FINANCIAL DEVELOPMENT, INVESTMENT, PRODUCTIVITY AND ECONOMIC GROWTH IN THE U.S.

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ABSTRACT

This paper uses time-series methods and a new Granger causality procedure to examine how financial development affects long-term economic growth in the U.S. It also examines whether there is a feedback or reverse causal effect from the growth processes to financial development. The results show that financial development affects growth by increasing the level of investment and its productivity. On the other hand, no evidence of reverse causality from economic growth to financial development is found. The findings are consistent with the view that financial development has a significant and independent positive effect on long-term economic growth.

INTRODUCTION

In recent years there has emerged a substantial body of theoretical models that established a positive link between financial development and economic growth. These models have also provided important insights into how financial development affects economic growth and vice versa. They show that financial development positively affects economic growth in two ways: One, by increasing the saving rate, thereby raising the level of investment and capital accumulation; and two, by enhancing the efficient allocation of investment, thereby increasing the productivity of investment (see, Pagano, 1993; Levine, 1997 for a comprehensive survey of the literature). While the effectiveness of a financial system can be determined by how well it performs these two functions, economists, however, emphasize that the efficiency enhancing role of the financial system is more important because of its long-run growth effect (see, Levine, 1993; Watchel, 2001). Consequently, how the financial structure (that is, the way the financial system is organized) impacts the efficiency (productivity) enhancing role of the financial system has become an important policy issue. This issue is at the core of the ongoing theoretical debate on the comparative advantages and disadvantages of different financial structures; in particular, between the Anglo-American market-based and German or Japanese bank-based financial systems[1]. If one form of financial structure is more conducive to economic growth than another then economic policy must take this into account.

The aim of this paper is to empirically examine how financial development affects economic growth in the U.S. More specifically, it attempts to determine whether financial development affects growth by increasing the level of investment, its productivity, or both. Although the study is limited to only the U.S., the findings will, however, have direct implications on the role of market-based financial system on economic growth and development because the U.S. financial system is considered as the leading example of the market-based financial system.[2]

Working with large cross-section of countries (developed and developing) and using the method of pure cross-country regression, or dynamic panel data methods such as the generalized methods of moments (GMM), several studies have examined the channels through which financial development affects economic growth (see, De Gregorio & Guidotti, 1995; Levine & Zarvos, 1998; Beck et al., 2000, and Benhabib and Spiegel, 2000, among others). However, many criticisms have been expressed against these studies with respect to the data and estimation methods they used. Predominant among which is that, cross-country/multi-country panel regression estimates "mask important cross country differences" (Levine and Zarvos, 1996; Darlauf, 2001)[3]. That is, the slope coefficient is taken to be identical across the countries included in the panel, which implies that financial development generates equivalent investment and productivity increases across countries. However, heterogeneity across countries in terms of their institutional and financial structures which plays a crucial role in determining the finance-growth relationship has been documented in the literature (Stigletz, 1985; Edwards and Fisher, 1994; La Porta et al., 1997; Shleifer & Vishny, 1998; Stulz, 2001). For example, as alluded to earlier, there is a rich diversity of opinion in the existing literature on the relationship between the financial structure (that is, the degree to which the financial system is bank or market-based) and long-term economic growth (see, Allen & Gale 1999; Levine, 2002 for a comprehensive review of this Literature).

All of these raise the possibility that the relationship between financial development and economic growth is country-specific, hence, the cross-country/multi-country panel estimates may not correspond to country specific estimates. Consequently, generalization based on cross-country or multi-country panels may provide incorrect inference for several countries included in the panel; thereby, seriously impairing their policy significance.

The shortcomings of the cross-country/panel estimators have prompted a number of researchers to rely on time-series method to examine the finance-growth nexus based on the data of individual countries (Neusser & Kuglar 1998; Rousseau & Watchtel 1998; Arestis & Luintel, 2001). As argued by Arestis & Luintel (2001, pp 17), 'time series methods can provide useful insights into differences of this [financial development and economic growth] relationship across countries and may illuminate important details that are hidden in averaged-out results'. However, no attempt has been made to use the same technique to investigate the channels through which financial development affects economic growth in the U.S[4]. This paper attempts to fill in this gap.

