Estimation of Short and Long Run Adjustment Speeds in a Co-integrated System in the Money Market: the Case of Brazilian Deposit and Lending Rates

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Abstract

This paper aims to calculate the adjustment speeds between the Brazilian Deposit and Lending (D-L) rates –both in the short and long runs- over the months between January 1997 and June 2016. Tests for stationary and co-integration, and finally, the error correction model (ECM) are employed with the ultimate objective: how Brazilian average commercial interest rates interacted during the sampled months? The deposit rates statistically are found to have a significant impact on the lending rates. Both rates are also found to be non-stationary at their level – but became stationary with an integrated order of one upon their first difference. Therefore, the ECM is employed in order to find how fast both rates adjusted toward respective equilibriums. The results are that the two series statistically displayed a monthly short-run speed of about 41.68% toward equilibrium, and their long-run adjustment is about 21.66% per month. Those speeds suggest that the Brazilian money market is not competitive and monetary policy has a relatively small effect on the difference between Brazilian D-L rates.

1. Introduction

Commercial banks act as intermediaries between savers and borrowers of money in the money market. The spread between the lending rate charged to borrowers and the cost of funds paid to lenders is one of the efficiency indicators of the competitiveness of an economy. If the spread is high, it would indicate that the money market is not competitive or a few large financial firms have a high leverage in setting the gap between D-L rates. These oligopolists could significantly reduce the ability of the Central Bank of Brazil (i.e., Banco Central do Brasil or BCB) to use monetary tools in its countercyclical economic policy.

Thus, a few dominant commercial banks are far more likely not to adjust the difference between D-L rates in complying with the competitive market forces of supply and demand for money. This will cause monetary instrumental tools to be less effective in the BCB's primary objective of moderating the fluctuation of economic activities –as desired. It is detrimental to the ability of economic policies to have some leverage over the Brazilian economy in the task of achieving a stable and sustainable economic growth rate in the long run –without the threat of inflation in the short run. It is more so since fiscal policy was found to cause both a budget deficit and inflation during the 1970s. Thus, monetary policy is considered to be the most effective weapon to "maneuver" the real economy in the short run.

Since the 1970's, as an example, Mishkin (1995) reasoned that fiscal policy used in smoothing out economic wavering could result in a negative difference between money spent in public programs and total tax revenue. The ultimate result would be higher tax rates to offset the previous shortfall of an expansionary fiscal policy. In addition, the lack of discipline by the government in utilizing policy instruments in a timely and effective manner could also fail to stabilize levels of economic activity and the general price level.

Moreover, Bernanke and Gertler (1995) believed that monetary tools are more effective in influencing the economy, at least in the short run. To be effective, monetary policy makers must have a thorough knowledge of how its countercyclical instruments could indirectly affect the real economy in the “black box” of monetary transmission mechanism. The central bank (CB) also must precisely determine the effective time for a policy change -according to Miskin (1995).

Since commercial banks are an entity in the inner mechanism that helps to transmit the interest rates set by the central bank (CB) to the market lending rate, depository financial institutions do play an important role in economic policy set by both the government and monetary authority. Nguyen (2012) in the published “Vietnamese Commercial Bank Rates” paper pointed out that the commercial banking system is one of important transmitters of the CB’s monetary effects in the “black box” –with the following excerpt.

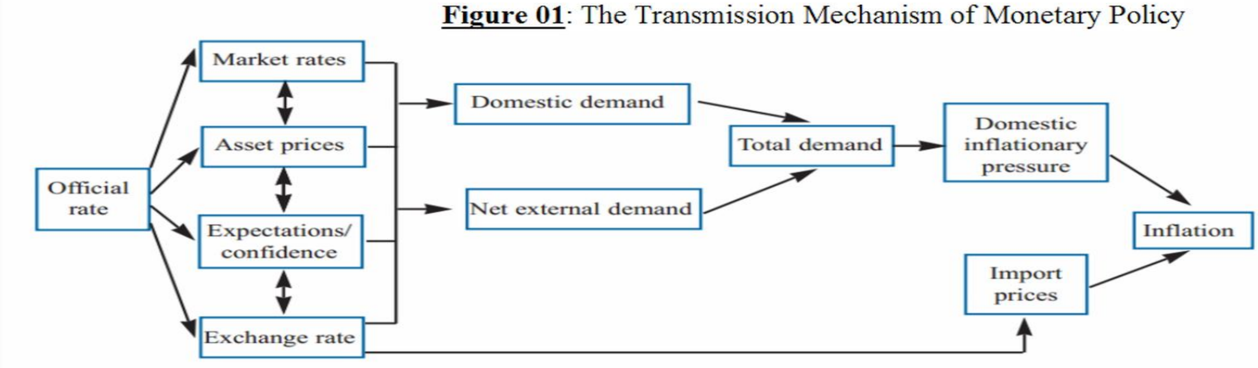
“As pointed out by Bernanke and Gertler (1995, p. 27), the same research that has established that changes in monetary policy are eventually followed by changes in real output, is largely silent about what happens in the interim. To address this void, the fall 1995 issue of the Journal of Economic Perspectives arranged a symposium on the monetary transmission mechanism. At this symposium, major papers were presented by prominent economists such as Frederic S. Mishkin, John B. Taylor, Ben S. Bernanke and Mark Gertler, Allan H. Meltzer, and Maurice Obstfeld and Kenneth Rogoff. In summarizing the papers presented at the symposium, Mishkin (1995, pp. 4-9) articulated that these authors identified several important channels through which monetary policy actions are transmitted to real economic activities: the interest rate channel, the exchange rate channel, other asset price effects and the credit channel.”

