CBB Working Paper 2012-…..

FINANCE AND GROWTH CAUSALITY

BY

ROLAND CRAIGWELL, ALLAN WRIGHT AND YANIQUE CARBY

CENTRAL BANK OF BARBADOS
Research and Economic Analysis Department

Finance and Growth Causality

Roland Craigwell

University of the West Indies, Cave Hill

Allan Wright

Research Department and Economic Analysis,

Central Bank of Barbados

Yanique Carby[1]

July 2012.

Abstract

There exists a wealth of literature that aims to establish what causal relationship exists between financial development and economic growth. That is, whether financial development causes economic growth, the "supply-leading hypothesis" or is it that economic growth leads financial development, the "demand-following hypothesis". Despite the number of research done in the area, there is a gap as it relates to studying the relationship between finance and growth over the course of development in the country. This study seeks to test the hypothesis of Patrick (1966) in the financial system of Barbados, which states that the direction of causality between financial development and economic growth changes over the course of development; i.e., at the early stage of development the supply-leading impetus is evident but as the real growth occurs in the economy, it will spark demand for financial services. The ratio of M2 to GDP is used as a measure of financial development and real GDP as a measure of economic growth. The results lend support for the demand-following hypothesis throughout the entire sample and sub-samples.

[1] Yanique Carby is a postgraduate student at the University of the West Indies, St. Augustine campus. This paper was carried out while on internship at the Central Bank of Barbados.

1. Introduction

Lucas described the relationship between financial development and economic growth as "overstressed" (Lucas, 1988), given the many literature that have sought to establish the relationship which exists between the two. The literature spans those who believe that financial development leads to economic growth; to those who believe that economic growth gives rise to a demand for financial services. However, on the matter of causality, the debate is still not settled. The dominant view seems to be that finance is indeed important in contributing to economic growth. Caribbean authors have also made their contribution and the results of their study have still not reached a consensus. Thus, this empirical analysis seeks to contribute to the debate by examining whether or not a causal relationship exists between financial development and economic growth in the Barbadian economy and the implication of this relationship for what Patrick (1966) poses as the stage-of-development hypothesis. This is done through the use of annual time series data (1946-2011) and the application of a Vector Error Correction Mechanism (VECM) model and Granger (1969) causality tests.

Prior to the 1950s, the financial system in Barbados was predominantly characterized by foreign owned banks. The British Caribbean Currency Board was in effect in 1951; before which, from 1938, the Barbadian government issued its first currency. Haynes (1995) dubbed the decade of the 1960s as the expansionary period of economic and financial development; and in the 1980s growth in non-bank financial services was evident. The economy grew by an average of 3.5 percent, raising income and the demand for financial services. The establishment of the Central Bank in 1972 and the issuance of its own currency was the major highlight of the 1970s.

Post-independent Barbados saw the financial system almost in a state of flux recessions (1974-75, 1981-82 and 1991). The first two recessions were direct results of the oil shocks in 1973 and

1979. The 1991 recession was very severe and resulted in destabilized fiscal and external sectors. Confidence had however been restored and the financial sector had grown significantly, and a greater proportion of savings entrusted to the commercial banks and other deposit taking institutions, as reflected by higher ratios of bank deposits to GDP. Financial liberalization became a specific goal of policy makers following the 1991 recession. The Barbadian economy grew on a steady upward path from 1996 to 2008, with the exception of a decline in output 2001 in the wake of September 11.

What this paper does is look at data over an extensive period of time within a Vector Error Correction Mechanism (VECM) framework. Constrained by data unavailability, the variables selected are the ratio of M2 to GDP as a measure of financial development and real GDP (1974 prices) as a measure of economic growth. The results show that there is unidirectional causality from economic growth to financial development.

The financial sector has continued to play a major role in the Barbadian economy as in other Caribbean economies. Haynes (1995) noted that most economic transactions are monetized and the financial system has proved to be a relatively efficient conduit of funds between savers and spenders. Thus, analyzing the causality which exists between finance and economic growth is very important since if it is established that the financial sector development Granger causes economic growth, the focus on financial development would then be well warranted and the country could continuously look the financial sector as a source of its growth.

The rest of paper is divided into four sections: Section 2 gives a review of relevant literature; Section 3 explores the methodology employed as well as the description of the data used. The

empirical tests follow in Section 4 accompanied by their interpretation; and a conclusion is then made in the final section.

2. Literature Review

Economists have been interested in the link which exists between finance and growth as evident in the wide cross section of studies done in the area. Yet, there seems to be no consensus on the matter. Dating back to Schumpeter (1911), the importance of financial services in promoting economic growth has been stressed. McKinnon (1973) and Shaw (1973) made their contribution by highlighting the importance of financial intermediation in promoting economic growth. Others, such as Robinson (1952), are not convinced of this role of finance in promoting growth and noted that financial development follows economic growth, while Lucas' (1988) conclusion was that the debate of the relationship between financial and economic development is "over-stressed".