Using long-term time-series data and the VAR method of analysis, this study attempts to empirically examine the channels through which financial development affects long-term economic growth in the U.S. In addition to the stated objective, it builds on the existing literature in two important ways. First, financial sector GDP (value added) is used as a measure of financial development. This is a major departure from the commonly used bank related measures such as: monetary aggregates like M2, liquid liabilities of the financial system, or bank credit to the private sector. As is explained below, compared to these measures, financial sector GDP is by far a better measure of financial development in a number of ways; one of which is that, it represents a broader measure of financial development. Consequently, unlike the other measures, it does not underestimate the level of financial development in industrialized countries like the United States, where a significant portion of financial development or innovation occurs outside the banking system[5]. Second, it uses a new Granger non-causality testing procedure developed by Toda & Yamamoto (1995) to conduct causality analysis. The use of this method enables to avoid the potential of pre-testing biases resulting from testing non-stationarity and cointegration of the data series.

The rest of the paper is organized as follows. First, in order to put the empirical analysis in proper perspective, a selective review of both the theoretical and empirical literature is provided. Next, an outlines of the methodology and model used in the empirical study is presented, followed by discussion of the data and measurement issues. The last two sections provide, respectively, the empirical results and the conclusion.

LINKAGES BETWEEN FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH

Analytical Framework

The theoretical framework adapted here draws essentially on the recent literature on endogenous growth theory, which shows that growth rate can be related to institutional arrangements (Romer 1986, Lucas 1988, Barro 1991, Grossman and Helpman 1991, among others). In this section, a simple endogenous growth model, the "AK model", where aggregate real output is a function of the aggregate capital stock is used to illustrate the potential impacts of financial development on economic growth.

$$Y_t = AK_t \tag{1}$$

Where Y_t and K_t are output and capital stock at time t, respectively and A is a constant measuring the amount of output produced for each unit of capital.[6] Assuming, that a fraction of income, σ, is saved and invested, and dropping the time indices, the capital accumulation (investment) equation is given by:

$$\Delta K = \sigma Y - \delta K \tag{2}$$

Where δ is the depreciation rate and both σ and δ are assumed to remain constant. Dividing both side of equation (2) by K results in the capital accumulation equation rewritten as: $\Delta K/K = \sigma Y/K - \delta$. Since, from equation (1), Y/K = A, substituting A for Y/K results in:

$$\Delta K \big/ K = \sigma A - \delta \tag{3}$$

Finally, by taking logarithms and derivatives of equation (1) and combining it with equation (3), the steady state growth rate can be written as:

$$y = \sigma A - \delta \tag{4}$$

Where, y represent growth rate of output. Equation (4) shows that the growth rate in output is the product of the saving rate and the marginal productivity of capital.

Equation (4) shows two ways through which financial development can affect economic growth. First, it increases σ, the saving rate, and thus, the investment rate. Second, it can increase A, the efficiency with which capital is used.

The former effect is strongly emphasized by McKinnon (1973) and Shaw (1973). In the McKinnon-Shaw model, a well-developed financial system mobilizes savings by channeling the small-denomination savings into profitable large-scale investments. These savings might not be available for investment without the participation of financial institutions because mobilizing savings of disparate savers is usually costly due to the existence of information asymmetries and transaction costs. Financial institutions lower the cost of mobilizing savings and also provide attractive instruments and saving vehicles while offering savers a high degree of liquidity[7].

There is also a large body of theoretical models that highlights the second, i.e., the efficiency-enhancing, role of financial development[8]. These models show that financial development can affect productivity of capital in two major ways. One, by collecting and processing information needed to evaluate alternative investment projects hence improving the allocation of resources; and two, by providing opportunities to investors to diversify and hedge risks, thereby inducing individuals to invest in riskier but more productive investment alternatives. For example, Greenwood & Jovanovic (1990), highlight the capacity of financial institutions to acquire and analyze information about the state of technology and channel investible funds to investment activities that yield the highest return. Similarly, King & Levine (1993), show that financial institutions can boost the rate of technological innovations by identifying those entrepreneurs with the best chance of successfully identifying new goods and production processes. Bencivenga & Smith (1991), present a model in which the presence of effective financial institutions eliminate liquidity risks, hence reducing the need to hold savings in liquid but unproductive or highly liquid and low-return investments. In a similar development, Levine (1991) shows how financial institutions such as banks, mutual funds, investment banks, and financial markets enhance the productivity of investments by pooling consumers' liquidity risk. In addition these models emphasize that there is a positive two way causal relationship between financial development and economic growth. They show that economic growth reduces the importance of fixed costs associated (incurred) in joining the financial market thereby facilitating the creation and expansion of more financial institutions.

