -3.151 at the 1%, 5%, and 10% level of significance, respectively; Critical values: ADF (c): -3.491, -2.888, and -2.581 at the 1%, 5%, and 10% level of significance, respectively; Critical values: KPSS(c,t): 0.216, 0.146 and 0.119 at the 1%, 5%, and 10% level of significance, respectively; Critical values: KPSS (c): 0.739, 0.463 and 0.347 at the 1%, 5%, and 10% level of significance, respectively.

Since the variables are stationary, there is no point of raising the issue of cointegration. In addition, since the ADL estimation of Eq.(6) using mdrate and watloan as variables yields the same results as the error correction model from Eq. (9), we only present the ECM results. A nonlinear estimation method using Newey-West robust standard errors has been utilized in the exercise. Table 5 contains results of the error correction model (see Eq.9).

The table indicates that the short-run impact (elasticity) is 0.345%. With a p-value of 0.000 associated to a Wald statistic of 26.384, the short-run elasticity is statistically different from zero. In addition, the short-run elasticity is also different from one with a p-value of 0.000 associated to a Wald statistic of 95.125. Basically, in the short- run there appears to be no full interest rate pass-through. The long-run impact or elasticity amounts to 0.925%. The latter value is statistically different from zero. With a p-value of 0.549 associated with a Wald statistic of 0.359, the long-run elasticity is not statistically different from 1. The two results combined indicate that while the pass-through impact in the short-term appears to be non-existent, in the long-run, it is fully effective. The key question is the extent of lag transmission. In this effect, we compute the mean lag and the median lag. The mean lag is 1.68; that is, it takes on average almost 2 quarters for the effect of minimum interest rate changes to be transmitted to the lending rates. In addition, 50% of the effect is transmitted in almost half a quarter.

Table 5: Error Correction Results of Eq. (9) for Average Total Loans

Dependent Variable: $\Delta watloan$
Method: Non Linear Least Squares
Sample (adjusted): 1980Q2 2007Q4
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\hat{\alpha}$	7.357129	0.532092	13.82680	0.0000
$\hat{\lambda}$	0.372853	0.069197	5.388252	0.0000
$\hat{\beta}$	0.925220	0.124801	7.413584	0.0000

R-squared	0.471785	Mean dependent var	0.004324
Adjusted R-squared	0.462003	S.D. dependent var	0.515614
S.E. of regression	0.378194	Akaike info criterion	0.919835
Sum squared resid	15.44730	Schwarz criterion	0.993066
Log likelihood	-48.05084	Hannan-Quinn criter.	0.949542

Note: the model is $\Delta watloan_t = \alpha\lambda + \beta\lambda\,\Delta mdrate_t - \lambda(watloan_{t-1} - \beta\, mdrate_{t-1}) + \lambda e_t$ where Δ stands for the first difference operator and other variables are defined as above, λ is the coefficient of adjustment, β is the long-term impact and $\beta\ \lambda$ is the short-term impact. "Hat" stands for estimate.

To check whether the results are robust with respect to other types of loans, we present the results with selected loan rates.

Table 6: Error Correction Results of Eq. (9) for Average Selected Loans

Dependent Variable: $\Delta wasloan$

Method: Non Linear Least Squares

Sample (adjusted): 1980Q2 2007Q4

Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\hat{\alpha}$	4.591171	0.709270	6.473092	0.0000
$\hat{\lambda}$	0.377417	0.058853	6.412831	0.0000
$\hat{\beta}$	1.342543	0.167438	8.018146	0.0000

R-squared	0.511625	Mean dependent var	0.002973
Adjusted R-squared	0.502581	S.D. dependent var	0.679459
S.E. of regression	0.479209	Akaike info criterion	1.393294
Sum squared resid	24.80122	Schwarz criterion	1.466524
Log likelihood	-74.32779	Hannan-Quinn criter.	1.423001

Note: the model is $\Delta wasloan_t = \alpha\lambda + \beta\lambda\,\Delta mdrate_t - \lambda(wasoan_{t-1} - \beta\, mdrate_{t-1}) + \lambda e_t$ where Δ stands for the first difference operator and other variables are defined as above. λ is the coefficient of adjustment, β is the long-term impact and $\beta\,\lambda$ is the short-term impact. "Hat" stands for estimate.