The stronger arguments though seem to be in favor of the fact that finance is important in promoting economic growth (though not directly) as evident in the theories put forward in the various growth models - the classical growth model, the neo-classical growth model and the endogenous growth theory - explaining the contribution of finance in economic development. For example, the Harrod-Domar (1946) classical growth model for closed economy states that the rate of growth of Gross National Product (GNP) is determined jointly by the national savings ratio and the national capital-output ratio. As such, the expansion of new capital stock through investment takes place only when these economies save a portion of their national income. This new investment generated through savings will lead to economic growth. The Harrod-Domar growth model was extended to open economies by Kennedy (1966), with savings having similar

implications. A quite popular classical work is that of Schumpeter (1911), which purports that financial intermediaries, in carrying out their financial services - such as mobilizing savings, evaluating projects, managing risks, monitoring managers and facilitating transactions - are essential for technological innovation and economic growth.

The second category of theory on growth is that of the Neo-Classical which attempt to explain long-run economic growth by looking at productivity, capital accumulation, population growth and technological progress. In Solow's (1956) growth model, the importance of savings and capital investment in promoting economic growth is stressed. His premise was that the capacity of the economy can be expanded if society saved part of their resources and used it to build into the future. Another contribution to the classical growth theory is Raymond Goldsmith, who focused on how the transformation of short-term into long-term financial instruments and providing long-term financing can result in economic growth which in this regard is building on Harrod-Domar's model (Goldsmith, 1969). He noted that liquidity can be generated in the financial system if there are surplus savers (persons who save more than they invest) and borrowers who want to invest more than they save so that the surplus is transferred to investors through financial instruments. Goldsmith alluded that the creation of liquidity is critical to the process of economic development.

The most recent addition to the growth literature is the endogenous growth models in which investments in research and development and in physical and human capital are major determinants of economic growth. It contrasts to the neo-classical economics which contends that technological progression and other external factors are the main source of economic growth. This model posits that financial intermediaries can affect the growth-creation process, as innovation and knowledge creation can only be achieved through costly research and

development activities, which are usually only possible when external funding is available through the financial system.

Valverde et al (2004), in his endogenous growth framework explained how the efficient operation of financial institutions leads to economic growth. The new growth model by Greenwood and Jovanovic (1990) highlights how improved capital allocation fosters faster economic growth. Many firms and entrepreneurs solicit capital thus financial intermediaries can realize scale economies in obtaining detailed information regarding firms' profitability and investment prospects, thereby greatly reducing verification and monitoring costs. With these promising firms and managers receiving funds, improved capital allocation efficiency fosters growth.

In addition Diamond (1984) concurs that financial intermediaries have means to efficiently monitor their borrowers, and hold diversified portfolios so as to maintain the safety of their depositors' funds. This result in information asymmetries and transaction costs can be reduced, which in the end will allow for increased and more efficient investment. Stiglitz (2001) however, notes that while examinations and monitoring yield some information, typically there remains a high level of residual information imperfection, which may lead to adverse selection and moral hazard in financial markets.

Evidence from King & Levine's (1993) study on 80 countries over the period 1960-1989 seems to support the Schumpeterian view that the financial system can promote economic growth.

Levine (1997) further outlined the functions of a financial system that help to promote economic growth as:

1. *the amelioration of risk;*
2. *economizing on the information acquisition costs involved in the evaluation of firms, managers and market conditions, thereby improving resource allocation;*
3. *Intermediaries may arise to mitigate the information acquisition and enforcement costs of monitoring firm managers and exerting corporate control ex post, i.e. after financing the activity;*
4. *To mobilize or pool savings from disparate savers;*
5. *The financial system leads to growth by facilitating exchange, which in turn promotes specialization and technological innovation*

In defining financial development Levine (1993) noted that it "occurs when financial instruments, markets, and intermediaries ameliorate – though not necessarily eliminate - the effects of information, enforcement, and transaction costs" (p. 870).

The basis of this research is Patrick's paper of 1966 in which he outlined the various linkages that could exist between finance and growth in underdeveloped countries. A range of studies since have sought to test empirically these hypotheses on the relationship between financial development and economic growth as put forward by Patrick. The "supply-leading hypothesis" postulates that the development of the financial system will lead to economic growth. Studies such as Craigwell *et al* (2001) have supported this hypothesis. On the other hand, the "demand-following hypothesis" posits that as real growth in the economy takes place, this will spark demand for financial services. Ganga (2001) found this hypothesis to be true in the case of Guyana.

Significant to this study is the stages-of-development hypothesis where Patrick puts forward that the relationship between finance and economic growth changes over the course of the development of a country. It is hypothesized that in the early stages of development, supply-leading will take place. Nevertheless, as the economy experiences real growth, this relationship becomes of lesser importance and the real growth in the economy will result in demand for greater financial development. However, in studies such as Wood (1993) and Lorde & Osaretin (2004), this claim is not supported.