Empirical Literature

The above theoretical developments have led to a large number of empirical investigations that used a number of different statistical techniques. A detailed review is provided in Levine (1997, 2003) and Watchell (2001). Here, only those that focused on empirically investigating the channels through which financial development affects economic growth are reviewed.

Most of the early works used pure cross-country growth regression methods in which the average per capita income/investment/productivity growth rate over some period is regressed on some measure of financial development and a set of control variables (De Gregorio & Guidotti 1995; Levine & Zarvos, 1998). The results showed the existence of a positive relationship between financial development and the volume and efficiency of investment and were taken as suggesting that cross-country differences in financial development explain a significant portion of the cross country differences in average growth rates. The problem with these studies is that the pure cross-country growth regression method of analysis fails to explicitly address the potential biases induced by endogeneity of the explanatory variables and cross-country heterogeneity or country specific effects. Hence, the estimates are biased and any statistical inference that can be gleaned from such analysis may be misleading. In light of these problems, recent empirical studies have used dynamic panel data methods such as the first differenced generalized methods of moments (GMM) as a way to control for the potential sources of biased coefficient estimates in cross-country regressions (see, Beck et al., 2000; Benhabib & Spiegel 2000). The results of these studies provide evidence of strong connection between the exogenous component of financial development and long-run economic growth. They however provide mixed evidence on the question of how financial development affects economic growth. While Benhabib & Spiegel (2000) provide evidence that the link works through increase in both the volume and efficiency of investment, Beck et al. (2000), on the other hand, provide evidence that the link works through only improvements in the efficiency of investment. Although the panel studies represent significant improvements over the pure cross-country studies, they, however, suffer from significant measurement and statistical shortcomings. First, as described above, the proxies for financial development used (see, description of the data below) do not adequately measure the functions of the financial system. Second, as agued by Levine (2003, pp. 43) 'in using high-frequency data the panel work is less directly linked to long-run growth and may not fully abstract from business-cycle and short run influences'. Third, it is assumed that the slope coefficient is identical across the countries included in the panel, which implies that financial development generates equivalent investment and productivity increase across countries, which may be rejected by the data (Levine and Zarvos, 1996; Darlauf, 2001; Levine, 2003).

Several studies have used the time-series data to examine the finance-growth links using different measures of financial development (Neusser & Kuglar 1998; Rousseau & Watchtel 1998; Arestis & Luintel 2001)[9]. However, they did not investigate the channels through which financial development affects economic growth.

EMPIRICAL FRAMEWORK AND ECONOMETRIC METHODOLOGY

Given the various theories on the relationship between financial development and economic growth, it is not possible to exclude the possibility that the variables of interest, that is, productivity, investment (INVEST), and financial development (FD), are jointly determined. Hence the empirical investigation into the relationships between these variables is carried out in a vector autoregressive (VAR) framework.

Using a VAR model, the following causality questions are tested: First, does FD cause an increase in the volume of investment (INVEST)? Second, does FD cause improvement in the productivity of investment? Moreover, questions of reverse causalities are tested in a similar manner. A unique advantage of a VAR technique of analysis is that it treats all variables as potentially endogenous and also facilitates investigation of the related concept of causality in the Granger (Granger 1969) sense.

In testing the above stated causality questions, a procedure analogous to that employed by Gregorio & Guidotti (1995) and Benhabib & Spiegel (2000) is used. That is, if financial development (FD) is found to causally affect real output (GDP) when an investment variable (INVEST) is included (controlled for) in the model, it indicates that financial development affects economic growth by changing the allocative efficiency or productivity of investment. This way, the productivity effect of FD is disentangled from its overall growth effect. In addition, if FD causally affects INVEST when the output variable (GDP) is included in the model, it means financial development causally affects the level of investment. The reverse causality issues, i.e., whether increase in GDP or INVEST causes FD are also tested in a similar manner.[10]

Following the literature, an unrestricted VAR model with deterministic terms can be written as,

$$Z_t = \sum_{i=1}^{k+1} \pi_i Z_{t-i} + \delta t + \mu + \varepsilon_t, \qquad \text{for } t = 1, \ldots\ldots, T \qquad (5)$$

Where, in this study, Z_t = [GDP, INVEST, FD] is a 3x1 vector of random variables; π_i are matrices of coefficients; μ and δ are (nx1) vector of constant and trend coefficients respectively; and ε_t is a (3x1) vector of white noise error terms.