Table 6 indicates that the short-run impact (elasticity) is 0.507%. With a p-value of 0.000 associated with an Wald statistic of 31.2698, the short-run elasticity is statistically different from zero. Moreover, the short-run impact is also statistically different from one as indicates the p-value of 0.000 assocaied with a Wald statistic of 29.638. That is, in the short-run there is no full interest rate pass-through effect. The table also indicates that the long-run elasticity is 1.343%. The latter value is statistically different from zero. With a p-value of 0.048 associated with a Wald statistic of 4.185, the long-run elasticity is statistically different from 1. However, given its size, we can ascertain that the interest pass-through is more than effective. Summing up, the two results combined indicate that interest rate pass-through is only fully effective in the long-run. The mean lag with a value of 1.65 means that on average almost 2 quarters are needed for

the effect of a change in the minimum deposit rate to be transmitted to the lending rates on selected loans. In addition, 50% of the effect is transmitted in almost half a quarter.

Irrespective of the type of lending rates, for Barbados the interest rate pass-through appears to be only fully effective in the long-run. Specifically, on average it takes almost 2 quarters for the interest pass-through to become fully effective.

Prior to 1991, the Central Bank maintained a ceiling on commercial banks' average lending rates. These ceilings were removed in the fourth quarter of 1991 as part of the measures undertaken to support the Government's stabilization programme. To determine whether the liberalisation of lending rates substantially affects the results obtained, the basic model was re-estimated, inclusive of a dummy variable designed to have values of 0 from 1980 to 1991 and 1 from 1992 and thereafter. Table 7 contains the results of the exercise. The upper part of the table (model with dummy variable) reports the results derived from the basic model plus a dummy variable capturing the potential 1992 structural change. For purposes of comparison, in the lower part of the table, the previous results from Tables 5 and 6 are also reported. As can be seen, the dummy variable capturing the structural change does not have an effect on the two sub-periods of the study (1980.1 -1991.4 and 1992.1-2007.4). The results derived previously therefore seem to hold.

Table 7: The Impact of the Liberalisation of Lending Rates in 1992

Dependent Var.	$\hat{\beta}_0$	$\hat{\beta}$	Dummy coef.	Mean Lag	$\hat{\beta}/\hat{\beta}_0$
Model with Dummy Variable (1980.1 - 2007.4)					
$\Delta watloan$	0.347 (0.000)	0.937 (0.000)	0.042 (0.681)	1.686	2.70
$\Delta wasloan$	0.492 (0.000)	1.294 (0.000)	-0.129 (0.235)	1.633	2.63
Basic Model (1980.1-2007.4)					
$\Delta watloan$	0.345 (0.000)	0.925 (0.000)		1.680	2.68
$\Delta wasloan$	0.507 (0.000)	1.343 (0.000)		1.650	2.65

Note: The basic model is $\Delta LR_t = \alpha\lambda + \beta\lambda\,\Delta DR_t - \lambda(LR_{t-1} - \beta\,DR_{t-1}) + \lambda e_t$ where *LR* is either *watloan* or *wasloa*n, *DR* is *mdrate* and parameters are as defined above. A dummy variable, designed to have values of 0 for each quarter from 1980 to 1991 and 1 thereafter, is added to the basic model in the case of "model with dummy variable." (…) are p-values.

Summing up, there are two major findings. First, the interest rate pass-through is fully complete only in the long-term. Second, it takes on average almost two quarters for the action of the Central Bank to be transmitted to commercial banks. One implication is that if the Central Bank desires the transmission to be instantaneous; that is, if the central bank wants to see the lending rate increase (decrease) by 100 basis points during the month of minimum deposit rate shock, the latter must be increased (decreased) by almost 300 basis points as the short-term impact is approximately one third of the long-term impact. Alternatively, the reason of high adjustment costs need to be investigated thoroughly. Although such an investigation is beyond the scope of our paper, we can cite market power (found as a dominant influence on Barbados interest rate spreads by Moore and Craigwell (2002)), switching costs, demand elasticity of loans and asymmetric information costs as potential determinants.

6. Concluding Remarks

Using an error correction model derived from a partial adjustment model, this paper empirically investigates the effectiveness of central bank's interest rate policy on commercial bank behaviour in Barbados for the period 1980 to 2007. A less than complete reaction of commercial banks to changes in central bank's policy rate is an impediment for a smooth functioning of the financial system. The study finds that the reaction of commercial banks' lending rate to changes in the central bank minimum rate is sticky in the short-run, but fully complete or effective in the long-run. On average, it takes approximately two quarters for the full effect of changes in the central bank's policy rate to be transmitted to the economy, via adjustments.