The Monetary Policy Committee of the Bank of England (BoE) in “The Transmission Mechanism of Monetary Policy”, however, does not believe that the benchmark interest rate set by a CB has a much real effect on an economy’s real GDP. The inner working mechanism in the “black box” is succinctly illustrated in Figure 01. In the long run, the real effect of monetary stances only causes changes in the general price level.

More importantly, changes in monetary policy also alter the private sector’s perception of the health of the economy, expected price inflation, real interest rates, asset prices, and the exchange rate. The expected rate of inflation matters since it affects the real cost of borrowing money and it also determines the nominal interest rate –including the D-L rates. The real interest rate is approximately the difference between the nominal interest rate and the expected inflation rate. For households and firms who are assumed to be rational, they are more likely to make their saving and investment decisions based on the real interest rate -if they are credit-constrained. Otherwise, cash-trapped individuals and firms must borrow as much money as they can in order to finance short-term needs -regardless of the cost of borrowing or the level of the lending rate -according to BoE.

In Figure 01, the market interest rates affect both domestic and foreign demand for goods, services and assets in a country. Therefore, commercial bank rates do have an influence on the health of total expenditures in an open economy which, in turn, will affect total production. Behaviors of the spread between D-L rates along with precise measurements of adjustment speeds become important for everyone –not only to measure effective levels of the BCB policy- but also to determine whether the Brazilian banking system functions as a competitive entity or an oligopolistic industry.

Figure 01: The Transmission Mechanism of Monetary Policy



Note: For simplicity, this figure does not show all interactions between variables, but these can be important.

Source : The Bank of England. “The transmission mechanism of monetary policy”

In a free and competitive market, forces of supply and demand for money will stabilize the spread or the premium interest earnings for the bank as intermediaries between fund borrowers and depositors. However, the lack of competition in a market that is dominated by a few large commercial and state-owned banks could keep the spread of D-L rates high. For example, when the interest rate set by the CB is lower, banks are slow to lower the lending rate to borrowers. When an inflationary monetary stance is taken by the CB, depository institutions will delay the timing of a higher interest rate on deposits. In other words, Brazilian banks are oligopolists, and this non-competitive banking system can be harmful to economic growth for Brazil. For example, the five largest Brazilian banks (which are subsidiaries of mostly local larger financial conglomerates) account for two-thirds of total assets –according to the World Bank (2006, p.43).

In the executive summary, the WB (2006) in “Brazil Interest Rates and Intermediation Spreads” reported that *“The unusually high cost of financial intermediation in Brazil, as measured by the reported difference between bank lending and deposit interest rates, is a major source of policy concern, and with good reason. Brazil is an international outlier in terms of published interest spreads -it is one of only four countries in the world that reports average spreads above 30 percentage points. … More generally, high spreads can be interpreted as a symptom of a poorly functioning financial system which, of itself, can hinder economic growth. Improving the functioning of the financial system is arguably a much higher priority for development policy in Brazil than in other countries to the extent that the binding constraint to investment and growth is the shortage of finance rather than the lack of high-return investment opportunities.”*

Therefore, this paper aims to measure the quantitative effect on lending from deposit rates by running an ordinary least squared (OLS) regression on the two series’ level. Finding the exact sizes of adjustment speeds for short and long run adjustments also help to measure some levels of financial soundness of the Brazilian banking system. The higher the coefficients of adjustment are the faster the market forces worked both in the short and long runs. Conversely, when monthly adjustment rates are below the average, statistical and significantly results of estimated coefficients of D-L rates signal that the Brazilian commercial banks are, in fact, oligopolists. In addition to this introductory section, this paper will contain a brief review of the literature in Section 2. Section 3 describes the estimation method used to reach the conclusions and section 4 will present statistical results and estimated adjustment speeds of lending and deposit interest rates –in the short and long runs. The concluding section will summarize this paper and restate key findings.

2. A Brief Literature Review

The transmission mechanism of monetary policy in Figure 01 has a broad range of factors that affect aggregate demand, which in turn, affect aggregate supply in an economy. Market rates, asset prices, expectations of the exchange rate each have their advantage in measuring the effect of monetary policy on real production. However, the market interest rates do play a sizeable role in determining the costs of saving, consumption and planned private real investments. They are a major force in a competitive and free market-oriented economy.