Assuming stationarity of the variables[11], a Granger non-causality test hypothesis can be expressed as linear restrictions on a subset of parameters using standard method such as the F-test. However, if the variables are non-stationary the standard test is ineffective as the test statistics, in general, lack standard distribution (Sims et. al. 1990, Toda & Philips 1993). Moreover, Engle & Granger (1987) and Granger (1988) show that a VAR model in first difference with cointegrated variables is misspecified, hence, results based on such models may lead to erroneous inferences. Consequently, several alternative methods of testing for causality in cointegrated VAR have emerged in the literature. The popular approach has been to re-parameterize the model into the equivalent vector error correction model (VECM) and to conduct causality tests following either the residual-based Engle-Granger two-stage method (Granger 1988, and Eangle & Granger 1987), or the Johansen-type error correction model (ECM) (Johansen 1990, Hall & Wickens 1993).

A major problem with the method of vector error correction modeling in causality analysis is that it is sequential in nature. More specifically, unit root and cointegration tests should be conducted before making causality analysis. Consequently, the validity of the causality inferences is conditional on avoiding biases in the estimation of integration and cointegration results. Econometric studies report that the pre-testing biases might be severe because the power of unit root test is generally very low and tests for Johansen cointegration are not very reliable in finite samples (see, Banergee and et al. 1986, Toda & Yamamoto 1995). Consequently, causality inferences made based on such procedures may suffer from pre-testing biases. Toda & Yamamota (1995) have developed an alternative approach to testing Granger non-causality, which does not require pre-testing for the integration or cointegration properties of the VAR system, thus avoiding the potential problems of the pre-testing biases. The procedure utilizes the Wald test statistic for testing linear restriction on the coefficients of a VAR in levels even in a non-stationary system. Causality test, using the procedure, is implemented in two steps: In the first step, the correct order of the level VAR (k) and the maximum order of integration (d_{max}) of the variables in the system are determined. The selected VAR(k) is then augmented by the maximal order of integration (d_{max}) and a (k + d_{max})th-order level VAR is estimated. In the second step, the Wald tests for linear or nonlinear restrictions are carried out on the first k coefficient matrices to conduct Granger non-causality inference.[12] Toda and Yamamoto (1995, p. 234-235), show that the Wald statistic corresponding to the appropriate elements of the first k matrices has a χ^2 distribution in the limit, no matter whether the VAR process is stationary, I(1), I(2), has a linear trend, or whether it is cointegrated.

Because of these attractive features, this study uses the Toda & Yamamoto (1995) procedure to conduct the causality analysis. Following the above discussion, the following VAR model is estimated.

$$\ln GDP_t = \alpha + \sum_{i=1}^{k}\beta_i \ln GDP_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\beta_j' \ln GDP_{t-j} + \sum_{i=1}^{k}\gamma_i \ln FD_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\gamma_j' \ln FD_{t-j} + \sum_{i=1}^{k}\lambda_i \ln INVEST_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\lambda_j' \ln INVEST_{t-j} + \xi_{1t} \quad (6)$$

$$\ln INVEST_t = \mu + \sum_{i=1}^{k}\varphi_i \ln GDP_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\varphi_j' \ln GDP_{t-j} + \sum_{i=1}^{k}v_i \ln FD_{t-i} + \sum_{j=k+1}^{k+d_{\max}}v_j' \ln FD_{t-j} + \sum_{i=1}^{k}\psi_i \ln INVEST_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\psi_j' \ln INVEST_{t-j} + \xi_{2t} \quad (7)$$

$$\ln FD_t = \omega + \sum_{i=1}^{k}\tau_i GDP_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\tau_j' \ln GDP_{t-j} + \sum_{i=1}^{k}\sigma_i \ln FD_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\sigma_j' \ln FD_{t-j} + \sum_{i=1}^{k}\delta_i \ln INVEST_{t-i} + \sum_{j=k+1}^{k+d_{\max}}\delta_j' \ln INVEST_{t-j} + \xi_{3t} \quad (8)$$

where GDP, INVEST, and FD are as defined before; ξ_{1t}, ξ_{2t}, and ξ_{3t} are assumed to be white noise errors terms. Using the model causality test is conducted by testing for zero restrictions of the coefficients of the lagged variables (excluding the extra ones). For example, the null hypothesis of Granger non-causality running from FD to Y is stated as, H_0: $\gamma_i = 0$, $\forall_i$. Similarly, the null of non-causality from FD to INV is stated as: H_o: $v_i = 0$, $\forall_i$. In each case, the Wald statistic will be asymptotically χ^2, with degrees of freedom equal to the number of restrictions.