A review of the literature of empirical studies within the Caribbean will highlight mixed results on tests on the direction of causality between finance and growth. These results range from unidirectional to a feedback relationship between financial development and economic growth, and intermediate relationships that are not so clear. The results also differ based on the methodology employed, the span of the period of study as well as how financial development is measured. Ganga (2001), using causality and cointegration tests, found that economic growth leads to long run financial development in the case of Guyana. This was established using annual data for 1985-2000 for the ratio of domestic credit to the private sector to GDP as a proxy for financial development, and real GDP as a measure of economic growth.

Granger's (1969) technique was also used by Byron (1997) and Modeste (1993) to investigate the relationship between financial development and economic growth. Byron used three different ratios indicative of financial development (financial intermediation, monetization and finance ratios) in addition to GNP and GDP per capita as measures of economic development using annual data for the period 1972-1995 for 13 CARICOM countries (Bahamas, Barbados, Belize, Guyana, Jamaica, Trinidad and Tobago and the OECS). Modeste on the other hand, used the variables growth in exports, the real interest rate, government savings and foreign savings

respectively, as a proportion of income as measures of financial development on pooled annual data for Barbados (1981-1991), Guyana (1978-1990), Jamaica (1978-1989), and Trinidad and Tobago (1981-1991). Both studies found a bi-directional relationship between finance and growth.

Similarly, the results from Wood (1993) indicate that for the entire period under study, there existed a bi-directional causal relationship between the two variables. Wood used a version of Granger causality owing to Hsiao (1979, 1981) to test the causal relationship between financial development and economic growth for Barbados for the period 1946-1990 and then for sub-periods 1946-1968 and 1969-1990 to test the stage-of-development hypothesis. He used the ratio of M2 to GDP as a measure of financial development. For the first sub-sample (1946-1968), it was found that causality ran in one direction from economic growth to financial development (demand-following); while for the second sub-sample, the study showed a supply-leading relationship where financial development induced economic growth. The results therefore run counter to what is proposed by Patrick's stage-of development hypothesis.

Patrick's stage-of-development hypothesis was also not supported in a similar study by Lorde & Osaretin (2004) which used the ratio of M2 to GDP as well as the ratio of credits provided by financial intermediaries to the private sector as indicators of financial development for Barbados (1966-2000), Jamaica (1960-2000), and Trinidad and Tobago (1960-2000). Applying Hsiao's (1979, 1981) stepwise Granger causality technique, the results showed supply-leading for Barbados and Trinidad and Tobago and a bi-directional causality in all cases, indicating that a demand-following response exists in all countries, at least in the short run. While Lorde & Osaretin checked for stationarity and long-run relationships between the variables, they did not explicitly test the stage-of-development hypothesis over particular periods but rather on a short-

run/long-run basis. There is no evidence that Modeste and Wood did checks for stationarity, and along with Byron, did not test for long-run relationship between finance and growth. Therefore, the results are not valid unless the variables are cointegrated. Wood acknowledged that the results may suffer from missing-variable bias and that the test is limited in detecting the effect of contemporaneous innovations in financial development and economic growth.

A further study by Ramlal & Watson (2005) found a somewhat perverse relationship between financial development and economic growth. The study formed a Vector Error Correction model (VECM), using quarterly data for the period 1970-2002 for Barbados, Jamaica, and Trinidad and Tobago. Financial development is measured as the ratio of broad money (M2) to GDP and the ratio of domestic credit to the private sector and GDP. Per capita growth in real GDP is used to represent economic growth. In the case of Jamaica, the private sector credit variable was found to be insignificant in interacting with the other variables; however, there was evidence of unidirectional causality from the money variable to economic growth. There was evidence of bidirectional causality between money and growth for Barbados and bidirectional causality for the two financial variables for Trinidad and Tobago. For both Barbados and Trinidad and Tobago, there is unidirectional causality from the money variable to the growth variable. Though some evidence of bidirectional causality is observed, there is also evidence of perverse relations in that forms of financial development may result in lower growth rates.

Craigwell, *et al* (2001) on the other hand found unidirectional causality from financial development to economic growth for Barbados. The study used a multivariate cointegrating Vector Autoregression (VAR) analysis on data covering the period 1974-1998, for real interest rate, real capital per capita and the ratio of total commercial bank deposits to nominal GDP at market prices as a proxy for financial development. However, the time span is limited and may

not adequately capture long-run effects. Their recommendations were that future study be done with a data set over a longer period so as to adequately capture long-run effects of financial development on economic growth using the same cointegrating VAR approach. It is by this means that this study is done.

Many of the studies highlighted above would have suffered from omitted variables bias, so a different approach was taken from the traditional examination of the finance-growth causality in a recent study by Iyare & Moore (2009). They established a Vector Error Correction Model (VECM) to investigate the relationship between real GDP per capita and financial development and included exogenous variables (control variables - savings, investment, trade openness and real interest rate - for four small open economies (Barbados, Jamaica, Singapore, and Trinidad and Tobago) for the period 1960-2003. The results show that there is a positive association between financial development and growth in all four countries. However the finance-growth link varies in the long run across countries and highlighted the fact that despite similarities amongst economies (in terms of size and openness), there can be differences in the level of importance of the link; also that cross-country approaches that investigate the financial development-growth relationship may overestimate this link.