When the deposit rate is high, households have more incentive to forego today’s consumption for tomorrow’s spending –since the opportunity cost of holding cash is high today. Similarly, Brazilian firms are more reluctant to finance investment when there is a shortage of funds with high lending rates –rather than the lack of high-return opportunities in investment (WB, 2006). Brazilian deposit rates were slow to rise when the BCB’s primary rates increase and lending rates were sticky in the short run when the BCB took an expansionary monetary stance.

This partially explains that “The phenomenon of high interest rate margins has had a long history in Brazil, and a stubborn one at that. While Brazil is not alone in having had very high inflation in the past and having successfully reduced it to single-digits, it is rather unique in not having achieved a reduction in interest spreads to moderate levels, as other countries with hyperinflation histories have managed to do.” –according to the World Bank (WB) in its report on the Brazilian interest rates and intermediation spreads on July 7, 2006 by its Brazil Country Management Unit.

According to Nguyen (2016) in the “Brazilian Interest Rate Pass-Through” paper, the author concluded that the short run pass-through rate is slow to respond to the change in the BCB’s targeted interest rates. This meant that the lending rates are sticky in the short run but more responsive to the BCB’s discount rate set approximately 33 months ago. Nguyen’s empirical findings also suggested that countercyclical monetary policy requires a long impact lag (about three years) to have a real effect on the economy.

Nguyen's findings provided evidence that the Brazilian banking system is not competitive but also is slow in responding to market forces of supply and demand for money –thus the commercial banks behave as oligopolists.

Moreover, in Brazil prior to June 2012, "the financial system is characterized by a high degree of conglomeration and public sector presence, but limited foreign bank participation. Total assets in the system are around 180 percent of GDP, more than half of which are held by depository institutions, one-third by investment and pension funds, and about 6 percent by insurance companies. Financial conglomerates—headed by a commercial bank and typically including investment banking, securities brokerage, asset management, and insurance subsidiaries—control around 75 percent of the system's assets. Public sector presence in the financial sector is significant: government-owned banks account for over 40 percent of total banking assets, and directed credit for low-income housing, agriculture, and infrastructure represents around 35 percent of total credit. Foreign bank participation is only about 17 percent of banking assets, lower than in other large Latin American countries." according to the IMF (2012, p.11) in its Country Report No. 12/206 in "Brazil: Financial System Stability Assessment" publication.

In addition, most economists would agree that monetary policy can have a significant impact on the real GDP –at least in the short run. This view depends on the assumption of neoclassical views of perfect competition in the money market and opportunity costs of spending and investments in explaining the effectiveness of a CB in most Economics textbook. Bernanke and Gertler (1995) pointed out that empirical studies of supposedly "interest-sensitive" personal consumption and planned private investment components (of the aggregate demand identity) resulted in great difficulty in explaining that nonclassical factors such as lagged production, sales or levels of competitiveness in the money and asset markets failed to adjust to interest rates set by the monetary authority.In "Inside the Black Box: The Credit Channel of Monetary Policy Instrument", Bernanke and Gertler (1995, p. 29) stated the following facts regarding the effectiveness of monetary policy: (1) a contractionary stance results in sustained declines in real GDP. However, an unexpected rise in the U.S. Federal Reserve Bank's discount rate only has transitory effects on interest rates in the financial markets, (2) private consumption and investment reacts more quickly to any tightening monetary policy, but inventory disinvestment adjusts more slowly because of a time lag. It implies that real production doesn't respond immediately after a change in private spending but will adjust in later time periods, eventually, (3) housing purchases react first, followed by spending on durables and non-durables, and finally, (4) planned fixed investments by firms don't adjust immediately but are behind much of the change in production and interest rates.

In explaining the internal functions inside the "Black Box", Bernanke and Gertler (1995, 34) also presented empirical results that reject the standard assumption that a higher real cost of borrowing have multiple effects on various components of private spending in the short run. The time lag effect on planned business fixed investments, for example, helps to explain why robust monetary policy changes failed to precisely determine the change in the aggregate demand function.

In short, Bernanke and Gertler (1995, p. 35) articulated that it is not easy to carry out monetary policy aimed at taming the fluctuation of economic activities in a precise manner of magnitude, timing and composition of the economy's reactions. More importantly, the health of the commercial banking system is tied to the condition of the economy. Moreover, recent financial deregulation and innovation in the U.S. since the 1980s and increased bank possessions of volatile financial securities and derivatives also affect banking lending rates. Therefore, the effect of any unexpected changes in the CB's policy will take time to affect the real economy, which in turn, will affect the commercial banking system's lending rates –afterward.

As a result, many researchers and policy makers are interested in estimating the degree and adjustment speeds of commercial banking rates in deposit, lending and retail markets. However, the degree and speed of pass-through and adjustment speeds vary across countries. Adjustment rates are lower for economies with low effectiveness of monetary policy, imperfect financial markets and a less sophisticated financial system (Pih Tai, Siok Sek and Wai Har 2012) in their regression using the Seemingly Unrelated Regression (SUR) equations. The published paper "Interest Rate Pass-Through and Monetary Transmission in Asia" attempted to estimate how fast the targeted Asian economies adjusted their respective D-L rates immediately after the financial crises in 1997 (January 1988 – June 1997). Its principle aim is to compare the pass-through rate across those Pacific countries before and after 1997.