Given the size of mean lag adjustment, the question of interest is how to make the lending rate fully effective in the short-term. According to the results of the study, in order to increase (decrease) lending rates by 100 basis points, the minimum deposit rate must be increased (decreased) by almost 300 basis points. Alternatively, the reasons for the high cost of adjustment must be carefully examined. Among others, market power, demand elasticity of loans, switching

costs and asymmetry in information costs could be the elements to look at to boost the effectiveness of interest rate policy.

The method and frequency through which the Central Bank communicates its policy intentions to the public may also be a possible determining factor of the effectiveness/non effectiveness of monetary policy. It has been shown elsewhere (see Blinder et al., 2008) that central bank's communication does indeed matter in smoothing transmission of monetary shocks. To the extent that more communication helps shape public expectations, it is envisaged that frequent communications of the Central Bank on the future directions it expects its monetary policy action to take should enhance the signaling.

The results presented here are derived from a model. A model, being what it is, always leaves room for improvement, among others, it is a good idea to analyze the extent to which the impact of positive monetary shocks differs from that of negative monetary shocks in the context of Barbadian data since commercial banks' reactions to interest rate changes may not necessarily be symmetric.

References

Acheampong, K. (2005). 'Bank Interest Rate Channel of Monetary Policy Transmission in Ghana', *Bank of Ghana Working Paper*, 10.

Angeloni, I. and Ehrmann, M. (2003). 'Monetary Transmission in the Euro Area: Early Evidence', *Economic Policy*, 18:469-501.

Blinder, S.A., Ehrmann,M., Fratzcher, M., de Haan, J., and Jansen, D-J. (2008). 'Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence', European Central Bank *Working Paper Series*, No. 898.

Borio, C. and Fritz, W. (1995). 'The Response of Short-Term Bank Lending Rates to Policy Rates: A Cross-Country Perspective', BIS *Working Paper*, No. 27.

Cottareli, C. and Koorelis, A. (1994). 'Financial Structure, Bank Lending Rates and The Transmission Mechanism of Monetary policy', *IMF Staff Policy Paper*, 42(3):670-700.

Donnay, M. and Degryse, H. (2001), 'Bank Lending rate Pass-Through and Differences in the Transmission of a Single EMU Monetary Policy', Center for Economic Studies *Discussion Paper*, K.U. Leuven, 01.17.

De Bondt, G. (2005). 'Interest Rate Pass-Through: Empirical Results for the Euro Area', *German Economic Review*, 6(1): 37-78.

De Bondt, G., Mojon,B. and Valla, N. (2005). 'Term Structure and The Sluggishness of Retail Bank Interest Rates in Euro Area Countries', European Central Bank Working Paper Series, No. 518.

Hendry, F.D.(1995). *Dynamic Econometrics*, Oxford University Press, Oxford.

Kaufmann, S. and Scharler, J. (2006). 'Financial Systems and the Cost of Channel Transmission of Monetary Policy Shocks, OeNB *Working Papers*, No. 116.

Kwapil, C. and Scharler, J. (2006). 'Limited Pass-Through from Policy to Retail Interest Rates: Empirical Evidence and Macroeconomic Implications', *Monetary Policy and The Economy*, Q4.

Moazzami, B. (1999). 'Lending Rate Stickiness and Monetary Transmission Mechanism: The Case of Canada and the United States', *Applied Financial Economics*, 9: 533-538.

Mojon, B. and Valla, N. (2005). 'Term Structure and The Sluggishness of Retail Bank Interest Rates in Euro Area Countries', European Central Bank *Working Paper Series*, No. 518.

Mojon, B. (2000). 'Financial Structure and The Interest Rate Channel of ECB Monetary policy, European Central Bank, *European Central Bank Working Paper Series*, No. 40.

Moore, W. and Craigwell, R.(2002). 'Market Power and Interest Rate Spreads in the Caribbean', *International Review of Applied Economics*, 9: 533-538.

Oliner, O.S. and Rudebusch, D.G. (1995). 'Is There a Bank lending Channel for Monetary Policy?, *Federal Reserve Bank of San Francisco Economic Review*, 2: 3-20.

Samuel, W. and Valderrama, L. (2006). 'The Monetary Policy Regime and Banking Spreads in Barbados', *IMF Working Paper*, 211: 24 p.

Sorensen, K. C. and Werner, T. (2006). 'Bank Interest Rate Pass-Through in the Euro Area: A Cross Country Comparison', European Central Bank *Working paper Series*, No. 580.

Toolsema,A.L., Sturm, J.-E., and de Haan, J. (2001). 'Convergence of Monetary Transmission In EMU-New Evidence', CESIfo *Working Paper*, N0. 465.