The survey of the literature highlighted the following limitations in the studies done: *(a) the limited timespan over which the studies were done; (b) failing to carry out proper checks for stationarity; (c) failing to take into account the long-run relationship between the variables used; (d) not investigating structural changes in the relationship between finance and growth; and (e) possible omitted variables bias.* What this paper sets out to do is investigate Patrick's stage-of-development hypothesis in Barbados by: *(a) looking at a data set for an extensive period of time; (b) carrying out checks for stationarity on this data set; (c) investigating long-run*

relationships between the variables; and (d) investigating if there is a change in the relationship between finance and growth over the period of study.

3. Methodology and Data

The meaning of causality in an economic sense was developed by Granger (1969) when he explained that an economic time series Y_t causes another, X_t, if its inclusion leads to a better prediction of X_t than if it was excluded. Causality can be unidirectional or bidirectional (feedback); and a feedback occurs when X_t is causing Y_t and Y_t is also causing X_t. The most common way to test for a causal relationship is Granger (1969) causality tests. This causality is to "see how much of the current *y* can be explained by past values of *y* and then to see whether adding lagged values of *x* can improve the explanation". *y* is said to be Granger-caused by *x* if it helps in the prediction of y, or equivalently if the coefficients on the lagged *x*'s are statistically significant (Eviews & User Guide, p.428).

Wood (1993) in testing Patrick's stage-of-development hypothesis, conducted causality testing on two subsamples using a version of Granger causality by Hsiao (1979,1981) to see if the relationship between financial development and economic growth changed over the two periods. A Similar procedure was used by Lorde (2004), though he did not explicitly test various time periods but looked at just long and short run relationships. This study however employs the regular Granger (1969) causality tests – both the short and the long run tests. Other methods of testing causality in temporal systems based on OLS estimates and the F-test have been suggested by Sims (1972). However, studies have shown that the Granger (1969) test outperforms the other methods in both large and small samples by providing more efficient estimates. The Granger-causality test is however limited in the sense that it is built on the premise of stationarity

and a two-way Granger-causality test without the consideration of the effects of other variables is subject to possible specification bias. So in cases where these considerations are not made, results may be invalid.

Granger causality is normally carried out within a VAR framework, for example as done by Craigwell, et al (2001). The said VAR framework will be used in this study on the overall sample as well as subsamples to investigate whether the relationship between financial development and economic growth changed pre and post-independence as well as pre and post liberalization.

Watson & Teelucksingh (2002) noted that the VAR is based on three basic tenets as proposed by Sims (1980):

1. There is no a priori endogenous-exogenous dichotomy in the system
2. There are no zero-type restrictions
3. There is no strict underlying economic theory on which the model is based

The general form of the model is given as:

$$X_t = \prod_1 X_{t-1} + \prod_2 X_{t-2} + \cdots + \prod_n X_{t-k} + \varepsilon_t$$

Where X_t is a vector of p variables, $\prod_1, \prod_2, \ldots, and\ \prod_k$ are (p×p) matrices of coefficients to be estimated, and ε_t is a vector of innovations with mean zero and covariance matrix $\boldsymbol{\Omega}$.

The functional form of the bivariate regression is given as:For the two variable VAR model, the specification is:

$$X_t = a_1 X_{t-1} + a_2 X_{t-2} + b_1 Y_{t-1} + b_2 Y_{t-2} + \varepsilon_{1t}$$

$$Y_t = c_1 X_{t-1} + c_2 X_{t-2} + d_1 X_{t-1} + d_2 Y_{t-2} + \varepsilon_{2t}$$

Where ε_1 and ε_2 are correlated white noise processes. If the β coefficients are jointly significant then the conclusion would be that y causes m.

Most economic time series are non-stationary. With this in mind, the following procedure is outlined below. The variables are first tested for stationarity by informally inspecting the time series plots of raw data and correlograms, as well as running OLS regression to identify the possibility of spurious regression (High R-squared and low Durbin-Watson Test statistic). Formal tests for unit root include the Augmented Dickey Fuller (ADF) test and the Phillips-Perron test. If the variables are found to have a unit root (non-stationary), the Johansen (1988) procedure can then be used to test for cointegration to identify the number of cointegrating vectors. This would indicate the number of cointegrating equations which would be estimated using a Vector Error Correction Mechanism (VECM) model. The VECM is the VAR in first difference with the lags of the independent variables used as "dependent" variables. The error correction mechanism (ECM) presupposes that some variable y has an equilibrium path. In the short-run, there are adjustments to deviations from the long-run path which are defined in the ECM model.

Cointegration is said to exist if any linear combination of I(1) variables results in an I(0) residual term. It indicates a long-run equilibrium relationship existing among variables and implies causality. Cointegration tests are only valid if the variables involved are known to be non-stationary. Therefore, if the variables are stationary, cointegration tests are not necessary and the VAR is carried out. What then follow are the Granger causality tests. This therefore sets the basis for investigating the causal relationship between the variables.