All except Malaysia, are found to adjust poorly to the difference among retail banking rates from the policy benchmark rate as *"From the perspective of monetary policy, we hardly find evidence on the effectiveness of monetary policy in Asian as the pass-through rates into D-L rates remain low in many economies and some economies even experience decline in the pass-through rate after the crisis. In these economies, the policy rate has low influences on the D-L rates. This situation implies that the government is not able to effectively control the market rate through the policy rate in bringing the economy to achieve the policy targets. The financial market is imperfect and lacks of financial integration."* –according to Pih Tai, Siok Sek and Wai Har (2012, p. 168).

In "Brazil Interest Rates and Intermediation Spreads", the WB (2006, p.43) with Report No. 36628 stated that *"The Brazilian banking system is large, concentrated, and highly interconnected domestically, but with relatively limited foreign participation. There are 1,475 deposit-taking financial institutions with assets exceeding 100 percent of GDP, including 137 banks, 4 development banks, and one savings bank as of November 2011. The five largest banks account for two-thirds of total assets and are typically part of larger financial conglomerates, which often include insurance, securities brokerage, and asset management operations. Foreign banks (mainly from Europe) control slightly less than 20 percent of total banking assets (down from close to 30 percent in 2002 and significantly less than in some other Latin American countries)."* as illustrated in a Figure 02.

Figure 02: Brazilian Banks by Ownership (In percent, unless otherwise noted)

Banks by control1/	Number	Net Worth	Total assets	Deposits	Loans
Public	13	33.5	43.3	45.9	41.9
Private	124	66.5	56.7	54.1	58.1
Domestic	67	39.6	39.1	38.0	40.2
Under foreign control	57	26.9	17.7	16.1	18.0
Total	137	100.0	100.0	100.0	100.0

As of September 2011.
1/ Public Includes BNDES and the Federal Savings Bank (Caixa).

Source: Brazil Interest Rates and Intermediation Spreads, the WB (2006, p.43) with Report No. 36628.

More importantly, historical Brazilian intermediation spreads are stubbornly high even after the macroeconomic stability has improved significantly along with the growth of its financial system (in size, diversification, sophistication along with Brazilian economic progress since 2002 –according to the IMF (2012, p. 6). Ones can argue that hyperinflation in the past explained the previous high spreads, but other economies which also experienced hyperinflation years (like Vietnam, Peru, Poland and Russia) managed to narrow the gap between D-L rates after their successful campaign to control their hyperinflation -except Brazil (WB 2006, pp. 9-10).

As of 2012, the Brazilian financial system was stuck in an environment where capital market development and potential growth were restrained by a high interest rate short duration equilibrium. Moreover, giant commercial and government-owned banks dominate the money market while the latter accounted for more than 40% of total banking assets. State-owned banks financed about 35% of total credit for low-income households, agriculture and infrastructure projects (the IMF, 2012, pp. 7-10).

In addition, the IMF (2012) reported that most financial contracts in Brazil were of short durations with high interest rates which complicated monetary transmission in stabilizing the economy. *"This largely reflects long-standing fundamental factors, including the legacy of past high inflation and volatility, the low level of domestic savings, and high intermediation spreads. Fiscal responsibility legislation, the inflation targeting regime, and a flexible exchange rate have yielded a sizeable reduction in interest rates in recent years. Banking spreads have also declined with improved efficiency (lower administrative costs) and declines in regulatory costs and the net interest margin. The concentration in short-duration and highly liquid assets reduces market liquidity risks for investment funds and banks but raises debt service costs for borrowers and discourages intermediation. Directed credit at below market rates (notably for agriculture and housing) helps some borrowers cope with these costs but, at the same time, narrows the monetary transmission channel. Indexation and short durations are deleterious to financial development, as they tilt the balance toward short-term consumer finance at the expense of long-term investment finance."* (the IMF, 2012, p.12)

3. Estimation Method

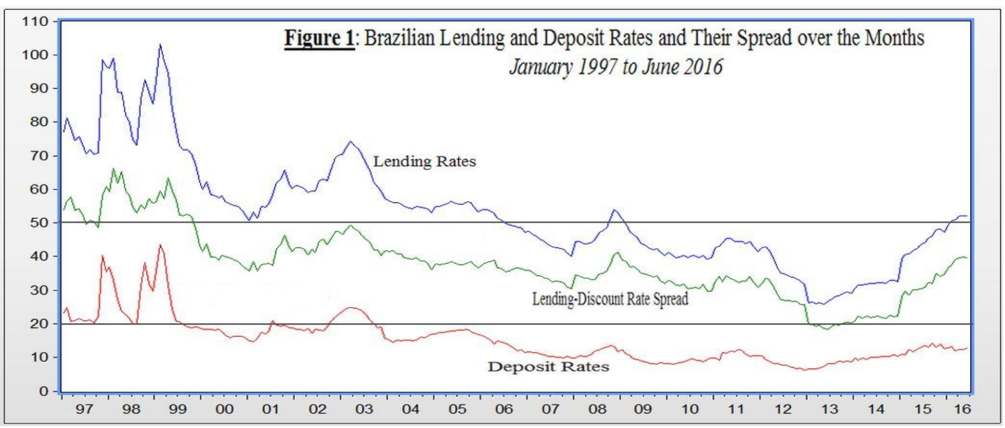
In Grangerian representation theorem in a published article by Engle and Granger (1987), two or more co-integrated time series have error correction mechanisms among them. Therefore, "*the error correction model, however, is particularly powerful since it allows an analyst to estimate both short term and long run effects of explanatory time series variables*" according to Luke Keele and Suzanna De Boef (2004, p. 4).

