Financial Development and the Volatility of Growth: Time Series Evidence for Mexico and United States

Rodolfo Cermeño
María José Roa García
Claudio González-Vega

Abstract

This paper reports time series evidence on the influence of financial deepening on growth and its volatility, for the cases of Mexico and the USA*. The paper contributes to the existing empirical literature in two relevant aspects. First, it focuses on two closely interconnected economies but quite different in terms of economic and financial development. Second, it uses time series methods to examine the relation between financial development and the volatility of growth. We find that, in the case of the* USA*, financial and money deepening seem to affect real output growth, but finance does not show a significant relation with growth*

R. Cermeño, Economics Division, Centro de Investigación y Docencia Económicas, CIDE, México <rodolfo.cermeno@cide.edu> and Department of Economics, Pontificia Universidad Católica del Perú, PUCP <rcermeno@pucp.pe>. M. J. Roa García, corresponding author, senior researcher, Centro de Estudios Monetarios Latinoamericanos, CEMLA, México <roa@cemla.org>. C. González Vega, Professor Emeritus, Department of Agricultural, Environmental and Development Economics, The Ohio State University, Columbus, Ohio, and Chairman of Board of Trustees, BBVA Microfinance Foundation. <gonzalez.4@osu.edu>.

volatility. In the case of Mexico, economic growth seems to precede financial deepening, while money deepening and output growth interact. We also find some evidence that financial deepening reduces the volatility of growth. This, in turn, leads to more rapid output growth. Further, faster growth in the USA *may result in faster growth in Mexico not only directly, a fact that is well known, but also through a reduction of Mexico's growth volatility.*

Keywords: financial development, monetary and credit deepening, growth, volatility, VAR *models, Granger-causality,* GARCH *models.*

JEL *classification: C22, C32, F43, O40.*

1. INTRODUCTION

For at least a couple of centuries, the influence of financial development on economic growth has attracted vigorous debate among economists. Despite numerous approaches –within the current consensus– on what circumstances may actually produce these effects, there is growing empirical evidence that financial variables have significantly influenced the rate of economic growth.

On the one hand, the theoretical literature has identified alternative mechanisms through which the performance of the financial system influences the fundamental determinants of economic growth. In particular, the accumulation of physical and human capital and technological innovation are spurred by the roles of the financial sector both in mobilizing and pooling savings, mostly from households (surplus units), and in reallocating this purchasing power to investment projects with high marginal rates of return (deficit units) as well as in improving the stock of information about investment opportunities and firm performance, the monitoring of managers and exercise of corporate control, and the pooling, exchanging, diversifying and mitigating of idiosyncratic and systemic risk. The financial development also helps in completing the institutional scaffolding of markets and in creating social capital.

On the other hand, the empirical literature suggests that a better performance of the financial system leads to higher output growth rates, although the specific channels for these effects are not fully specified (Beck, Levine and Loayza, 2000). Further, both the theoretical and the empirical contributions recognize and discuss issues about reverse causality; indeed, economic growth also influences financial development.

In turn, there is a literature –albeit not as developed– that examines the influence of financial deepening on the volatility of the growth process. Here as well, theoretical contributions have identified mechanisms through which finance may influence volatility. In particular, by diversifying production risks, smoothing responses to liquidity shocks, contributing to the mobilization of savings –as precautionary reserves– and improving the stock of information, the efficient performance of the financial sector may diminish the volatility of output growth. Empirical contributions seem to support the theoretical predictions in this case as well.

The objective of this paper is to assess the influence of financial deepening on the rate and volatility of output growth in the cases of Mexico and the USA, using time series methods. The paper attempts to contribute to the existing empirical literature in two important aspects. First, it focuses on two closely interconnected but quite different economies in terms of economic and financial development.[1] Second, the paper investigates not only the relation between finance and the rate of growth but also the links between finance and the volatility of growth. While the former relation has been investigated, generally using Granger-causality tests, the later

---

[1] While the financial sector in the USA has been characterized by a high degree of development and penetration as well as a high level of competition along history, despite bank concentration at the state level in some periods, in the case of Mexico the formal financial system, even after public policies to the effect, has not been able to reach most of the population and the informal financial sector has thrived (Haber et al., 2008). High banking concentration and financial exclussion of large segments of the population still presist, as in most developing countries (CNVB, 2011; Demirgüç-Kunt and Klapper, 2012).

issue has not yet been investigated with time series methodologies, at the country level.

The methodological approach includes the following tasks. In the first place, unit root tests are carried out to determine if the variables do exhibit stochastic trends. Next, cointegration and Granger-causality tests between finance and real economic activity are implemented in the context of VAR models with integrated variables. Finally, the relation between measures of financial development and the volatility of growth is investigated using GARCH models. In all cases, diagnostic checks, particularly autocorrelation tests, are implemented to make sure that the estimated models are well specified.

We find that, in the case of the USA, financial deepening is positively related to the rate of economic growth but that it is not significantly related to the volatility of the growth process. In contrast, in the case of Mexico, economic growth appears to precede financial deepening, although we also find some evidence of a connection in the opposite direction. In any case, financial deepening seems to have a positive impact on growth by reducing volatility, since we find growth and growth volatility to be negatively related. Further, higher growth rates in the USA may result not only in higher growth rates in the Mexican economy—a fact that is well known—but also in a less volatile growth process which, in turn, favors rapid growth in Mexico. Thus, this paper explicitly identifies a *volatility channel* for output growth in Mexico, which has important implications for understanding the links between these two economies. To the best of our knowledge, this finding, on the effect of US growth on growth volatility in Mexico, is novel.

The remainder of the paper proceeds as follows. Section 2 reviews some related theoretical and empirical literature. Section 3 describes the time series methodology used in the study. Section 4 presents and discusses the empirical results. The main conclusions are summarized in Section 5.

2. THEORETICAL AND EMPIRICAL BACKGROUND

2.1 Financial Development and Economic Growth

Interest in the relation between financial institutions and economic growth is not new. Earlier, when exploring the role of institutions, Hamilton (1791) and Bagehot (1873) and then Schumpeter (1934) and Hicks (1969) had looked into this relation. Attention to the connection between finance and growth increased in the second half of the last century (Gurley and Shaw, 1955 and 1960; Cameron et al., 1967; Goldsmith, 1969; McKinnon, 1973 and 1976; Shaw, 1973).[2] These authors supported the view that financial development has a positive impact on economic growth. Others, however, have questioned the role of finance in economic growth and have claimed that financial deepening is a consequence, not a cause, of economic growth (Robinson, 1952; Lucas, 1988). Towards the end of the century, however, interest in identifying a positive influence of financial development on economic growth resurfaced. After offering a complete review of the theoretical literature, Levine (2004) concludes that, despite the diversity of approaches, there is wide support for the view that financial variables have a significant impact on economic growth.

There is as well an ambitious collection of empirical contributions in the literature. Levine (2004) offers, again, a complete review. These contributions use different techniques and methods: growth regressions for a cross-section of countries (Goldsmith, 1969; King and Levine, 1993; Levine and Zervos,

---

[2] As Levine (1997) highlights, the pioneers analyzed the role of finance in economic growth with models that formalized the financial sector solely in terms of money and introduced a distinction between the financial and real sectors of the economy. Nevertheless, as these more recent contributions have highlighted, the financial sector is *real.* Based on their approach, Fry (1988) examines several models of growth with money, including Kapur (1976), Galbis (1977), and Mathieson (1980) as well as the contributions of Spellman and of González-Vega, included in McKinnon (1976).

1998; La Porta et al., 1999; Levine, Loayza and Beck, 2000), time series analysis (Jung, 1986; Demetriades and Hussein, 1996; Arestis et al., 2001; Shan et al., 2001; Ang and McKibbin, 2007) and panel techniques (Levine, Loayza and Beck, 2000; Beck, Levine and Loayza, 2000; Loayza and Ranciere, 2002; Calderon and Liu, 2003; Christopoulus and Tsionas, 2004; Hassan et al., 2009). Some studies explore these issues at the industry or firm level (Rajan and Zingales, 1998; Ahlin and Jiang, 2005; Aghion, Fally, and Scarpeta, 2006).[3] More recently, Greenwood et al. (2010) show that most countries could have increased their output growth had they had a more efficient financial sector. In general, while most studies using cross-country and panel data techniques find that economies with a better performing financial sector achieve higher rates of growth, the empirical time series literature is more controversial, since it focuses on very specific cases.

A potential challenge for the empirical analysis is reverse causality; the level of economic activity and technological change may influence, in turn, financial development. On the one hand, innovations in telecommunications and data management have reduced transaction costs and have encouraged the development of new financial products (Merton, 1992; Gup, 2003). On the other hand, economic development encourages savers and investors to channel resources to the financial system (Greenwood and Jovanovic, 1990). Fung (2009) empirically explores the potential convergence of financial development and economic growth. Middle-income and high-income countries tend to converge, not only with respect to their per capita GDP but also with respect to financial deepening. Countries with low incomes but with a healthy financial development catch up with middle-income countries, while those countries that lack a well-performing financial system are caught in a poverty trap.