Sims (1980) and others recommend against the differencing even if the variables contain a unit root. They argue that the goal of a VAR analysis is to determine the interrelationships among the variables, not to determine the parameter estimates. The main argument against differencing is that it "throws" away information concerning the co-movement in the data (such as the cointegrating relationships).

Data

Studies have considered a credit variable and measures of technological advances as proxies for financial development. However, for the purpose of this study, financial development is measured as the ratio of M2 to GDP and the growth rate in real GDP is used as a measure of economic growth. Though simple, these variables give adequate representation for the purpose of this study. The ratio of M2[2] to GDP is a monetization ratio which indicates the level of financial development indicative of the liquid form of monetary aggregates which are related to the ability of the financial system to provide liquidity or a medium of exchange. These variables were used on the basis of availability of data as the use of other variables is constrained greatly by the limited data available as well as they are widely used in other studies investigating the similar relationships (See Wood, 1993, Lorde & Osaretin, 2004).

Annual observations for the period 1946-2011 were obtained from the Central Bank of Barbados. This period spans more than six decades and is adequate to examine the long run relationship between finance and growth as well as to enable the data to be sub-divided into three periods: pre-independence[3] (1946-1966) and post-independence to pre-liberalization (1967-1990) and post-liberalization (1991-2011). This is to investigate Patrick's stage-of-development

[2] M2 is M1 (which is currency with the public plus demand deposits) plus quasi money (where quasi money is time deposits and savings deposits).
[3] Barbados gained independence in 1966.

hypothesis; in this case, to see if there is a difference in the relationship between finance and growth over the various periods. Pre-independence can be classified as the time in which the country did not have an independent financial system but the financial system was controlled by the colonial power. Post-independence saw an independent financial system and then further on much liberalization. Patrick's stages-of-development hypothesis posits that at the early stage of development (which would be pre-independence), finance leads economic growth; but as real growth occurs in the economy, it will spark financial development which changes the relationship. Therefore, the *a prior* expectation if this hypothesis holds, is to see a supply-leading relationship in the pre independence period, then demand-following in subsequent periods.

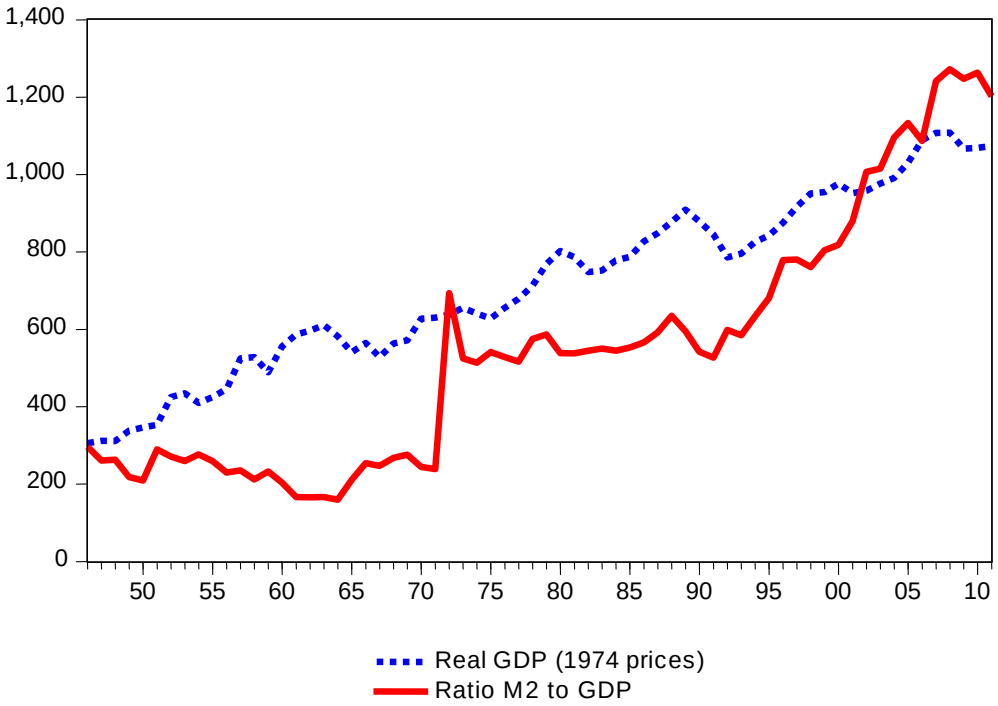
4. Results[4]

Stationarity Tests

Recall that weak stationarity requires that the mean (first moment) and variance/covariance (second moments) are independent of time. As such, a natural starting point in identifying stationarity is an inspection of the plot of the economic series against time. The plots show that there is an upward trend in both the ratio of M2 to GDP and the real GDP series which means that over time, the mean is changing and the series is growing in a fairly systematic manner. As such, this is indicative of a non-stationary series. When first differenced however, there seems to be no change in the trend of the plot of the two variables. That is, both plots fluctuate around a fixed mean with a tendency to return quickly to this mean whenever there is movement away from it which would point to one unit root in both variables.

[4] The estimations were carried out using Eviews version 7.