In this study, as a result, we want to know how strong is the relationship between D-L rates at level, and how fast do they adjust between themselves both in the short and long run in stationary and co-integrated D-L series. The magnitude of the D-L relationship and adjustment speeds rates will give us some ideas of how efficient the Brazilian money market is or what kind of market structure does it belong to, i.e. competition or oligopoly (since there are a few financial conglomerates dominated the industry.) Thus, the two-stage Engle-Granger regression is a more appropriate ECM method in finding both the relational strength and correction speeds between Brazilian D-L rates.

3.1. Variables and Data Sources

To investigate the joint behaviors of the Brazilian lending and deposit rates both in the short run and in the long run, this study utilizes historical data of the lending ($LENDR_t$) and deposit rates ($DEPR_t$) from January 1997 through June 2016[1] as shown in Figure 1. The data is obtained from the International Financial Statistics Database (2016) of the International Monetary Fund. $LENDR_t$ and $DEPR_t$ are non-stationary. The D-L spread is the difference between $LENDR_t$ and $DEPR_t$ –and is computed by the author.

The Brazilian commercial bank lending rate is the weighted average of interest charged on loans to households and firms. The deposit rate is the average interest rate paid to deposits by individuals and corporations.



3.1.1. Descriptive Statistics of the D-L and their Spread Rates

In the executive summary, Brazil was reported as one of the four outliners with an average spread of more than 30% (the World Bank, 2006). This statistics is confirmed in this study. The mean between D-L rates, on the average for the sampled months, is 37.85022%. The D-L spread's median is 37.18862%. Its maximum and minimum percents are 66.15 and 18.30242, respectively. Table 1 details descriptive statistics for Brazilian rates in Figure 1.

Table 1:	**Depr**	**Lendr**	**Spread = Lendr - Depr**
Mean	15.2596	53.1098	37.8502
Median	13.7628	51.3000	37.1886
Maximum	43.5200	103.0800	66.1500
Minimum	6.1311	25.8000	18.3024
Std. Dev.	6.8050	16.3313	10.1014

[1] *I am grateful to Dr. Chu Nguyen (an Associate professor of Economics and Finance, Chairman of the FAMIS Department and Director of the Research Department, College of Business, University of Houston-Downtown) for his Brazilian historical data set of D-L rates used in this study.*

3.2. Model Specification

In general, financial time series data are normally non-stationary such as movements of interest rates or market values of Standard and Poor 500 (SP500) and the Dow Jones 30 indexes. Consequentially, a regression on their level would result in spurious estimates as evidenced when the Durbin-Watson (DW) statistics could be smaller than R-squared (R^2) estimate. This is because observations are correlated by a given time lag in the residuals as DW statistics revealed but R^2 does not. The coefficient of determination (R^2) indicates the percentage of total variation in the dependent variable that can be explained by the regression equation. Therefore, R^2 can be very high since data at levels are highly correlated over times, and that the DW value indicates the significance of autocorrelation in a time series.

Thus, residuals of a regression on levels of a time series data set should be examined and tested in order to detect a spurious regression –along with estimates of R^2 and DW statistics. A unit-root test on the residuals revealed that $LENDR_t$, $DEPR_t$ and their residual (in a standard OLS regression on their level) are non-stationary with the following model of method of least squares in Eq. 1.

$$LENDR_t = a + b\ DEPR_t + u_t \quad (1)$$

Where, $LENDR_t$ = lending rates in percentage
$DEPR_t$ = deposit rates in percentage
u_t = Difference between monthly data and its estimated values (or residues)
t = month
a = intercept of a linear function
b = slope coefficient where estimates of a and b represent the relationship between $LENDR_t$ and $DEPR_t$ in the long run

Regression results on Eq. 1 are displayed in Table 2 and confirm that the OLS estimation is seriously spurious. An R^2 coefficient (of 0.901017) is greater than the DW statistics of 0.35092 (which is much less than one). The latter statistics revealed that the sample residuals in Eq. 1 are significantly correlated to one another in successive time periods. Therefore, there are autocorrelations in the monthly Brazilian lending and deposit rates; thus, they are not stationary.

The estimated coefficient of Eq. 1 cannot be called the best regression model. Therefore, the moving average (MA) test is applied in order to correct the OLS estimation at level. The results of an ARMA Maximum Likelihood (BFGS) Least Squared method are presented in Table 2.