---

[3] Some contributions combine the influence of finance with other determinants of growth, such as legal regime, property rights and political pluralism (Hassan et al., 2009); remittances (Giuliano and Ruiz-Arranz, 2009); or even international integration (Masten et al., 2008).

2.2 Financial Development and Growth Volatility

The literature on financial development and growth volatility is based on any one of the functions performed by financial intermediaries (Levine, 1997 and 2004). Basically, three strands of research can be identified. The first, based on portfolio theory, argues that financial development implies the creation of different instruments for risk diversification, which would encourage growth and reduce uncertainty (Greenwood and Jovanovic, 1990; Levine, 1991; Saint-Paul, 1992; King and Levine, 1993; Devereux and Smith, 1994; Obstfeld, 1994; Acemoğlu and Ziliboti, 1997). A more efficient financial sector would be able to fund a larger number of high-productivity projects, despite their riskiness, and in this way it would reduce growth volatility. Aggregate risk declines through portfolio diversification, while the lower risk encourages investors and the higher productivity of the projects enhances economic growth.[4] In contrast, with limited portfolio diversification, there is greater uncertainty related to high-productivity projects and economic growth is slower.[5]

---

[4] Nevertheless, some authors claim that financial development may reduce the rate of output growth (Pagano, 1993; Devereux and Smith, 1994). The reason is that, in reducing risk, portfolio diversification would allow agents to reduce their precautionary savings, which may decelerate economic growth (Mirman, 1971). If the effect of the reduction in the rate of savings on growth is stronger than the effect of the investment in more productive projects, due to diversification, the rate of growth may diminish. Which effect dominates will depend on the elasticity of intertemporal substitution.

[5] While the papers based on a portfolio approach predict that less developed countries tend to invest in more secure but less productive sectors, Koren and Tenreyro (2004) argue that poor countries concentrate their production in a few sectors but with high specific risk (agriculture), thus rejecting the trade-off between volatility and productivity. These authors show, empirically, that as countries develop, they tend to move to less volatile productive activities.

Some papers analyze this question in more detail. Acemoğlu and Ziliboti (1997) examine the variance of productivity, which may depend negatively or positively on the number of projects implemented in the economy, concluding that the variance only diminishes with financial development if the productivity of risky projects is high enough and the degree of indivisibility of the projects is also high. Along the same lines, Greenwood and Jovanovic (1990) find that the variance of growth rates depends positively on the rate of return of projects, the intertemporal discount factor, and the amount of funds available for investment. Again, these authors obtain the result that the higher the amount of funds available for investment, more projects are implemented and risk diminishes since the portfolio would be better diversified. Aghion, Banerjee, and Piketty (1999) develop a theoretical model and show that, by mobilizing savings and facilitating the creation of reserves, the financial sector allows the economy to better absorb shocks, particularly negative shocks. González-Vega and Villafani-Ibarnegaray (2007) show, however, that the procyclical behavior of credit portfolios depends on the credit technology used as well as the characteristics of producers.

There are a number of empirical investigations based on the portfolio approach. Easterly, Islam and Stiglitz (2000) discuss the importance of financial development on growth volatility. While price and wage rigidities have been advocated to explain output fluctuations, these authors defend the hypothesis that the degree of development of the financial sector determines the stability of the economy. However, greater access to financial markets also allows firms to increase their financial leverage, which may imply higher risks and greater volatility. In their empirical analysis, they conclude that the relation between volatility and financial development is not linear. Thus, although greater financial development may well reduce volatility initially, at more advanced levels rising financial activity may amplify the effect of shocks on the economy. Related to this result, using a dynamic panel data model, Kunieda (2008) shows that the effect of financial development on volatility is concave; in the early development stages there is less output volatility, with additional development, volatility is greater, while with a mature financial sector volatility declines again.

The second strand of research focuses on the effects of information asymmetries and incomplete markets on output volatility. Some examples are Bernanke and Getler (1989), Greenwald and Stiglitz (1993), Kiyotaki and Moore (1997), Carlstrom and Fuerst (1997), Edwards and Végh (1997), Bernanke, Gertler and Gilchrist (1999), Jaffee and Stiglitz (2000), De Meza and Webb (2006).These market failures may lead to credit rationing and inefficiencies that may reduce growth and increase volatility. Also, a reduction in the borrowers' financial capacity (the maximum overhang of past debt they may feasibly carry) could reinforce and propagate the effects of real and monetary shocks.[6] In this respect, Beck et al. (2006) find some evidence that financial intermediaries could magnify monetary shocks, particularly in countries where firms have very limited access to capital markets. In turn, Denizer et al. (2000) find that, while more developed financial sectors lead to fewer fluctuations in real output, the importance of banks in the system is most robust in explaining the reduction of the volatility of consumption and investment. Similarly, Dynan et al. (2005), Cecchetti et al. (2006) and Jalil (2009) find evidence that financial development reduces the volatility of economic growth.

The third strand of theoretical work starts with Aghion et al. (2004), who argue that due to various market imperfections and restrictions, financial markets become less effective to facilitate the absorption of aggregate shocks, which leads to higher growth volatility. Their empirical results for a panel of countries during the 1960-2000 period show that less financial development is associated with higher exposure to shocks and

---

[6] Some of these papers argue that the financial system was determinant in magnifying the Great Depression of 1929. In particular, the lack of confidence in financial institutions and the insolvency of debtors were determinants of the persistence and severity of the Great Depression.

greater negative effects of volatility on growth. Aghion and Banerjee (2005) consider the same model and conclude that in closed economies fluctuations are triggered by the interaction between credit restrictions and interest rates, while in open economies the source of instability is the interaction between the real exchange rate and interest rates. Farías (2007) shows that, in the case of developed countries, the volatility of investment is greater with incomplete financial markets.

Aghion et al. (2006) find that exchange rate volatility may have a significant effect on long-run productivity in the case of countries with lower levels of financial development. Also, Aghion and Marinescu (2006) argue that countercyclical fiscal policies have positive effects on productivity growth, particularly in countries with low degrees of financial development. Federici and Caprioli (2009) find that a high degree of financial development is critical for the existence of transmission effects among countries following credit crises.

Using a standard real business cycle model for an open economy, Özbilgin (2010) shows that financial development and market integration are associated with a greater volatility of investment and output. Mallick (2009) finds that the long-run variance of real GDP is affected by the degree of financial development. In turn, Aysan (2006) finds that greater volatility increases the costs associated with financial market imperfections and induces higher interest rates and higher costs of loans. This, in turn, leads enterprises not to choose the most productive technologies (because they become more expensive), which leads to lower rates of economic growth.[7]

There is also some literature about the effects of volatility itself on the rate of economic growth. While the empirical

---

[7] Some papers highlight the importance of factors such as the structure of the financial sector, type of development, institutional mechanisms and competitiveness, or even macroeconomic instability, which may influence growth and volatility. See, for example, Denizer et al. (2000), Cetorelli and Gambera (2001), Freeman (2002), Clarke (2004), Claessens and Laeven (2005), Beck et al. (2006), Dehejia et al. (2007), Garret et al. (2007) and Mitchener et al. (2010).

contributions (Aizenman and Marion, 1993; Ramey and Ramey, 1995; Blattman et al., 2004; Koren and Tenreyro, 2004; Aghion et al., 2004) find a negative correlation between volatility and growth, theoretical treatments claim that the connection may be either positive or negative. Jones et al. (2000) conclude that the sign of the relation between volatility and growth depends on two effects. On the one hand, greater volatility reduces the risk-adjusted returns on investment, thereby discouraging investment and growth. On the other hand, greater volatility increases precautionary savings, which might affect economic growth positively. The net effect depends on the value of the elasticity of intertemporal substitution. In contrast, Black (1987) shows that investment in more specialized and risky technologies may lead to higher but more volatile growth rates, thus implying a positive link between growth and volatility.

3. EMPIRICAL TIME SERIES APPROACH

3.1 Characterization of the variables

First, we characterize the dynamics of real output and the measures of financial development, both in levels and growth rates, by applying various unit root tests. This inspection is critical, in order to avoid potentially misleading inferences. We implement four unit root tests, namely, the augmented Dickey-Fuller (Dickey and Fuller, 1979, 1981), Dickey-Fuller GLS (Elliot, Rothenberg and Stock, 1996), PP (Phillips and Perron, 1988), MZt (Ng and Perron, 2001) and the KPSS (Kwiatkowsky, Phillips, Schmidt and Shin, 1992) tests. As is well known, the null hypothesis for the first four tests is that the process has a unit root, while the last test considers stationarity as the null hypothesis.