Figure 1: Plot of Real GDP (1974 prices) and Ratio of M2 to GDP



Another informal test for unit root is inspection of the correlogram. The Autocorrelation functions for both variables show high positive values that decay at a very slow rate; this points to non-stationarity. The first-difference of both variables shows the autocorrelation function fluctuating between positive and negative values which are an implication of non-stationary series. In addition, OLS regression shows a high R^2 (0.811) and a low Durbin-Watson statistic (0.199). This in itself implies that there is a problem of serial correlation, spurious regression and non-stationarity. The data is exhibiting a relationship with time rather than the dependent variable. However, these are informal tests and on their own cannot conclusively determine the stationarity property of a variable.

Formally, the Augmented Dickey Fuller (ADF) Test was used to test for the presence of a unit root. The null hypothesis of the ADF test is that there exists at least one unit root, while the

alternative is that the series is stationary. The test was done in levels and first differences and in both cases with an intercept/ intercept and trend and/ no intercept and trend. The results are shown in the tables below.

Tables 1(a) and (b): Augmented Dickey Fuller (ADF) Tests

	LEVEL		
	INTERCEPT	INTERCEPT & TREND	NO INTERCEPT & TREND
EG	-0.892	-4.090**	2.802
FD	0.0761	-2.550	1.363
	FIRST DIFFERENCE		
	INTERCEPT	INTERCEPT & TREND	NO INTERCEPT & TREND
EG	-6.584***	-6.547***	-5.857***
FD	-9.972***	-10.170***	-9.547***

*** significance @ 1%

** significance @ 5%

Both series admit to at least one unit root. The ADF tests reveal that after first differencing the series do not admit to a unit root which would indicate that the variables real GDP and ratio of M2 to GDP are integrated of order 1, I(1) an indication that the variables are cointegratable[5].

Cointegration Test

The selection of the correct lag length is very crucial in carrying out any further tests as this has implications for the cointegration, VECM and Granger causality tests. Long lag lengths consume degrees of freedom and too small will lead to misspecification. According to the lag length selection criteria, the optimal lag length which minimizes the *Akaike information criterion* (AIC) is 2 and the *Schwarz Bayesian criterion* (SBC) 1. Either of these can be used. A lag length of 2 was chosen.

[5] The underlying cointegration theory states that any linear combination of I(1) variables result in I(0) residual term.

Several tests were done in attempting to come up with the most appropriate data trend. The results point to a linear deterministic trend. With this selection, the Johansen cointegration test indicates that the variables are cointegrated and has one cointegrating vector. This means that there is one cointegrating equation which is estimated in the VECM.

Tables 2(a) and (b): Tests for Cointegration Rank

(i) Trace Statistic

Null	Alternative	Statistic	95% Critical Value	Decision
r = 0	r ≥ 1	29.896	25.872	Reject H_0
r = 1	r ≥ 2	8.043	12.518	Do not Reject H_0

(ii) Maximum Eigenvalue Statistic

Null	Alternative	Statistic	95% Critical Value	Decision
r = 0	r ≥ 1	21.852	19.387	Reject H_0
r = 1	r ≥ 2	5.69	8.044	Do not Reject H_0

The conclusion is therefore that there is one cointegrating equation at the 5% level of significance. The error term is I(0) and therefore stationary.

Vector Error Correction Mechanism (VECM) Model

An initial indication that the VECM is a good system is that the adjustment coefficients are negative and significant. Negativity is important in order for the adjustment coefficient to bring the system back into equilibrium, while significance is important in order to help determine the

relevance of the long run coefficients. The null hypothesis is that the adjustment coefficient is equal to zero (not significant). The degrees of freedom (df) used are 60df and from t-tables yield the following critical values (two-tailed test):

At 1% significance level: 2.6603

At 5% significance level: 2.0003

At 10% significance level: 1.6705

Table 3: Test for Significance of Adjustment Coefficients

Equation	t-stat	Level of significance		
		1%	5%	10%
ΔEG_t	-3.087	Significant	Significant	Significant
ΔFD_t	-3.751	Significant	Significant	Significant

Both adjustment coefficients are negative and significant at the 5% level of significance which indicates that an economically meaningful long-run relationship was represented by the data. The speed of adjustment to long-run equilibrium on the financial development equation is 1.5% and for the economic growth equation is 0.84%.

Granger Causality Tests

Common knowledge is that correlation does not necessarily imply as correlation could exists but simply be spurious or meaningless. To test for causality, the Granger (1969) test was employed. The Bivariate Granger causality test provides an evaluation in terms of which variable causes the other, in a temporal sense. This test is contingent upon the use of the appropriate lag length (2 is used as was used above). The theory is couched in terms of the relevance of all past information. The tests for Granger causality showed that there is unidirectional causality from economic growth to economic growth to financial development which is what Ganga (2001) found in the case of Guyana. However, this is contrary to what was found by Craigwell, et al (2001) for the

Barbadian economy who found causality running from financial development to economic growth; and Byron (1997) which found bidirectional causality.