Table 2: Results of OLS Parameter Estimation at Level for Eq. 1

Dependent Variable:	**LENDR**	Method:	**Least Squares**	
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Intercept	19.93360	0.82780	24.08038	0.00000
DEPR	2.17554	0.03726	58.39478	0.00000
MA (1)	0.63344	0.04228	14.98353	0.00000
Adjusted R-squared	0.946655		DW Stat	1.181397

In Table 2, the high statistically significant coefficient of $DEPR_t$ indicates a strong relationship between the D-L rates at levels. When the former increased by 1%, for example, the latter ($LENDR_t$) changed by about 2.18% per month.

3.2.1. Unit Root Tests

The ADF test statistics for $LENDR_t$ is *minus* 1.791840 and for $DEPR_t$ is *minus* 2.987205. With a confidence region of 96.24%, a unit root test of $DEPR_t$ (with an intercept) does not exist at 5% and 10% significant levels.

However, a second unit-root test on $DEPR_t$ in level with no intercept revealed that $DEPR_t$ is highly auto-correlated over the months. With this test, the ADF statistics is -1.108138 with its corresponding MacKinnon (1996) one-sided p-values of 0.1272. In addition, other t-statistics with -2.575055, -1.942212 and -1.615780 all failed to reject the null hypothesis of a unit root in $DEPR_t$ at 1%, 5% and 10% levels of significance, respectively.

Autocorrelations among monthly u_t in Eq. 1 also exist. With an ADF statistics of -2.330068, it fails to reject the null hypothesis that u_t has a unit root –with a constant and a linear trend in the exogenous variable.

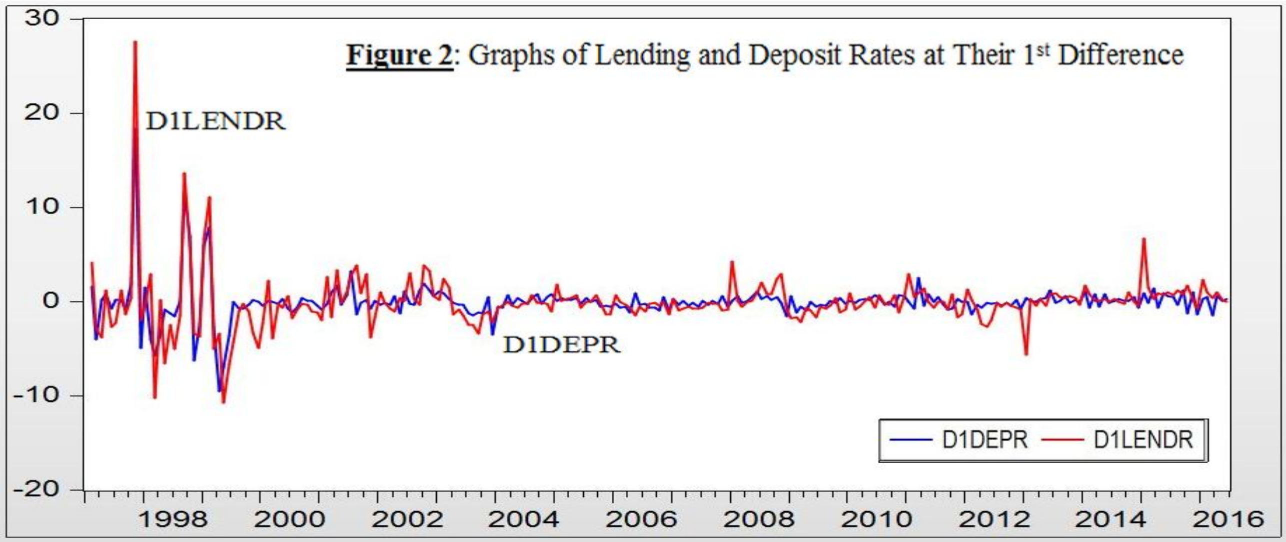
The model for the Augmented Dickey-Fuller (ADF) test (1979) is the following.

$$\Delta X_t = \lambda_0 + \lambda_1 X_{t-1} + \lambda_2 T + \sum_{i=1}^{n} \varphi i \Delta X_{t-i} + \epsilon$$

Where ***T*** is a trend variable, $\boldsymbol{\lambda}$ and $\boldsymbol{\varphi}$ are to be estimated, Δ is the difference operator, ***X*** is the natural logarithm of the time series. Finally, $\boldsymbol{\epsilon}$ is the random error term of the ADF test model for a unit-root on a targeted variable.

3.2.2. Single-Equation Co-integration Test

Since LENDR and DEPR contains autocorrelated data, the first difference is performed on each variable where $D1LENDR = LENDR_t - LENDR_{t-1}$ and $D1DEPR = DEPR_t - DEPR_{t-1}$. Their respective first differenced monthly series (which are stationary) are shown in Figure 2.