3.2 Granger-causality Testing

In order to examine the Granger-causality between real economic activity and finance, we specify the following bivariate VAR model:

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \Sigma_{j=1}^{p} \boldsymbol{A}_j \begin{bmatrix} y_{t-j} \\ x_{t-j} \end{bmatrix} + \begin{bmatrix} u_{y,t} \\ u_{x,t} \end{bmatrix}, \tag{1}$$

where y and x are, respectively, the logarithms of real GDP and a measure of financial development.[8] The matrices $\boldsymbol{A}_j$ are 2×2 coefficient matrices where the coefficients $A_{12,j}$ capture the effect of financial development on real output, while the coefficients $A_{21,j}$ indicate the opposite effect, from real output to financial development. The terms $u_{y,t}$ and $u_{x,t}$ are random shocks that satisfy the conventional assumptions of zero mean, constant variance and constant contemporaneous covariance.[9] The subindex $j = 1,2...,p$ indicates the number of lags. Given that these variables are likely to show stochastic trends, we follow the approach proposed by Lütkepohl and Reimers (1992), for the case of bivariate VAR models with $I(1)$ variables. Thus, specification 1 can be rewritten in VEC form as:

$$\begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} = \Sigma_{j=1}^{p-1} \boldsymbol{\Gamma}_j \begin{bmatrix} \Delta y_{t-j} \\ \Delta x_{t-j} \end{bmatrix} + \boldsymbol{\Pi} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{y,t} \\ u_{x,t} \end{bmatrix}, \tag{2}$$

where the matrices $\boldsymbol{\Gamma}_j$ and $\boldsymbol{\Pi}$ are linear combinations of the A_j matrices defined in 1. Let r be the rank of $\boldsymbol{\Pi}$. For these purposes, Lütkepohl and Reimers (1992) establish that if $r = 1$ o 2, Granger non-causality from x to y, with the null hypothesis $A_{12,1} = A_{12,2} = ... = A_{12,p-1}$ in system 1, can be tested by means of a Wald test, which has an asymptotic Chi-squared distribution.[10]

---

[8] We use the ratios of domestic credit, credit supplied by the banking sector, and money supply (M2 and M3), all in nominal terms, to nominal GDP, as indicators of financial development.

[9] It is tempting to consider other variables in the vector. However, in the absence of a well-structured model, we focus on just these two variables. In this way, the focus is on the bivariate marginal or unconditional distribution of real economic activity and indicators of financial development.

[10] If $r = 2$, the system becomes a $VAR(p)$ in levels, as in Equation 1; while if $r = 1$, the system must be modelled as a $VEC(p-1)$

For the case when *r = 0* (no cointegration), non-causality can be tested using results from the VAR *(p−1)* model in first differences given by Equation 2, with $\mathbf{\Pi} = 0$. In this case, the Wald-test for the null hypothesis $\Gamma_{12,1} = \Gamma_{12,2} = \ldots = \Gamma_{12,p-1} = 0$ follows a $\chi^2_{(p-1)}$ distribution. The reverse causality can be evaluated in a similar way.

The rank *r* is determined using Jonhansen's (1988, 1991) trace and maximum eigenvalue tests. Following proposition 8.1 in Lütkepohl (2005), the number of lags *p* is determined using the Schwarz (SC) and Hannan-Quin (HQ) criteria, which are consistent in the previous setting.

3.3 A Time Series Model of Growth and Volatility

In order to evaluate the dynamics of growth and its volatility, we specify the following time series model with GARCH-in-mean effects:

$$\Delta y_t = \beta_0 + \beta_1 \Delta y_{t-1} + \phi \sigma^2_{y,t} + u_{y,t} + \theta_1 u_{y,t-1} \tag{3}$$

$$\sigma^2_{y,t} = \alpha + \gamma \sigma^2_{y,t-1} + \delta u^2_{y,t-1} + \xi D_t + \psi \Delta y_{t-1} + \varphi \Delta x_{t-1} \tag{4}$$

Equation 3 models output growth as an *ARMA (1,1)* process, augmented by a GARCH-in-mean effect (ϕ), which attempts to capture the effect of growth volatility on the rate of output growth. This specification is justified both on theoretical and empirical grounds. Theoretically, Campbell (1994) shows that, under certain assumptions, a stochastic growth model implies an *ARMA (2,1)* process for output (in logarithms). Thus, the first difference of the previous process, which is the growth rate of output, can be modeled as an *ARMA (1,1)* process.[11] In turn, from time series theory, it is well known that an invertible *MA* process is equivalent to an *AR* process of infinite order and,

---

model, as in Equation 2.

[11] Assuming, for example, that the persistence parameter of the technology shock process equals one.

therefore, empirically, an *ARMA (1,1)* process can approximate a relatively large *AR* process in a very efficient way.[12] In practice, it is important to show that the estimated residuals from Equation 3 do not display any significant autocorrelation pattern, thus avoiding spurious ARCH effects due to misspecification.

Equation 4 specifies the conditional variance of $u_{y,t}$ as a GARCH (1, 1) process and characterizes the dynamics of growth volatility.[13] The parameter φ captures the effect of financial development on the volatility of real GDP growth and ψ measures the feedback effect from growth to its own volatility. The variables Δy_{t-1} and Δx_{t-1} refer to the first lag of real GDP growth and the growth rate of a measure of financial development, respectively. Also, D_t is an indicator variable that takes the value of 1 if $u_{y,t-1} < 0$ and zero otherwise; thus, ξ is an asymmetry parameter. The error term is allowed to follow the generalized error distribution.[14]

The time series model given by Equations 3 and 4 is chosen for two main reasons. First, as it will be shown in the next section, the evidence on cointegration between real economic growth and measures of financial development is not strong, particularly in the case of Mexico; therefore, econometrically, it is reasonable and safer to formulate a model in terms of growth rates instead of levels. Second, most measures of financial development, despite their variability, do not exhibit time-varying volatility, making it impossible to use the well-known class of bivariate GARCH models.[15]

---

[12] Schwert (1987) shows that there are compelling reasons to model economic time series as ARIMA processes and that, in practice, these processes fit the data well.

[13] It is worth mentioning that this class of models was initiated with the pioneering work by Engle (1982) and Bollerslev (1986).

[14] This distribution, which is more general than the normal distribution, was proposed by Nelson (1991). It is normalized to have zero mean and unit variance and can accommodate virtually any degree of kurtosis present in the data. Particular cases of this distribution are the normal distribution and the so-called double exponential distribution.

[15] Preliminarily, the dynamics of real GDP growth as well as the

In the case of Mexico, both the growth and volatility equations include the contemporaneous growth rate of USA. Namely, they are specified as:

$$\Delta y_t = \beta_0 + \beta_1 \Delta y_{t-1} + \omega \Delta y_t^{US} + \phi \sigma^2_{y,t} + \theta_1 u_{y,t-1} \tag{3a}$$

$$\sigma^2_{y,t} = \alpha + \gamma \sigma^2_{y,t-1} + \delta u^2_{y,t-1} + \xi D_t + \psi \Delta y_{t-1} + \varphi \Delta x_{t-1} + \zeta \Delta y_t^{US} . \tag{4a}$$

Thus, the growth of the US economy (Δy^{US}) is allowed to influence both the mean and the volatility of Mexico's growth process. It is well known that the effect of US growth on Mexican growth is positive $(\omega > 0)$. For the effect of US growth on Mexico's growth volatility, a plausible hypothesis is that $\zeta < 0$, which may also be justified by the fact that Mexico's growth rate depends highly and positively on economic growth in its northern neighbor.

A reduction of growth in the USA is, undeniably, bad news for Mexico's future economic performance. This, in turn, increases uncertainty in the decision-making of Mexican economic agents, particularly but not exclusively about consumption and investment, thus inducing greater uncertainty about Mexican growth. Two possible mechanisms for this influence are exports to and remittances from USA, which are directly linked to economic performance in USA.[16]

---

measures of financial development are characterized as *AR* processes and the possibility of volatility patterns over time is evaluated by means of LM tests. ARCH effects were found only for the growth of real GDP processes but not for the financial development measures. One exception was the growth of the ratio domestic credit to GDP (GDCRGDP) in the case of the USA.

[16] It should be noticed that inclusion of the extra regressors Δy_{t-1} and Δx_{t-1} in Equation 4, and Δy_{t-1}, Δx_{t-1} and Δy_t^{US} in Equation 4a might result in negative values of the conditional variance. However, in the present case this problem does not arise.

4. EMPIRICAL RESULTS

4.1 Data Sources and Variables

We use quarterly data from the International Monetary Fund's *International Financial Statistics.* The data are available for 1957Q03-2016Q02 period for USA and for 1986Q02-2016Q01 period for Mexico. The primary variables are nominal domestic credit (NDCR), nominal credit supplied by the banking sector (CPBS), nominal money supply (M2 and M3), nominal gross domestic product (NGDP) and the GDP implicit deflator (GDPID).[17] With these variables, we construct four financial indicators and one measure of real activity, as shown in Table 1.