DESCRIPTION OF DATA

Following the literature, the output variable (GDP) is measured by real GDP and the investment variable (INVEST) by real fixed capital. While the measurement of the level of output and investment is straightforward, the same cannot be said about financial development because there are not concrete definitions of what financial development is. Therefore, finding an appropriate indicator of financial development has been a major challenge to researchers. A wide variety of measures (proxies) of financial development have been used (proposed) in the literature. Several studies have used a broader measure of financial development, mainly bank-based measures such as: the ratio of a monetary aggregates (typically M2) to GDP; the ratio of liquid liabilities to GDP; and the ratio of bank credit to the private sector to GDP (See, among others, Gregorio & Guidotti, 1995; Levine & Zarvos, 1998; Levine et al. 2000;

Beck et al. 2000, Arestis & Luintel, 2001). However, it is generally recognized that these measures are vaguely related to the role the financial system plays in economic growth as advocated by the theories, hence, they are considered as poor indicators of financial development. For example, it is argued that the ratio of M2 to GDP is likely to represent or measure the degree of monetization of the economy, or the ability of the financial system to provide liquidity rather than the level of financial development (Gregorio & Guidotti, 1995; Watchel, 2000). Moreover, it is hard to compare them across time due to institutional and structural changes in the financial system. Private credit to the private sector likewise poses difficulties because as Kaminsky et al. (1998) have shown, a high credit aggregate could be a leading indicator for financial instability and crash rather than an indicator of financial development. Furthermore, both indicators are bank-based measures and do not include financial activities that occur outside the financial intermediaries, such as, investment banks, mutual funds, insurance companies, security dealers and brokers, where a significant portion of the financial development takes place in industrialized countries like the United States. Recently, several studies have argued that GDP of the financial sector can adequately represents the role of the financial system as described by the theories (Neussar & Kugler, 1998; Watchel, 2000; Graff, 2002). Several strengths of this measure as an indicator (proxy) of financial development are noted. First, as argued by Graff (2002 p. 51), it represents the share of resources a society devotes to run its financial institutions at a given time, hence, "the effort to keep transaction costs (as well as frictions and market failures due to informational asymmetry that are mitigated by the financial system) low." Second, unlike the other measures, it represents real inputs which accords with macroeconomic concepts in the tradition of growth accounting. Third, it represents all the activities of a financial system; that is, all financial transactions "involving the creation, liquidation, or change in ownership of financial assets and/or facilitating financial transactions". Finally, it is "invariant to the structural changes within the financial sector" (Neusser & Kugler 1998, p. 639).[13] In view of the above discussion, this study uses the financial sector GDP as a proxy of financial development, which is a measurement of value added provided by the financial system. The data is obtained from the STAN Industry database, which is compiled by the OECD.[14] The data frequency is annual and covers the period 1970-2001. The choice of the period is, however, dictated by the availability of long-term time series data for all the three variables of interest.

EMPIRICAL RESULTS

According to the econometric methodology outlined above, causality analysis should be preceded by unit root tests aimed at establishing the time series characteristics (order of integration) of each of the variables. The two most commonly used techniques of unit root tests are the Augmented Dickey-Fuller (ADF) test developed by Said & Dickey (1984), and the Phillips-Perron (PP) test developed by Phillips & Perron (1988). However, Perron (1989) shows that structural breaks in the time series can bias test of unit root estimates. Hence, a number of techniques have been developed to circumvent this problem. In this study, a unit root test procedure developed by Zivot and Andrews (1992) that allows breaks in the deterministic terms is employed to test for trend break stationarity of the data series. The procedure provides three different models for testing three possible types of structural breaks in the trend functions of a data series: Structural break in the intercept, the slope, and both the intercept and the slope. The advantage of the Zivot and Andrews procedure is that the choice of the breakpoints is determined endogenously rather than on a priori observation of the data which might introduce pre-testing problems[15]. The unit root test results based on the Zivot and Andrews test procedure are reported in Table 1. The results show that the variables are level non-stationary, denoted as, I(1) and difference stationary, denoted as, I(0).