Table 4: VECM Granger Causality Test

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1946 2011
Included observations: 63

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	7.430525	2	0.0243
All	7.430525	2	0.0243

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	2.368729	2	0.3059
All	2.368729	2	0.3059

Sub-periods

For the sub-periods, 1946-1966 & 1967-2011 as well as 1946-1971 & 1972-2011, the same tests as done above were done and indicated non-stationarity and admitted one unit root. However, because of the small number of observations in each sub-sample and the fact that cointegration is a long-run relationship, it was not possible to test for cointegration. Given though that cointegration tests on the entire sample revealed cointegration between the two variables, causality in the sub-periods was still estimated in the VECM framework. The results indicated that causality run from economic growth to financial development in all sub-samples.

5. Conclusion

This study undertook the task of testing Patrick's stage-of-development hypothesis in the Barbadian economy through the use of Granger (1969) causality tests utilizing cointegration and VECM analysis (and associated perquisite tests). The hypothesis states that at the early stage of development, financial development will cause economic growth but as real growth takes place in the economy, the relationship will change. The tests in this study showed that causality ran unidirectional from economic growth to financial throughout the entire sample as well as in the subsamples. The results are not in accordance with other studies in the region which found bidirectional causality as well as causality running from finance to economic growth. It also did not lend support to Patrick's stage-of-development hypothesis.

Notwithstanding though, the results are sensitive to the measures of financial development and economic growth used. For example, other measures may yield different results. In light of this, these results are mere indicative than conclusive and the debate on the causal relationship between finance and growth has room for further contributions.

Bibliography

Byron, S. (1997). CARICOM Financial Development & Economic Growth: Some Initial Statistical Relationships. *Financial Development and Economic Growth*, 485-501.

Craigwell, R., Downes, D., & Howard, M. (2001). The Finance-Growth Nexus: A Multivariate VAR Analysis of a Small Open Economy. *Savings and Development, 2*, 209-223.

Ganga, G. (2001). Financial Development and Economic Growth in Guyana. *XXXIII Annual Monetary Studies Conference.* Belize City: Caribbean Centre for Money and Finance.

Goldsmith, R. W. (1969). *Financial Structure and Development.* New Haven, CT: Yale University Press.

Granger, C. (1969, August). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica, 37*(3), 424-438.

Greene, W. E. (1997). *Econometric Analysis* (Third ed.). New Jersey: Prentice Hall.

Gujarati, D. N. (2004). *Basic Econometrics* (Fourth ed.). New York: The McGraw-Hill Companies.

Haynes, C. (1995). *The Financial Structure in Barbados 1950-1990: A Survey.* Central Bank of Barbados.

Iyare, S., & Moore, W. (2011). Financial Sector Development and Growth in Small Open Economies. *Applied Economies, 43*, 1289-1297.

King, R., & Levine, R. (1993, August). Finance and Growth: Schumpeter Might Be Right. *The Quarterly Journal of Economics, 108*(2), 717-737.

Levine, R. (1997, June). Financial Development and Economic Growth: Views and Agenda. *Journal of Economic Literature, XXXV*, 688-726.

Lorde, T., & Osaretin, I. (2004). The Importance of Financial Sector Reform: Development and Efficiency in Caribbean Banking. *XXXVIth Annual Monetary Studies Conference .* Trinidad and Tobago: Caribbean Centre for Money and Finance.

Modeste, N. (1993). An Emperical Test of the McKinnon Model of Financial Unrepression and Economic Growth: The Experience of Some Caribbean Countries. *Social and Economic Studies , 42*(2&3), 81-93.

Patrick, H. (1966, January). Financial Development and Economic Growth in Underdeveloped Countries. *Economic Development and Cultural Change*, 174-189.

Ramlal, V., & Watson, P. K. (2005). Financial Development and Economic Growth in the CARICOM sub region.

Schumpeter, J. (1934). *The Theory of Economic Development.* MA: Harvard University Press.

Sims, & A., C. (1980, January). Macroeconomics and Reality. *Econometrica, 48*(1), 1-48.

Watson, P., & Teelucksingh, S. S. (2002). *A Practical Introduction to Econometrics Motheds: Classical and Modern.* Jamaica: University of the West Indies Press.

Wood, A. (1993). Financial Development and Economic Growth in Barbados: Causal Evidence. *Savings and Development, 4*, 379-390.