In the related empirical literature, the indicators DCRGDP and BSCGDP are considered measures of credit deepening, while M2GDP and M3GDP are referred to as money deepening. All of them are accepted measures of financial development. The growth rates of all variables are annualized percentages.

4.2 Unit Root Testing Results

Table A.1, in the Appendix, shows the unit root testing results. For the USA, there is strong evidence that all variables in levels (logarithms) are consistent with unit root processes. In addition, except in the cases of the BSCGDP (MZt test) and the DCRGDP (DF-GLS and MZt tests) measures, the results indicate that the growth rates of all variables are consistent with stationary processes. Thus, we may conclude that all variables in levels may be characterized as $I(1)$ processes.

In the case of Mexico, there is wide support for the unit root hypothesis for all variables in levels, although this is not the case for the first differences since, in various instances, the tests do not support stationarity, as expected. This is particularly

---

[17] In the case of Mexico, the information for NDCR and CPBS is only available for the 1997Q03-2016Q01 period and in the case of the USA, M2 and M3 are only available for the 1959Q03-2016Q02 period.

Table 1

DEFINITION OF VARIABLES

Levels		*Growth rates*	
Name	*Definition*	*Name*	*Definition*
RGDP	$\ln\left(\frac{NGDP}{GDPID}\right)$	GRGDP	$\Delta\ln\left(\frac{NGDP}{GDPID}\right)\times 400$
DCRGDP	$\ln\left(\frac{NDCR}{NGDP}\right)$	GDCRGDP	$\Delta\ln\left(\frac{NDCR}{NGDP}\right)\times 400$
BSCGDP	$\ln\left(\frac{CPBS}{NGDP}\right)$	GBSCGDP	$\Delta\ln\left(\frac{CPBS}{NGDP}\right)\times 400$
M2GDP	$\ln\left(\frac{M2}{NGDP}\right)$	GM2GDP	$\Delta\ln\left(\frac{M2}{NGDP}\right)\times 400$
M3GDP	$\ln\left(\frac{M3}{NGDP}\right)$	GM3GDP	$\Delta\ln\left(\frac{M3}{NGDP}\right)\times 400$

All variables are expressed in natural logarithms *ln* and Δ is the first-difference operator. All ratios are calculated using nominal values.

notorious in the case of the MZt test, which indicates that all variables are nonstationary in first differences.[18] Fortunately, in most cases, the alternative unit root tests reject the unit root hypothesis for the first differences and the KPSS test cannot reject the null hypothesis of stationarity of the first differences at the 5% level of significance, for all variables.

---

[18] These results are contradictory and they might be explained by the small sample sizes and the likely seasonal effects present in the data.

4.3 Granger-causality between Growth and Financial Deepening

Table 2 reports the results of the Granger-causality tests, based on VAR estimation results. For each case, the lag order corresponds to the Schwarz or Hannan-Quinn criteria, whichever is higher. The lag orders as well as the cointegration ranks, obtained using Johansen's trace and maximum eigenvalue tests, are shown in the Appendix, Table A.2. For practical reasons, the Granger-causality tests are performed for all ranks *(r = 2,1,0)*, following the methodology outlined in section 3.2.[19] As shown in Table 2, in the case of the USA, in several cases the results reject the hypothesis of Granger non-causality from the indicators of financial development to real GDP. However, the results confirm the hypothesis of Granger non-causality from real GDP to financial development. This is not surprising, given the mature stage of development already present in the US financial system and the importance of the equity and other markets beyond money and credit.

In the case of Mexico, the hypothesis of non-causality from the indicators of financial development to real GDP is also rejected, but in fewer cases (for M2 and M3 but not for the credit indicators); while the hypothesis of non-causality from real GDP to financial development is rejected in several cases. Thus, in contrast to the results obtained for the USA, in the case of Mexico the stronger direction of causality seems to go from real GDP to financial development. While these results might appear to support mostly the views of Robinson (1952) and Lucas (1988), in the case of Mexico, where the ratio of credit

---

[19] The first case ($r = 2$) implies that the variables are stationary in levels and so the testing is carried out using estimation results from a $VAR(p)$ in levels. The second case ($r = 1$) implies that the variables are $I(1)$ but they are cointegrated, so Granger non-causality is tested using a VEC model with $(p-1)$ lagged differences. The third case ($r = 0$) implies that the variables are $I(1)$ but they are not cointegrated, so Granger non-causality is tested in a $VAR(p-1)$ in first differences.

granted to the private sector to the GDP has been particularly low, market failures and distorting policies might have muted the potential influence of finance on growth, an issue that is not explored here. Similar results are, however, reported by Ang and McKibbin (2007) for the case of Malaysia and by Hassan et al. (2011) for the Sub-Saharan Africa and East Asia-Pacific regions.

4.4 Financial Deepening and the Volatility of Growth

Tables 3 and 4 show the estimation results of the model described in Section 3.3, for the cases of the USA and Mexico, respectively. A few remarks are warranted. First, the time spans are not the same in both cases; approximately, the number of observations for the USA doubles that of Mexico. Thus, in the Mexican case, the econometric results may not be as robust or reliable as in the case of the USA. Second, in the case of Mexico, the data showed marked seasonality and, therefore, seasonal dummies were included in the estimation. Third, in both cases, the asymmetry parameter ξ was not statistically significant and so we excluded it from all estimations. Finally, in all cases, after estimating the full model, we examined the correlograms of standardized residuals and their squares and found no evidence of autocorrelation. Therefore, the estimated models can be considered well specified.[20]

As shown in Table 3, the estimation results for the USA are quite similar in all the cases considered. First, the *ARMA(1,1)* representation for the growth process seems adequate. Also, the GARCH-in-mean parameter ϕ is not statistically significant in all cases, implying that growth volatility does not affect the growth rate of output. This result is consistent with the view

---

[20] Also, in both cases, we carried out LM tests to make sure that the residuals of the proposed growth equation did not exhibit any significant (at the 5% or better) autocorrelation patterns and, at the same time, they showed ARCH effects. The results are shown in Table A.3 in the Appendix.

Table 2

GRANGER NON-CAUSALITY TESTS

Granger non-causality		*Rank equal to 2*		*Rank equal to 1*		*Rank equal to 0*	
from:	*to:*	*T, L*	*W test*	*T, L*	*W test*	*T, L*	*W test*
				USA (1957Q01-2016Q02)			
DCRGDP	REALGDP	235.2	4.99 (0.0825)	235.1	4.19[a] (0.0406)	235.1	12.47[a] (0.0004)
REALGDP	DCRGDP	235.2	3.46 (0.1774)	235.1	1.66 (0.1972)	235.1	1.16 (0.2813)
BSCGDP	REALGDP	235.2	6.57[a] (0.0374)	235.1	3.29 (0.0697)	235.1	10.64[a] (0.0011)
REALGDP	BSCGDP	235.2	2.46 (0.2923)	235.1	0.61 (0.4332)	235.1	0.17 (0.6807)
M2GDP	REALGDP	227.2	4.79 (0.0914)	227.1	2.43 (0.1188)	227.1	10.38[a] (0.0013)
REALGDP	M2GDP	227.2	2.23 (0.3281)	227.1	0.78 (0.3775)	227.1	0.04 (0.8331)
M3GDP	REALGDP	222.2	8.04[a] (0.0180)	222.1	4.13[a] (0.0422)	222.1	13.06[a] (0.0003)
REALGDP	M3GDP	222.2	3.19 (0.2028)	222.1	2.76 (0.0967)	222.1	0.32 (0.5707)

Mexico (1981Q01-2016Q01)

DCRGDP	REALGDP	74.3	4.36 (0.2252)	74.2	3.49 (0.1748)	74.2	1.45 (0.4845)
REALGDP	DCRGDP	74.3	24.73[a] (0.0000)	74.2	15.11[a] (0.0005)	74.2	16.64[a] (0.0002)
BSCGDP	REALGDP	74.3	5.31 (0.1507)	74.2	1.22 (0.5436)	74.2	2.55 (0.2798)
REALGDP	BSCGDP	74.3	15.66[a] (0.0087)	74.2	5.29 (0.0709)	74.2	11.29[a] (0.0035)
M2GDP	REALGDP	115.7	14.63[a] (0.0410)	115.6	8.41 (0.2097)	115.6	9.76 (0.1353)
REALGDP	M2GDP	115.7	12.32 (0.0906)	115.6	5.75 (0.4521)	115.6	15.23[a] (0.0186)
M3GDP	REALGDP	117.5	15.58[a] (0.0082)	117.4	7.06 (0.1327)	117.4	4.77 (0.3114)
REALGDP	M3GDP	117.5	18.11[a] (0.0028)	117.4	5.30 (0.2581)	117.4	12.81[a] (0.0122)

Note: The tests for the case of rank 2 use estimation results from a VAR in levels while the tests for the case of rank 0 are based on estimation results of the VAR in first differences. In the case of rank 1, the tests are based on a VEC model. *T* and *L* indicate, respectively, the number of observations and lag order in each case. The Wald test for Granger non-causality is denoted by *W*-test. In all cases, the *W*-test has *L* degrees of freedom.