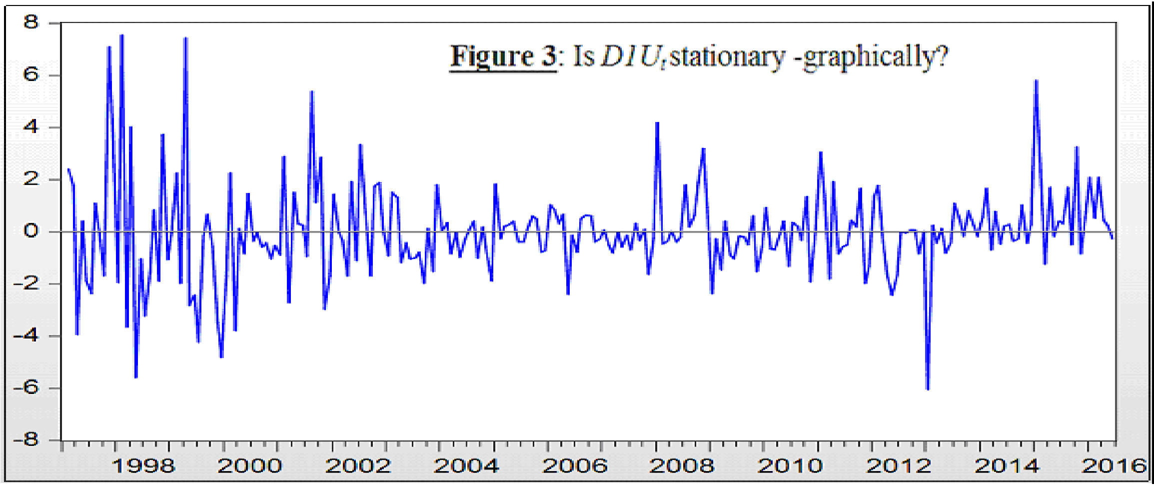
The Engle-Granger test method is employed with a maximum lag of three months and a constant level in testing whether D1LENDR and D1DEPR are co-integrated at an order of one. Statistical results in Table 3 reject the null hypothesis and to accept the alternative that both rates have a long run relationship and behave as a co-integrated system.

Table 3: Results of Engle-Granger Co-integration Test on *D1LENDR* and *D1DEPR*

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
D1LENDR	-17.32775	0.0000	-261.3817	0.0000
D1DEPR	-11.21463	0.0000	-560.6421	0.0000

*MacKinnon (1996) p-values.

Graphically, Figure 3 displays the behavior of $D1U_t$ from a standard least squared regression in Eq. 2. $D1U_t$ series seems to randomly fluctuate around its mean of zero over the sample period. Statistics from the ADF test also reveals that the residue series ($D1U_t$) does not have a unit root. The ADF statistics for ($D1U_t$) is robust with -17.29042 indicating that $D1U_t$ is stationary. In addition, t-ratios for 1%, 5% and 10% critical values are –3.458470, -2.873809 and -2.573384, respectively. All t-tests reject the null hypothesis of a unit root in $D1U_t$.



If the exogenous and endogenous variables are stationary, the OLS method not only is feasible but also is the best regression method to model the Brazilian interest rate behaviors. That is where the error correction model is effective in finding speeds of adjustment in short and long runs toward their respective equilibrium in the short and long run deviations in the two interest rates.

Since both *D1LENDR* and *D1DEPR* are I(1) and stationary, therefore, it is necessary to capture and to store their residue in Eq. 2 in their first differenced form. It can be done by running an OLS regression on Eq. 2 with their respective first-differencing series. $D1U_t$ will store residue series in Eq. 2.

$$D1LENDR_t = a + b\ D1DEPR_t + D1U_t \quad (2)$$

Regression results on Eq. 2 are displayed in Table 4 and confirm that the OLS on first differenced D-L rates estimation is not spurious. An adjusted R^2 (0.628049) is less than DW statistics of 2.245677. With a higher-than-2 DW value, successive error terms in Eq. 2 are, on average, much different in value from one another. About 63% of total variation in $D1LENDR_t$ can be explained by $D1DEPR_t$.

Table 4: Results of the First-Stage OLS Parameter Estimation of Equation 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Intercept	-0.056302	0.120295	-0.468035	0.6402
D1DEPR	1.127115	0.056874	19.81761	0.0000
R-squared	0.629652		**Adjusted R-squared**	0.628049
F-statistic	392.7376		**Durbin-Watson stat**	2.245677

3.2.3. The Second-Stage OLS (i.e. The Error Correction Model (ECM))

It is observed that most macroeconomic variables are integrated of order one. As a result, one simple way to render the variables stationary is to take the first difference on the series. However, a major issue with running a regression on the first differenced data is the loss of the present of a meaningful long-run adjustment coefficient in the model. To solve this problem, Engle and Granger (1987) introduced the error-correction model is a way to capture a common trend among the longitude observations of co-integrated variables.