Table 1
Zivot-Andrews Test for a Unit Root in the Presence of a Structural Break

	Model A		Model B		Model C	
	Level	First difference	Level	First difference	Level	First Difference
GDP	-4.58[1]	-4.48[0]	-4.38[1]	-4.52[0]	-4.49[1]	-4.49[0]
INV	-3.94[0]	-5.36[0]	-3.05[0]	-5.13[0]	-4.24[0]	-5.38[0]
FD	-4.03[1]	-5.02[2]	-3.89[1]	-5.13[2]	-4.00[1]	-5.39[2]

Notes: The estimation results for Models A, B, and C are based on the following equations:

Model A: $$y_t = \mu + \phi DU_t(\lambda) + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k-1} \Delta\gamma_{t-i} + \varepsilon_t \qquad \text{(a)}$$

Model B: $$y_t = \mu + \theta DT_t(\lambda) + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k-1} \Delta\gamma_{t-i} + \varepsilon_t \qquad \text{(b)}$$

Model C:
$$y_t = \mu + \phi DU_t(\lambda) + \beta t + \theta DT_t + \alpha y_{t-1} + \sum_{i=1}^{k-1} \Delta\gamma_{t-i} + \varepsilon_t \qquad \text{(c)}$$

Where y is a time series of interest; $DU_t(\lambda) = 1$ for $t > T\lambda$ and zero otherwise; and $\lambda = T_B/T$ represents the location where the structural break lies; where T is the sample size and T_B is the date when the structural break occurred. Model A allows for only changes in the intercept; Model B allows for only changes in the slope; and Model C allows for changes in both intercept and slope. The procedure tests for the presence of a unit root by choosing the break point that gives the least favorable result for the null of H_o: $\alpha = 0$ in each of the models using the test statistics $t_\alpha(\lambda)$

The null hypothesis is that the data series of interest is integrated without an exogenous structural break, against the alternative that the series can be represented by a trend stationary process with a once only breakpoint occurring at some endogenously determined time. The 1% critical values for Models A, B, and C are, respectively, -5. 34, -4.93, and -5.57, the corresponding 5% critical values are -4.80, 4.42 and -5.08. Figures in brackets are the lag-length. The general to specific recursive procedure is used to select the appropriate lag length to ensure the residual in the Zivot and Andrews (1992) unit root test regressions are white noise. Following the procedure, first the unit root test regression is estimated with a sufficiently long period of lag length (k^{max}) and sequentially drop the last included lag if it is not statistically significant at the 10% significance level. k^{max} is set at four.

The next step is to conduct the causality analysis by estimating the VAR model described above. This is implemented in two stages. First, the appropriate lag length for the VAR model is selected. To achieve this, the Akaike (AIC) and Schwarz (SIC) model selection criteria for selecting the lag length are used. The results are reported in Table 2A. It can be observed that while the AIC criterion selects a lag length of four, the BIC criterion selects a lag length of two. Since the BIC criterion is more parsimonious than the AIC, a VAR model of order two, VAR(2), is selected. In addition, misspecification tests are carried out for serial correlation, normality, and ARCH structure in the residuals of the selected VAR model. The results are reported in Table 2B. Overall, it appears that VAR(2) model fits the data reasonably well. The selected VAR(2) is then augmented by the maximum order of integration in the

TABLE 2
MODEL SELECTION CRITERIA

Table 2A
Selection of the Order of the VAR, Z = (GDP, INV, FD)

Lag order	k = 1	k = 2	k = 3	k = 4
AIC	-20.95	-21.56	-21.91	-22.11
BIC	-20.2	-20.44	-20.35	-20.12
LR		23.59 (0.00)	15.09 (0.09)	10.19 (0.33)

Notes: AIC and BIC are as defined above. LR stands for Likelihood Ratio. LR is a χ^2 test for the exclusion of the last lag and figures in parenthesis are the *p*-values.