[a] The *W*-test is significant at the 5% or better. For the case of Mexico, seasonal dummies were included.

Table 3

GARCH-M ESTIMATION RESULTS FOR UNITED STATES

	Case 1		***Case 2***		***Case 3***		***Case 4***	
	GREALGDP and GDCRGDP		*GREALGDP and GBSCGDP*		*GREALGDP and GM2GDP*		*GREALGDP and GM3GDP*	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
				Conditional mean				
Cons.	1.02^{b}	0.30	1.06^{b}	1.04	0.95^{b}	0.87	1.03^{b}	1.08
	(0.01)	(0.60)	(0.01)	(0.12)	(0.02)	(0.18)	(0.02)	(0.12)
AR(1)	0.65^{c}	0.65^{c}	0.65^{c}	0.65^{c}	0.67^{c}	0.67^{c}	0.66^{c}	0.66^{c}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
MA(1)	–0.37^{b}	–0.36^{b}	–0.37^{b}	–0.37^{b}	–0.40^{b}	–0.40^{b}	–0.39^{b}	–0.39^{b}
	(0.02)	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.02)	(0.02)
ϕ	n. a.	0.24	n. a.	–0.00	n. a.	0.03	n. a.	–0.02
		(0.14)		(0.98)		(0.86)		(0.93)
				Conditional variance				
Cons.	0.90	0.57	1.05	1.04	0.97	0.93	1.16	1.18
	(0.21)	(0.30)	(0.17)	(0.17)	(0.21)	(0.22)	(0.18)	(0.18)

ARCH (1)	0.20^b (0.02)	0.17^b (0.02)	0.18^b (0.03)	0.18^b (0.03)	0.21^b (0.02)	0.20^b (0.02)	0.21^b (0.02)	0.21^b (0.02)
GARCH (1)	0.73^c (0.00)	0.78^c (0.00)	0.74^c (0.00)	0.74^c (0.00)	0.72^c (0.00)	0.73^c (0.00)	0.71^c (0.00)	0.71^c (0.00)
ψ	−0.06 (0.78)	−0.06 (0.74)	−0.03 (0.87)	−0.03 (0.87)	−0.07 (0.73)	−0.06 (0.76)	−0.10 (0.65)	−0.10 (0.63)
φ	−0.01 (0.92)	0.06 (0.44)	−0.07 (0.46)	−0.07 (0.47)	0.00 (0.98)	0.00 (0.99)	0.00 (0.98)	0.00 (0.99)
Adj-R^2	0.12	0.11	0.12	0.11	0.10	0.10	0.10	0.10
Log L	−590.25	−589.79	−589.90	−589.90	−562.99	−562.98	−553.99	−553.98
Observations	236	236	236	236	228	228	223	223

All models were estimated by maximum likelihood using the numerical optimization algorithm Marquardt, with the software Eviews 9. For each model, columns *a* and *b* refer to estimation results of the models without and with GARCH-in-mean effects respectively. Numbers in parenthesis are *p*-values. The conditional mean equation was specified as an *ARMA (1,1)*. [a], [b], [c] indicate significance levels at the 10%, 5% and 1% levels, respectively.

that the likely effects of growth volatility on risk-adjusted investment returns and precautionary savings cancel out. Alternatively, Black's (1987) hypothesis that higher volatility may be positively related to the average growth rates of the economy is not confirmed by these data.

For the conditional variance process, the results show significant ARCH and GARCH coefficients. Growth volatility in USA is a highly persistent process but stationary, since the sum of the ARCH and GARCH parameters is close to unity (about 0.93 on average). We also find that $\psi < 0$. This may imply that more rapid growth in the US economy tends to reduce its volatility, although this result is not statistically significant.

As for the effect of finance on growth volatility, in the case of USA we find some positive and negative values for the parameter φ, but in all the estimated models they are not statistically significant. Thus, we may conclude that finance and growth volatility are unrelated in this country.

The results for Mexico are shown in Table 4. For the conditional mean process, we find that Mexico's output growth is well approximated by an *ARMA* (1,1) and that seasonal effects are present in the data. More importantly, output growth is positively related to the growth rate of the US economy; the result that $\omega > 0$ is significant and quite robust. It reflects the well-known fact that Mexico's growth is highly dependent on US growth. In addition, we find that $\phi < 0$ and that it is significant in three out of the four estimations.

Thus, in the case of Mexico, greater growth volatility is detrimental for the growth process, in contrast with the USA, where we found no effect. A plausible interpretation of this result is that the negative effect of greater growth volatility on investment–through the need for higher risk-adjusted returns–dominates its positive effect on the accumulation of precautionary savings, particularly in view of the large role that the Mexican government has played as insurer of last resort, thereby discouraging deposit mobilization.

Although growth volatility in Mexico seems to be less persistent than in the USA, the growth process in Mexico is by far more volatile than in the USA. This result is implied by the very high and statistically significant constant parameter in the conditional variance process for Mexico. This may reflect, in part, the smaller size and lesser opportunities for diversification of the Mexican economy, compared to the USA.

In a couple cases, we find that the parameter ψ is statistically significant at the 10% significance level. This implies that changes in growth rates of real GDP may affect the predictability of this process, though this effect is neither strong nor robust; in other words, there is some weak evidence on feedback effects from output growth to the volatility of growth.

As far as the effect of financial development on the volatility of growth, captured by the parameter φ, in the cases related to the money deepening measures, M2 and M3, we find that this parameter is negative and statistically significant. This suggests that financial development may reduce Mexico's growth volatility.

Interestingly, the findings of $\varphi < 0$ and $\phi < 0$ taken together imply a positive effect from financial development to economic growth through the volatility channel: That is, greater financial development–measured as money deepening–reduces the volatility of growth which, in turn, leads to higher output growth.

Finally, we find that the growth rate of the USA may affect Mexico's growth through the volatility channel, since we find the result $\zeta < 0$ to be significant in some cases. This result suggests that the volatility of growth in Mexico may depend on the economic performance of the USA. Thus, we find some evidence that higher growth rates in the USA reduce Mexico's growth volatility and, given the negative relation between growth volatility and growth rates, this would lead to more rapid growth in Mexico.

Table 4

GARCH-M ESTIMATION RESULTS FOR MEXICO

	Case 1		***Case 2***		***Case 3***		***Case 4***	
	GREALGDP and GDCRGDP		*GREALGDP and GBSCGDP*		*GREALGDP and GM2GDP*		*GREALGDP and GM3GDP*	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
				Conditional mean				
Cons.	–10.4^{c}	–6.3^{b}	–11.9^{c}	–9.8^{c}	–14.2^{c}	–8.1^{b}	–14.6^{c}	–6.0
	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.11)
MA(1)	–0.67^{c}	–0.58^{c}	–0.66^{c}	–0.62^{c}	–0.58^{c}	–0.60^{c}	–0.58^{c}	–0.58^{c}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SD(2)	16.5^{c}	21.7^{c}	20.6^{c}	22.2^{c}	24.8^{c}	26.0^{c}	25.4^{c}	26.6^{c}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SD(4)	24.7^{c}	28.1^{c}	27.7^{c}	29.4^{c}	32.8^{c}	34.2^{c}	33.2^{c}	33.8^{c}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ϕ	n. a.	–0.73^{c}	n. a.	–0.34	n. a.	–0.67^{b}	n. a.	–0.96^{b}
		(0.00)		(0.13)		(0.05)		(0.01)
ω	1.18^{c}	0.76^{c}	1.07^{c}	0.95^{c}	0.92^{c}	0.85^{c}	0.93	0.75^{c}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
				Conditional variance				
Cons.	20.2	41.4^{c}	39.5	46.9^{b}	96.2^{b}	63.6^{b}	104.8^{b}	47.2^{c}
	(0.20)	(0.00)	(0.14)	(0.02)	(0.02)	(0.03)	(0.02)	(0.00)

	Case 1		*Case 2*		*Case 3*		*Case 4*	
	GREALGDP and GDCRGDP		*GREALGDP and GBSCGDP*		*GREALGDP and GM2GDP*		*GREALGDP and GM3GDP*	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
ARCH (1)	0.03 (0.86)	-0.12^{b} (0.03)	–0.14 (0.17)	-0.17^{c} (0.00)	0.03 (0.78)	0.03 (0.68)	0.02 (0.88)	–0.01 (0.82)
GARCH (1)	0.73^{b} (0.01)	0.68^{c} (0.00)	0.66^{b} (0.05)	0.65^{c} (0.00)	0.19 (0.57)	0.43 (0.11)	0.14 (0.70)	0.61^{c} (0.00)
ψ	1.53 (0.14)	0.28 (0.77)	0.92 (0.55)	0.29 (0.83)	–1.31 (0.16)	-1.63^{a} (0.06)	–1.19 (0.20)	-1.16^{a} (0.05)
φ	0.15 (0.76)	–0.28 (0.52)	0.32 (0.71)	0.08 (0.93)	-1.95^{a} (0.06)	-1.76^{b} (0.04)	-2.01^{a} (0.10)	-1.49^{c} (0.00)
ζ	-5.05^{b} (0.01)	-7.63^{c} (0.00)	–6.64 (0.06)	-7.45^{a} (0.05)	–9.14 (0.11)	–4.63 (0.2691)	–9.53 (0.12)	–3.96 (0.16)
Adj-R^2	0.68	0.66	0.67	0.66	0.70	0.70	0.70	0.68
Log L	–251.2	–249.9	–252.9	–250.3	–426.7	–424.1	–426.8	–423.8
Obs.	75	75	75	75	120	120	120	120

All models were estimated by maximum likelihood using the numerical optimization algorithm Marquardt, with the software Eviews 9. For each model, columns *a* and *b* refer to estimation results of the models without and with GARCH-in-mean effects respectively. Numbers in parenthesis are *p*-values. The mean equation was specified, originally, as an *ARMA (1, 1)* but the *AR* parameter resulted not significant and, therefore, it was excluded. In all cases, based on a preliminary estimation, seasonal dummies (*SD*) for the quarters 2 and 4 were included and they kept highly significant. ^{a}, ^{b}, ^{c} indicate significance levels at the 10%, 5% and 1% respectively.