Thus, the second-stage estimation utilized the OLS regression with error correction coefficients of *b1* and *b2* for short and long run adjustment speeds, respectively -when $D1U_{t-1}$, is employed as an explanatory variable. All variables are required to be stationary in an Error Correction Model (ECM), and they are -in this empirical study. Eq. 3 is the ECM.

$$D1LENDR_t = b1\ D1DEPR_{t-1} + b2\ D1U_{t-1} + v_t \quad (3)$$

Where the long run correction term is: $D1U_t = (D1LENDR_t - a - b\ D1DEPR_t)$ in Eq.2
And $D1LENDR_t$ = the first difference in lending rates at month t
$D1DEPR_{t-1}$ = the first difference in deposit rates in last months
b1 and *b2* represent the short and long run adjustment speeds (respectively) to be estimated.
v_t = error terms for the ECM in Eq. 3

The estimated coefficient *b1* represents the short run adjustment speed between D-L rates. The parameter *b2* represents the same variables' long run rate of adjustment –and should be negative and statistically significant for their stability in both rates in the long run.

4. Empirical Results

Table 5 displays results of ECM estimates. The DW test statistics (*d*) is 1.943809 which is very close to 2.00. *d* indicates that the sample residuals have no autocorrelations. R^2 is 0.107832 which is much less than DW statistics –as expected.

Table 5: Results of ECM Parameter Estimation of Equation 3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$D1DEPR_{t-1}$	0.416799	0.087872	4.743246	0.0000
$D1U_{t-1}$	-0.266591	0.101678	-2.621906	0.0093
R-squared	0.111694		**Adjusted R-squared**	0.107832
Prob (F-statistic)	0.0000		**Durbin-Watson stat**	1.943809

The estimated *b1* (for $D1DEPR_{t-1}$) is positive (as expected) and explains the positive monthly relationship between D-L rates. More importantly, *b1* is statistically and highly significant, and it represents the short run equilibrium coefficient between the lending and deposit rates in the current month. The coefficient *b2* (for $D1U_{t-1}$) is negative and statistically significant (as expected) –and its t-ratio reject the null hypothesis at a 1% significant level. It is also known as the error correction coefficient –in the long run.

4.1 The Short and Long Run Adjustments toward Equilibriums

The short-run speed of adjustments toward equilibrium is the estimated *b1*. With a coefficient value of 0.416799, *b1* indicates that the rate at which the previous time period disequilibrium between co-integrated interest rates is being corrected at a speed of about 41.68% per month.

The long-run speed of adjustments toward equilibrium is the estimated *b2*. $D1U_{t-1}$ contains residues of the first differenced *LENDR* and *DEPR* series obtained from the OLS regression in Eq. 2. *b2* represents an estimated long-run adjustment speed in correcting the deviation from the two series' long- run relationship in the previous month. The expected $D1U_{t-1}$ coefficient is negative and is statistically significant at 1%. With a value of *minus* 0.26689 for *b2*, a Brazilian co-integrated system (of deposit and lending rates) corrects itself at a rate of about 26.66% in each month in reaching its long-run equilibrium (or its long-run stable spread between the two monthly interest rates) from January 1997 to June 2016.

5. Conclusion

In an attempt to investigate the competitive level for the Brazilian money market, in particular, and its financial system, in general, this study estimates the coefficient of the deposit rate variable that affects the dependent variable of lending rates at levels using the OLS method. With an estimated of 2.27880 and a t-ratio of 45.9546, the coefficient implies that deposit rates have a strong effect on the rate borrowers must pay on interest payments. For example, when the former (*DEPR*) increased by 1%, the latter (*LENDR*) changed by about 2.18% per month. An estimated change of 2.18% meant that a contractionary monetary policy by the Central Bank of Brazil (CCB) could cost the private sector proportionally more in financing household spending and planned investments or for acquisitions of assets. This policy has adverse effects on the economy at large –as a result. Thus, any attempts to fight off price inflation with a tightening monetary policy by the BCB will rapidly deteriorate the health of the economy and raise the cost of doing business in Brazil.

However, OLS results also produced spurious estimates and indicated autocorrelations between D-L rates. Thus, endogenous unit root and co-integrations tests were conducted and transformed with their respective first difference on the D-L rates. They were found to be an integrated system of order one, and their common residue in an ordinary least squared regression were saved for later ECM regression in Eq. 3. The findings were that the short and long run adjustment speeds are 41.68% and 26.68% per month, respectively, where both were found to be statistically significant at 1% level. Below average adjustment speeds for lending rates meant that the Brazilian depository institutions operate in an oligopolistic industry -where lending firms have market influence on the demand for money in the financial system. The dominant state-owned and the five largest private commercial banks, for example, collectively dominated the market for commercial loans as illustrated with Figure 02.

This non-competitive market environment helps to explain an unusually high spread of the D-L rates and is deleterious to Brazilian economic growth rates.

In short, a strong effect of the deposit rate on the lending rate and oligopolic characteristics of the Brazilian financial system imply that that the money market is not competitive. It also confirms that loans which were made for short-term consumer financing (with below market rates) at the expense of long-term investments by firms (with above market rates) act as a disincentive signal for the private sector to engage in real production of goods, services and assets.

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