Table 2B
***P* - Values for Misspecification for the VAR(2)**

	GDP	INV	FD
JB	0.08	0.68	0.75
LM(4)	0.03	0.06	0.01
ARCH(4)	0.93	0.43	0.89

Notes: JB is Jarque-Bera test for normality of the residual, LM(4) denotes Lagrange multiplier test for serial autocorrelation up to 4^{th} order in the residual; and ARCH(4) is Lagrange multiplier test for residual ARCH.

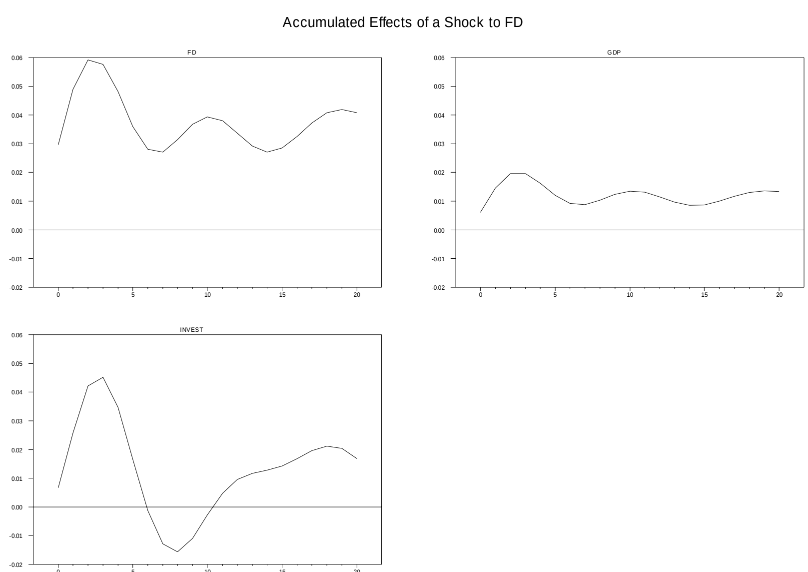
series, which, as shown above, is equal to one. Hence a VAR of lag order of three (VAR(3)) is estimated. Next, tests for non-causality restrictions on the parameters of interest are conducted using the standard Wald tests. The results are summarized in Table 3. It can be observed from the table that, during the period under consideration, the null that FD does not Granger cause GDP when INVEST is controlled for in the model is rejected at the conventional 5% level. Similarly, the null that FD does not Granger cause INVEST is rejected at the 5% level. Furthermore, the test results show that the null that GDP does not Granger causes FD can not rejected even at 10% level; the same holds true for the null that INVEST does not Granger Cause FD.

A limitation of the causality analysis is that, other than showing the direction of causal relationships between variables, it does not provide information on the nature of the reported causal effects. For example, it not possible to determine whether the causal effect of FD on GDP/INVEST is positive or negative because multivariate VAR coefficients are difficult to interpret. Hence, accumulated impulse response analysis is conducted to provide information on the nature of the long-term effect of FD on GDP and INVEST. In general, impulse response functions associated with the estimated VAR model measure the effect of a one-standard-deviation innovation in a variable on current and future value of all variables. Because innovations within a VAR are generally not contemporaneously independent of each other, the Cholesky decomposition method is used to orthogonalize the residuals of the VAR, and FD is ordered prior to GDP and INVEST. This ordering was chosen because the Wald tests conducted indicate that the direction of Granger causality runs from FD to GDP and INVEST without reverse effects[16]. Figure 1 traces the separate effects of one standard deviation innovation in FD on GDP, and INVEST over a 20-year period. It can be observed that the effect of FD on GDP is consistently positive. The same can be said about the effect of FD on INVEST except for a few years were the effect is negative but the long - run cumulative effect is positive.

TABLE 3
RESULTS OF CAUSALITY TESTS

Null Hypothesis	**Test Statistic**	***P*-value**
A. Financial Development does not Granger cause Productivity of investment	$\chi^2(1) = 5.35$	0.03
B. Financial Development does not Granger cause Investment	$\chi^2(1) = 4.23$	0.05
C. GDP does not Granger cause Financial Development	$\chi^2(1) = 1.64$	0.21
D. Investment does not Granger cause Financial Development	$\chi^2(1) = 1.05$	0.32

FIGURE 1
ACCUMULATED RESPONSE FUNCTIONS



Overall, the findings are consistent with the results of cross-country/panel empirical studies, in particular, Levine and Zarvos (1998) and Benhabib and Spiegel (2000) that have provided evidence that financial development has significant and positive effect on long-term growth through its investment and productivity effects.