5. CONCLUSIONS

Using time series methods, in this paper we empirically investigate the effects of financial development on the growth of real GDP and on its volatility, in the cases of Mexico and the USA. The paper also explores the possible effect of output growth in the USA on the volatility of the Mexican output growth, a channel that is worth investigating, given the enormous influence of the US economy on Mexico's economic performance.

The Granger-causality tests suggest that, in the case of the USA, financial development positively influences economic growth, but we find no evidence that this relation occurs in the opposite direction. The results for Mexico, however, provide some support for bidirectional causality; that is, there is a relation from economic growth to finance as well as from finance to economic growth, although the former is stronger than the later, at least for the shorter period examined.

Results from the time series model relating growth and volatility suggest that, in the case of the USA, financial development (money and credit deepening) does not affect the volatility of growth and that such volatility is unrelated as well to output growth. In the case of Mexico, however, the growth of the financial sector–particularly money deepening–seems to have a positive influence on economic growth, by reducing the volatility of output growth. Finally, more rapid growth in USA not only positively influences Mexico's growth directly, a fact that is well known, but also indirectly, by reducing growth volatility in Mexico. Thus, the performance of the US economy continues to be, through several channels, critical for the pace and stability of growth in Mexico.

Overall, these results suggest that Mexico is far from achieving its potential for more rapid and more stable output growth, unless–among other determinants–it fosters the development of a financial sector capable of promoting growth more widely and deeply. Further investigation, both theoretical and empirical, will be necessary to identify the specific channels and mechanisms through which these impacts may occur and the appropriate policies to encourage financial deepening.

APPENDIX

Table A.1

UNIT ROOT TESTS

Test	*REALGDP*	*DCRGDP*	*BSCGDP*	*M2GDP*	*M3GDP*
United States (1957Q01-2016Q02)					
ADF	−1.060	−1.297	−0.406	−1.117	−0.984
	−7.655^{a}	−16.454^{a}	−15.587^{a}	−5.323^{a}	−10.151^{a}
DF-GLS	3.910	2.176	2.247	−1.284	−1.113
	−5.238^{a}	−1.262	−2.067^{b}	−3.229^{a}	−5.268^{a}
PP	−0.974	−1.313	−0.401	−0.670	−0.987
	−10.936^{a}	−16.425^{a}	−15.596^{a}	−13.114^{a}	−10.185^{a}
MZT	4.547	2.234	2.297	−1.485	−1.139
	−4.693^{a}	−0.996	−1.505	−2.493^{b}	−4.713^{a}
KPSS	2.074^{a}	1.988^{a}	1.988^{a}	0.481^{b}	0.604^{b}
	0.410^{c}	0.148	0.087	0.313	0.278
Mexico (1981Q01-2016Q01)					
ADF	1.527	−0.460	0.281	0.152	0.044
	−3.417^{b}	−2.415	−3.297^{b}	−6.966^{a}	−4.580^{a}
DF-GLS	2.061	−0.701	0.064	1.109	1.290
	−0.549	−1.510	−2.223^{b}	−2.130^{b}	−2.175^{b}
PP	−0.010	0.440	0.490	−0.652	−0.227
	−22.577^{a}	−8.201^{a}	−10.415^{a}	−13.536^{a}	−12.845^{a}
MZT	3.425	−1.171	−0.140	1.244	1.529
	1.306	−0.627	−0.967	−1.527	−1.602
KPSS	1.416^{a}	0.698^{b}	0.846^{a}	1.299^{a}	1.229^{a}
	0.045	0.436^{c}	0.389^{c}	0.040	0.074

Note: For each test two entries are displayed. The first shows results for the level of the variables (in logarithms) and the second entry shows the results for the growth rates. The null hypothesis for the ADF, DF-GLS, PP and MZt tests is that the series has a unit root, while the null for the KPSS test is that the series is stationary. In all cases the test equation includes an intercept. For the first four tests the number of lags was determined using the Schwarz information criterion. The symbols ^{a}, ^{b} and ^{c} indicate significance levels at the 1%, 5% and 10% respectively.

Table A.2

VAR LAG ORDER AND COINTEGRATION RANK

Variables in VAR	*No. of obs.*	*Seasonal dummies*	*Lag order*		*Cointegration rank*	
			SC	*HQ*	*Tr*	*Max λ*
United States (1957Q01-2016Q02)						
REALGDP,DCRGDP	225	Yes	2	2	(0,0)	(0,0)
REALGDP,BSCGDP	225	Yes	2	2	(1,1)	(1,1)
REALGDP, M2GDP	217	Yes	2	2	(0,0)	(0,0)
REALGDP,M3GDP	212	No	2	2	(1,1)	(1,1)
Mexico (1981Q01-2016Q01)						
REALGDP,DCRGDP	65	Yes	1	3	(1,1)	(1,1)
REALGDP,BSCGDP	65	Yes	1	3	(1,1)	(1,1)
REALGDP,M2GDP	110	Yes	1	7	(1,0)	(1,0)
REALGDP,M3GDP	110	Yes	1	5	(1,1)	(1,1)

The lag orders correspond to the Schwarz criterion (SC) and Hannan-Quinn criterion (HQ), which are both consistent in this setting. The cointegration rank is determined using Johansen´s trace (Tr) and maximum eigenvalue (Max λ) tests. In all cases, the VEC model allows for an intercept in the cointegration relation and no trends in the variables. Two values are displayed for each test and they are obtained using the number of lags given by the SC and HQ criteria respectively.

Table A.3

LM TESTS FOR RESIDUAL AUTOCORRELATION (AR) AND ARCH EFFECTS

Lag	*United States*		*Mexico*	
	AR	*ARCH*	*AR*	*ARCH*
1	0.03 (0.87)	3.74 (0.05)^{b}	0.06 (0.80)	14.46 (0.00)^{a}
2	0.66 (0.72)	12.54 (0.00)^{a}	0.18 (0.91)	14.38 (0.00)^{a}
4	1.56 (0.82)	17.22 (0.00)^{a}	2.38 (0.67)	17.13 (0.00)^{a}
8	7.63 (0.47)	22.26 (0.00)^{a}	6.38 (0.60)	92.91 (0.00)^{a}
12	13.70 (0.32)	26.84 (0.01)^{a}	11.09 (0.52)	19.66 (0.07)^{c}

The growth process was modeled as *ARMA (1,1)* solely, without GARCH effects. Specifically Equations 3 and 3a were fitted to output growth of the USA and Mexico, respectively. In the case of Mexico the *AR* term was excluded since it resulted not significant; also, seasonal dummy variables for quarters 2 and 4 were included in this case. As usual, ^{a}, ^{b}, ^{c} indicate significance levels at the 10%, 5% and 1%, respectively. In both cases, the errors of the growth equation are free of auto-correlation even at lag 12th and yet there is overwhelming evidence on ARCH effects.

References

Acemoğlu, D., and F. Zilibotti (1997), "Was Prometheus Unbound by Chance? Risk, Diversification and Growth," *Journal of Political Economy,* Vol. 105, pp. 709-751

Aghion, P., and I. Marinescu (2006), *Cyclical Budgetary Policy and Economic Growth: What Do We Learn from OECD Panel Data?*, Working Paper.

Aghion, P., and A. Banerjee (2005), *Volatility and Growth,* Clarendon Lectures, Oxford University Press.

Aghion, P., A. Banerjee and T. Piketty (1999), "Dualism and Macroeconomic Volatility," *Quarterly Journal of Economics,* Vol. 114, pp. 1359-1397.

Aghion, P., M. Angeletos, A. Banerjee and K. Manova (2004), "Volatibility and Growth: The Role of Financial Development," mimeo., Department of Economics, Harvard University.