Appendix

Table 5: VAR Lag length Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: EG FD
Exogenous variables: C DUMMY1972
Sample: 1946 2011
Included observations: 60

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-774.3342	NA	6.35e+08	25.94447	26.08410	25.99909
1	-597.0434	330.9428	1968447.	20.16811	20.44736*	20.27734
2	-590.7997	11.23867*	1828324.*	20.09332*	20.51219	20.25717*
3	-589.3752	2.469086	1995918.	20.17917	20.73767	20.39763
4	-585.8144	5.934779	2031603.	20.19381	20.89193	20.46688
5	-580.9153	7.838497	1980816.	20.16384	21.00158	20.49153
6	-579.5551	2.085668	2177299.	20.25184	21.22920	20.63414

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 6: Johansen Cointegration Test

Sample (adjusted): 1949 2011
Included observations: 63 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: FD EG
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.293094	29.89561	25.87211	0.0149
At most 1	0.119861	8.043557	12.51798	0.2481

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.293094	21.85205	19.38704	0.0215

At most 1	0.119861	8.043557	12.51798	0.2481

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

FD	EG	@TREND(47)
-0.000881	-0.029642	0.363518
0.006082	-0.004106	-0.084770

Unrestricted Adjustment Coefficients (alpha):

D(FD)	20.66985	-19.44686
D(EG)	12.48541	5.435150

1 Cointegrating Equation(s): Log likelihood -643.3130

Normalized cointegrating coefficients (standard error in parentheses)

FD	EG	@TREND(47)
1.000000	33.64824	-412.6427
	(6.98905)	(82.5781)

Adjustment coefficients (standard error in parentheses)

D(FD)	-0.018209
	(0.00755)
D(EG)	-0.010999
	(0.00291)

Table 7: VECM Estimates

Vector Error Correction Estimates
Sample (adjusted): 1949 2011
Included observations: 63 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
FD(-1)	1.000000
EG(-1)	34.70031
	(6.86290)
	[5.05622]
@TREND(46)	-448.4410
	(81.0360)
	[-5.53385]
C	-10346.24

Error Correction:	D(FD)	D(EG)
CointEq1	-0.015441	-0.008417
	(0.00412)	(0.00273)
	[-3.75075]	[-3.08702]
D(FD(-1))	-0.275898	0.060257
	(0.07556)	(0.05004)
	[-3.65142]	[1.20410]
D(FD(-2))	-0.097610	-0.031446
	(0.07675)	(0.05083)
	[-1.27176]	[-0.61860]
D(EG(-1))	0.028678	0.347319
	(0.19590)	(0.12975)
	[0.14639]	[2.67684]
D(EG(-2))	0.556419	0.069826
	(0.20516)	(0.13588)
	[2.71207]	[0.51387]
C	7.130357	6.664711
	(6.38943)	(4.23177)
	[1.11596]	[1.57492]
DUMMY1972	413.4228	-3.610827
	(42.7887)	(28.3393)
	[9.66197]	[-0.12741]
R-squared	0.717243	0.224834
Adj. R-squared	0.686947	0.141780
Sum sq. resids	95500.50	41891.60
S.E. equation	41.29608	27.35076
F-statistic	23.67495	2.707091
Log likelihood	-320.0913	-294.1339
Akaike AIC	10.38385	9.559805
Schwarz SC	10.62198	9.797931
Mean dependent	14.89960	12.11111
S.D. dependent	73.80743	29.52366
Determinant resid covariance (dof adj.)		1206877.
Determinant resid covariance		953581.9
Log likelihood		-612.4776
Akaike information criterion		19.98342
Schwarz criterion		20.56172

Table 8: Granger Causality Test (1946-1966)

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1946 1966
Included observations: 18

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	15.33723	2	0.0005
All	15.33723	2	0.0005

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	2.320786	2	0.3134
All	2.320786	2	0.3134

Table 9: Granger Causality Test (1967-2011)

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1967 2011
Included observations: 45

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	5.943061	2	0.0512
All	5.943061	2	0.0512

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	1.423974	2	0.4907
All	1.423974	2	0.4907

Table 10: Granger Causality Test (1968-1990)

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1967 1990
Included observations: 24

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	9.980061	2	0.0068
All	9.980061	2	0.0068

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	0.486556	2	0.7841
All	0.486556	2	0.7841

Table 11: Granger Causality Test (1991-2011)

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1991 2011
Included observations: 21

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	0.310830	2	0.8561
All	0.310830	2	0.8561

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	1.536035	2	0.4639
All	1.536035	2	0.4639

Table 12: Granger Causality Test (1946-1971)

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1946 1971
Included observations: 23

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	4.658581	2	0.0974
All	4.658581	2	0.0974

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	0.701134	2	0.7043
All	0.701134	2	0.7043

Table 13: Granger Causality Test (1971-2011)

VEC Granger Causality/Block Exogeneity Wald Tests
Sample: 1972 2011
Included observations: 40

Dependent variable: D(FD)

Excluded	Chi-sq	df	Prob.
D(EG)	9.038397	2	0.0109
All	9.038397	2	0.0109

Dependent variable: D(EG)

Excluded	Chi-sq	df	Prob.
D(FD)	2.992393	2	0.2240
All	2.992393	2	0.2240

Table 14: Serial Correlation Test

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 1946 2011
Included observations: 63

Lags	LM-Stat	Prob
1	6.851651	0.1439
2	0.809350	0.9372
3	0.716144	0.9493
4	0.953374	0.9168
5	1.735660	0.7842
6	0.992269	0.9110
7	8.839171	0.0652
8	8.241950	0.0831
9	3.238687	0.5187
10	5.373649	0.2511
11	4.151901	0.3858
12	8.910460	0.0634

Probs from chi-square with 4 df.