CONCLUSION

This paper uses the new Granger non-causality test developed by Toda and Yamamoto (1995) to examine how financial development affects long-term growth in the U.S. The findings suggest that financial development plays a significant role in economic growth by increasing both the level and the productivity of investment. On the other hand, the results provide no evidence of reverse causality running from real GDP to financial development or from increased real investment to financial development suggesting that financial development independently generate positive economic growth.

ENDNOTES

* The author would like to thank two anonymous referees for their valuable comments and suggestions.

1. A financial structure is considered as bank-based if most of the savings are channeled to borrowers through financial intermediaries. By contrast, a financial structure is considered market-based if borrowers obtain funds mostly directly from lenders by issuing financial instruments in the financial markets. See Allen and Gale (1999).

2. The financial system of Great Britain also is considered as market-based. However, due to lack of sufficiently long-term data on the proxy variable for financial development used in this study, similar analysis could not be undertaken for Great Britain.

3. See also, Quah (1993) and Pesaran & Smith (1995).

4. An exception to this generalization is Nausser & Kuglar (1998), which, based on time-series data, studies the effect of financial development on economic growth in several OECD countries including the U.S. However, it is limited to the impact of financial development on the growth of the manufacturing sector and does not address the question whether financial development promotes growth by increasing the level of investment.

5. See, for example, Nausser & Kuglar (1998) and Graff (2002) who used financial sector GDP as a measure of financial development in examining the finance-growth relationship.

6. For simplicity, it is assumed that population remains constant and the economy is closed.

7. While the main channel of transmission emphasized by the McKinnon and Shaw model is the effect of FD on the level of savings, it also recognizes that positive interest rates make the allocation of investible funds more efficient, thus providing additional effect on economic growth.

8. The most notable early works in this regard are Schumpeter (1911) and Goldsmith (1969). Both authors emphasize the role of financial development in increasing productivity and promoting technological development.

9. These studies provide mixed evidence on the relationship between financial development and
economic growth in the U.S., ranging from a bidirectional to a weak or complete lack of significant statistical relationship.

10. Despite its multivariate nature, the model differs from cross-country or panel models used by De Gregorio & Guidotti (1995), Benhabib & Spiegel (2000) and Beck et al. (2000) that allow for an array of conditioning variables that may affect long-run growth in real GDP or investment. However, the dynamic nature of the model serves to compensate for the exclusion of other factors. It is to be noted that a time series dynamic model, such as the vector autoregressive (VAR) model employed in this study, expresses each variable as a linear function of its own past values, the past values of all other variables being considered, and a serially uncorrelated error term. The inclusion of past values (lags) of each of the dependent variables accounts (proxies) for possible omitted variables that affect both the past and the current levels of the dependent variable (see, Rousseau & Watchel 1998, pp. 662, for similar explanation).

11. A time series y_t is defined to be stationary if for all t it is true that: $E(y_t) = \mu$; $Var(y_t) = \sigma^2$; $Cov(y_t, y_{t-k}) = \gamma_k$, k = 1, 2, 3,… These conditions require the process to

have a constant mean and variance and autocovariances that depend only upon the distance in time between the two observations. It is known that shocks (such as policy interventions) to a stationary time series have can only have a temporary effect; over time, the effects of the shocks will dissipate and the series will regress to its long-run mean level (see, Enders 2004, for more discussion)

12. For example, if the true data generating process is VAR(k), with I(1) variables, a VAR(k+1) model is estimated and test for Granger non-causality is conducted based on the first k coefficients.

13. It is to be noted that this is not a direct measure of the quality and quantity of the financial services provided. But as argued by Neusser & Kugler (1998), it may be considered a "better measurement" compared to the other measures.

14. The database is compiled based on member countries' Annual National Accounts tables and other sources such as national business survey/census. But, since most of the data points are estimated, they do not represent official member countries submissions. See, OECD (2002) for a detailed description of the database. The database is available online at www.sourceoced.org.

15. Additional description of the procedure and models is provided in the notes to Table 1.

16. It is known that, orthogonalizatin using the Cholesly method, makes the impulse response results sensitive to the ordering of the VAR. Changing the ordering of GDP and INVEST in the VAR resulted has little qualitative changes in the results.

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