Aghion, P., P. Bacchetta, R. Rancière and K. Rogoff (2006), "Exchange Rate Volatility and Productivity Growth: The Role of Financial Development," *Journal of Monetary Economics*, Vol. 56, No. 4, pp. 494-513.

Aghion, P., T. Fally and S. Scarpeta (2006), *Credit Constraints as a Barrier to the Entry and Post-entry Growth of Firms: Lessons from Firm Level Cross Country Panel Data*, Working Paper, October, Harvard University.

Ahlin, C., and N. Jiang (2005), *Can Microcredit Bring Development*, Working Paper, No. 05-019, Department of Economics, Vanderbilt University, Nashville.

Aizenman, J., and N. Marion (1993), "Policy Uncertainty, Persistence and Growth," *Review of International Economics,* No. 2, pp. 145-163.

Ang, J. B., and W. J. McKibbin (2007), "Financial Liberalization, Financial Sector Development and Growth: Evidence from Malaysia," *Journal of Development Economics*, Vol. 84, pp. 215-233.

Arestis, P., P. O. Demetriades, and K. B. Luintel (2001), "Financial Development and Economic Growth: The Role of Stock Markets," *Journal of Money, Credit, and Banking,* Vol. 33, pp. 16-41.

Aysan, A. F. (2006), "The Effects of Volatility on Growth and Financial Development Through Capital Market Imperfections," Munich Personal RePEC Archive (MPRA) Paper, No. 5486.

Bagehot, W. (1873), *Lombard Street: A Description of the Money Market*, Orion Editions, Philadelphia.

Beck, T., D. Asli and V. Maksimovic (2006), "The Influence of Financial and Legal Institutions on Firm Size," *Journal of Banking and Finance*, Vol. 30, pp. 2995-3015.

Beck, T., R. Levine and N. Loayza (2000), "Finance and the Sources of Growth, "*Journal of Financial Economics*, Vol. 58, pp. 261-300.

Bernanke, B. S., and M. Gertler (1989), "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review,* No. 79, pp. 14-31.

Bernanke, B. S., M. Gertler, and Simon Gilchrist (1999), "The Financial Accelerator in a Quantitative Business Cycle Framework," *Handbook of Macroeconomics,* Vol. 1, pp. 1341-1393.

Black, F. (1987), *Bussines Cycles and Equilibrium,* Basil Blackwell, New York.

Blattman, C., J. Hwang and J. Williamson (2004), *The Impact of the Terms of Trade on Economic Development in the Periphery, 1870-1939: Volatility and Secular Change,* NBER Working Paper, No. 10600.

Bollerslev, T. (1986), "Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics,* Vol. 31, pp. 307-327.

Calderón, C., and L. Liu (2003), "The Direction of Causality between Financial Development and Economic Growth," *Journal of Development Economics,* Vol. 72, No. 1, pp. 321-334.

Campbell, J. Y. (1994), "Inspecting the Mechanism: An Analytical Approach to the Stochastic Growth Model," *Journal of Monetary Economics,* Vol. 33, pp. 463-506.

Cameron, R., Olga Crisp, Hugh T. Patrick, and Richard Tilly (1967), *Banking in the Early Stages of Industrialization: A Study in Comparative Economic History,* Oxford University Press, New York.

Carlstrom, Charles T., and Timothy S. Fuerst (1997), "Agency Costs, Net Worth, and Business Fluctuations: A Computable General Equilibrium Analysis," *The American Economic Review,* pp. 893-910.

Cecchetti, S. G., A. Flores-Lagune and S. Krause (2006), "Financial Development, Consumption Smoothing, and the Reduced Volatility of Real Growth," AEA Conference Papers.

Cetorelli, N., and M. Gambera (2001), "Banking Market Structure, Financial Dependence, and Growth: International Evidence from Industry Data", *Journal of Finance,* Vol. 106, No. 2, pp. 617-648.

Claessens, S., and L. Laeven (2005), "Financial Dependence, Banking Sector Competition, and Economic Growth", *Journal of the European Economic Association,* Vol. 3, No. 1, pp. 179-207.

Clarke, M. Z. (2004), "Geographic Deregulation of Banking and Economic Growth," *Journal of Money, Credit, and Banking*, Vol. 36, No. 5, pp. 929-942.

Comisión Nacional Bancaria de Valores, CNBV (2011), *Tercer Reporte de Inclusión Financiera.*

Christopoulos, Dimitris K., and Efthymios G. Tsionas (2004), "Financial Development and Economic Growth: Evidence from Panel Unit Root and Cointegration Tests," *Journal of Development Economics,* Vol. 73, No. 1, pp. 55-74.

De Meza, D., and D. Webb (2006), "Credit Rationing: Something's Gotta Give," *Economica,* Vol. 73, pp. 563-578.

Dehejia, R., y A. Lleras-Muney (2007), "Financial Development and Pathways of Growth: State Branching and Deposit Insurance Laws in the United States 1900-1940," *The Journal of Law and Economics,* Vol. 50.

Demetriades, P., and K. Hussein (1996), "Does Financial Development Cause Economic Growth? Time Series Evidence from 16 Countries," *Journal of Development Economics,* Vol. 51, pp. 387-411.

Denizer, C., M. F. Iyigun and A. L. Owen (2000), *Finance and Macroeconomic Volatility*, Policy Research Working Papers, No. 2487, The World Bank.

Demirgüç-Kunt, A., and L. Klapper (2012), *Measuring Financial Inclusion: The Global Findex*, Policy Research Working Papers, No. 6025, The World Bank.

Devereux, M. B., and G. W. Smith (1994), "International Risk Sharing and Economic Growth," *International Economic Review,* Vol. 35, pp. 535-550.

Dickey, D., and W. Fuller (1979), "Distribution of the Estimators for Auto-regresive Time Series with a Unit Root," *Journal of the American Statistical Association,* Vol. 74, pp. 427-431.

Dickey, D., and W. Fuller (1981), "Likelihood Ratio Tests for Autoregresive Time Series with a Unit Root," *Econometrica,* Vol. 49, pp. 1057-1072.

Dynan, K. E., D. W. Elmendorf and D. E. Sichel (2005), "Can Financial Innovation Explain the Reduced Volatility of Economic Activity?," Carnegie-Rochester Conference on Public Policy.

Easterly, W., R. Islam and J. Stiglitz (2000), "Shaken and Stirred: Explaining Growth Volatility," *World Bank Economic Review.*

Edwards, S., and C. A. Végh (1997), "Banks and Macroeconomics Disturbances under Predetermined Exchange Rates," *Journal of Monetary Economics*, Vol. 40, pp. 239-278.

Elliot, G., T. Rothenberg, and J. Stock (1996), "Efficient Tests for an Autoregressive Unit Root," *Econometrica*, Vol. 64, pp. 813-836.

Engle, R. (1982), "Autoregressive Conditional Heteroskedasticity with Estimates of the Volatility of UK Inflation", *Econometrica*, Vol. 50, pp. 987-1007.

Farías, M. E. (2007), *Uncertainty and Volatility on Financial Markets: The Effects on Growth and Development*, Universidad de Chile.

Federici, D., and F. Caprioli (2009), "Financial Development and Growth: An Empirical Analysis," *Economic Modelling*, Vol. 26, No. 2, pp. 285-294.

Freeman, D. G. (2002), "Did State Bank Branching Deregulation Produce Large Growth Effects?," *Economics Letters*, Vol. 75, No. 3, pp. 383-389.

Fry, M. (1988), *Money, Interest and Banking in Economic Development*, The Johns Hopkins University Press, Baltimore.

Fung, M. (2009), "Financial Development and Economic Growth: Convergence or Divergence?," *Journal of International Money and Finance*, Vol. 28, pp. 56-67.

Galbis, V. (1977), "Financial Intermediation and Economic Growth in Less-developed Countries: A Theoretical Approach," *Journal of Development Studies*, Vol. 13, No. 2, pp. 58-72.

Garrett, T. A., G. A. Wagner and D. C. Wheelock (2007), "Regional Disparities in the Spatial Correlation of State Income Growth, 1977-2002," *Annals of Regional Science*, Vol. 41, No. 3, pp. 601-618.

Giuliano, P., and M. Ruiz-Arranz (2009), "Remittances, Financial Development and Growth," *Journal of Development Economics*, Vol. 90, No. 1, pp. 144-152.

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

González-Vega, C., and M. Villafani-Ibarnegaray (2007), "Las microfinanzas en la profundización del sistema financiero. el caso de Bolivia," *Trimestre Económico,* No. 293, pp. 5-68.

Granger, C. (1969). "Investigating Causal Relationships by Econometric Models and Cross Spectral Methods," *Econometrica,* Vol. 37, pp. 424-438.

Greenwald, B., and J. Stiglitz (1993), "Financial Market Imperfections and Business Cycles," *Quarterly Journal of Economics,* Vol. 108, pp. 77-114.

Greenwood, J., and B. Jovanovic (1990), "Financial Development, Growth, and the Distribution of Income," *Journal of Political Economy,* Vol. 98, pp. 1076-1107.

Greenwood, J., J. M. Sánchez and C. Wang (2010), *Quantifying the Impact of Financial Development on Economic Development*, Working Paper, No. 10-05, Federal Reserve Bank of Richmond.

Gup, E.B., ed. (2003), *The Future of Banking*, Quorum, Westport, CT.

Gurley, J. G., and E. S. Shaw (1955), "Financial Aspects of Economic Development," *American Economic Review*, Vol. 45, No. 4, pp. 515-538.

Gurley, J. G., and E. S. Shaw (1960), *Money in a Theory of Finance*, The Brookings Institution, Washington, D.C.

Haber, S. H., North, D. C. and B. R. Weingas (2008), *Political Institutions and Financial Development*, Stanford University Press.

Hamilton, A. (1791), "National Bank", in H. C. Lodge (ed.), *The Works of Alexander Hamilton*, Volume 3, G. P. Putman's Sons, New York, 1904.

Hasan, I., P. Wachtel and M. Zhou (2009), "Institutional Development, Financial Deepening and Economic Growth: Evidence from China," *Journal of Banking & Finance*, Vol. 33, No. 1, pp. 157-170.

Hassan, M. K., B. Sánchez, and J-S Yu (2011), "Financial Development and Economic Growth: New Evidence from Panel Data," *The Quarterly Review of Economics and Finance*, Vol. 51, pp. 88-104.

Hicks, J. (1969), *A Theory of Economic History*, Clarendon Press, Oxford.

Jaffee, D., and J. Stiglitz (2000), "Credit Rationing", in *Handbook of Monetary Economics*, Elsevier.

Jalil, A. (2009), *Financial Development and Reduced Growth Volatility: Evidence from China*, International Trade and Finance Association Conference Papers, 19th International Conference Working Papers, No. 21.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors," *Journal of Economic Dynamics and Control*, Vol. 12, pp. 231-254.

Johansen, S. (1991), "Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models," *Econometrica*, Vol. 59, pp. 1551-1580.

Jones, L., R. Manuelli and E. Stacchetti (2000), "Technology and Policy Shocks in Models of Endogenous Growth," Federal Reserve Bank of Minneapolis Working Paper, No. 281.

Jung, W. S. (1986), "Financial Development and Economic Growth: International Evidence," *Economic Development and Cultural Change*, Vol. 34, pp. 333-346.

Kapur, B. K. (1976), "Alternative Stabilization Policies for Less-developed Economies," *Journal of Political Economy*, Vol. 84, No. 4, pp.777-795.

King, R. G., and R. Levine (1993), "Finance, Entrepreneurship and Growth: Theory and Evidence," *Journal of Monetary Economics*, Vol. 32, pp. 513-542.

Kiyotaki, N., and J. Moore (1997), "Credit Cycles," *Journal of Political Economy,* Vol. 105, No. 2, pp. 211-248.

Koren, M., and S. Tenreyro (2004), "Diversification and Development," mimeo., Harvard University and Federal Reserve Bank of Boston.

Kunieda, T. (2008), "Financial Development and Volatility of Growth Rates: New Evidence," mimeo., Ryukoku University.

Kwiatkowsky, P., Schmidt and Shin (1992), "Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root," *Journal of Econometrics*, Vol. 54, pp. 159-178.

La Porta, R., F. López-de-Silanes, A. Shleifer and R. Vishny (1999), "Corporate Ownership around the World," *Journal of Finance,* Vol. 54, pp. 471-517.

Levine, R. (1991), "Stock Markets, Growth, and Tax Policy," *Journal of Finance,* Vol. 46, pp. 1445-1465.

Levine, R. (1992), *Financial Structures and Economic Development,* Policy ResearchWorking Paper Series, núm. 849, The World Bank.

Levine, R. (1997), "Financial Development and Economic Growth: Views and Agenda," *Journal of Economic Literature*, Vol. 35, pp. 688-726.

Levine, R. (2004), *Finance and Growth: Theory and Evidence,* NBER Working Paper Series, No. 10766.

Levine, R., and S. Zervos (1998), "Stock Markets, Banks and Economic Growth", *American Economic Review,* Vol. 88, pp. 357-558.

Levine, R., N. Loayza and T. Beck (2000), "Financial Intermediation and Growth: Causality and Causes," *Journal of Monetary Economics,* Vol. 46, pp. 31-77.

Loayza, N., and R. Rancière (2002), "Financial Fragility, Financial Development, and Growth," mimeo., World Bank.

Lucas, R. E. Jr. (1988), "On the Mechanics of Development Planning," *Journal of Monetary Economics,* Vol. 22, No. 1, July, pp. 3-42.

Lütkepohl, Helmut (2005), *New Introduction to Multiple Time Series Analysis*, Springer Science & Business Media.

Lütkepohl, H., and H. E. Reimers (1992), "Granger-causality in Cointegrated VAR Processes: The Case of the Term Structure," *Economics Letters,* Vol. 40, pp. 263-268.

Mallick, D. (2009), *Financial Development, Shocks, and Growth Volatility,* MPRA Paper, No. 17799, University Library of Munich, Germany.

Masten, A. B., F. Coricelli and I. Masten (2008), "Non-linear Growth Effects of Financial Development: Does Financial Integration Matter?," *Journal of International Money and Finance,* Vol. 27, No. 2, pp. 295-313.

Mathieson, D.J. (1980), "Financial Reform and Stabilization Policy in a Developing Economy," *Journal of Development Economics,* Vol. 7, No. 3, pp. 359-395.

McKinnon, R.I. (1973), *Money and Capital in Economic Development,* The Brookings Institutions, Washington, D.C.

McKinnon, R.I., ed. (1976), *Money and Finance in Economic Growth and Development: Essays in Honor of Edward S. Shaw,* Marcel Dekker, New York.

Merton, R. C. (1992), "Financial Innovation and Economic Performance," *Journal of Applied Corporate Finance,* Vol. 4, pp. 12-22.

Mirman, L. (1971), "Uncertainty and Optimal Consumption Decisions", *Econometrica,* Vol. 39, pp. 179-185.

Mitchener, K. J., and D. C. Wheelock (2010), *Does the Structure of Banking Markets Affect Economic Growth?. Evidence from U.S. State Banking Markets,* NBER Working Paper, No. 15710.

Nelson, D. B. (1991), "Conditional Heteroskedaasticity in Asset Returns: A New Approach", *Econometrica,* Vol. 59, pp. 347-370.

Ng, S., and P. Perron (2001), "LAG Length Selection and the Construction of Unit Root Tests with Good Size and Power," *Econometrica,* Vol. 69, pp. 1519-1554.

Obstfeld, M. (1994), "Risk-taking, Global Diversification, and Growth," *American Economic Review,* Vol. 84, pp. 1310-1329.

Özbilgin, H. M. (2010), "Financial Market Participation and the Developing Country Business Cycle," *Journal of Development Economics,* Vol. 92, No. 2, pp. 125-137.

Pagano, M. (1993), "Financial Markets and Growth: An Overview", *European Economic Review,* Vol. 37, pp. 613-622.

Phillips, P. C. B., and P. Perron (2001), "Testing for a Unit Root in Time Series Regression," *Biometrica,* Vol. 75, pp. 335-446.

Rajan, R. G., and L. Zingales (1998), "Financial Dependence and Growth," *American Economic Review,* Vol. 88, pp. 559-586.

Ramey, G., and V. Ramey (1995), "Cross-country Evidence on the Link between Volatility and Growth," *The American Economic Review,* Vol. 85, pp. 1138-1151.

Robinson, J. (1952), "The Generalization of the General Theory," in *The Rate of Interest and Other Essays,* Macmillan, London, pp. 67-142.

Romer, P. (1986), "Increasing Returns and Long-Run Growth," *Journal of Political Economy,* Vol. 94, No. 5, October, pp. 1002-1037.

Romer, P. (1990), "Endogenous Technological Change," *Journal of Political Economy,* Vol. 98, No. 5, October, part II, pp. S71-S102.

Saint-Paul, G. (1992), "Technological Choice, Financial Markets and Economic Development," *European Economic Review,* Vol. 36, pp. 763-781.

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

Schwert, G. W. (1987). "Effects of Model Specification on Tests for Unit Roots in Macroeconomic Data," *Journal of Monetary Economics*, Vol. 20, pp. 73-103.

Shan, J. Z., Morris, A. G. and F. Sun (2001), "Financial Development and Economic Growth: An Egg-chicken Problem?," *Review of International Economics*, Vol. 9, No. 3, pp. 443-454.

Shaw, E. S. (1973), *Financial Deepening in Economic Development*, Oxford University Press, Nueva York.

Sims, C. (1972), "Money, Income and Causality," *American Economic Review*, Vol. 62, pp. 540-552.