RESEARCH PROJECT

Financial Development and Macroeconomic Volatility

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Abstract

This paper studies the relationship between financial sector size and macroeconomic volatility. First, we develop a theoretical model based on Bacchetta and Caminal (2000) where we make the moral hazard problem a function of financial sector size and quality. Second, using a panel dataset consisting of 103 countries from 1981 to 2010, we look for an empirical relationship between the size of the financial sector and volatility of economic growth. We differentiate countries with respect to the quality of their financial sector. The results suggest a hump-shaped relationship for countries with high-quality financial sectors, suggesting that sufficiently large financial sectors offer diversification opportunities that outweigh the stability risk inherently attached to financial development. We estimate that growth volatility reaches a maximum when private credit over GDP is between 125 percent and 135 percent. In contrast, in countries with low-quality financial sectors no significant relationship is found.

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Introduction

Before the financial crisis, economists emphasized the benefits of having a deeper or larger financial sector. Numerous studies confirmed the positive correlation between financial development and economic growth. After 2008, however, more research is directed towards incorporating systemic risk and moral hazard costs in estimating the influence of financial sector size on economic output. This new literature tends to point out an ambiguous and potentially negative effect of having a very large financial sector. The main focus of our research lies in the effect of financial sector size on the second moment of economic growth, i.e. output volatility. This paper intends to trawl through the ocean of current literature, distill it into a model with tractable predictions and empirically challenge them.

Underdeveloped financial markets are regarded as a major cause of macroeconomic volatility by most economists. The goal of this paper is to provide an indication whether a larger financial sector relative to the size of the economy unambiguously affects output growth volatility. We explore this question by looking at the relationship between financial sector size and output growth volatility, conditional on financial sector quality — both from a theoretical and from an empirical point of view. Going through the vast amount of current literature, we come up with a model that incorporates the effect of financial sector size and quality on moral hazard costs and look at the resulting effect on growth volatility. To test our hypothesis and theoretical results in practice, we empirically estimate the relationship between size and quality of the financial sector and growth volatility using self-collected panel data of 103 countries over 30 years. We contribute to the existing research by estimating the effect of financial sector size on output growth volatility, conditional on financial sector quality. To the best of our knowledge, the estimation of this specific relation has not been carried out before in the literature.

Section 1 addresses the theoretical part of our work, including an extensive literature review, the theoretical model, its predictions and a connection to the empirical work. Section 2 is devoted to the empirical analysis and contains a description of the data and methodology used, the estimation results and their interpretation.

1 Financial Development and Output Growth: A Theoretical View

There is extensive research on the numerous ties between financial sector and economic growth. We present an overview of existing literature on financial and economic development in Section 1.1. This section also includes a survey of the literature on second-moment consequences of financial development on economic growth, which represents the core of our analysis. In Section 1.2, we introduce a theoretical model that uses endogenous moral hazard costs to find the influence of financial sector size and quality on output growth volatility and provides the basis for the empirical study.

1.1 Literature Review

The links between financial sector development and growth were originally investigated by economists through a historical perspective. Hicks (1969) argues that capital market improvements, which mitigated liquidity risk, were primary causes of the industrial revolution in England. One of the most famous contributions to the financial-real sector nexus remains that of Gerschenkron (1962), who puts the role of the banking sector and the scarcity of capital into the context of "economic backwardness" to show that output growth comes second to a solid financial sector. Citing Germany as an example, Gerschenkron (1962) shows how the latter's banking sector facilitated the acquisition of information about firms and triggered the industrial revolution in the 19^{th} century.

The theoretical literature on the relationship between financial development and growth was pioneered by Schumpeter (1934 - original print in 1911) with his exposition on "creative destruction". The channels through which the development of a solid financial system may affect economic growth are numerous. Levine (1997) distinguishes five of them: Financial systems (i) facilitate the trading, hedging, diversifying, and pooling of risk; (ii) allocate resources; (iii) monitor managers and exert corporate control; (iv) mobilize savings; and (v) facilitate the exchange of goods and services. The process through which financial development affects growth is summarized in Figure 1. Each

function of the financial sector is susceptible to affect growth via two channels — capital accumulation and technological innovation — and eventually determines steady-state growth, see Romer (1986, 1990).

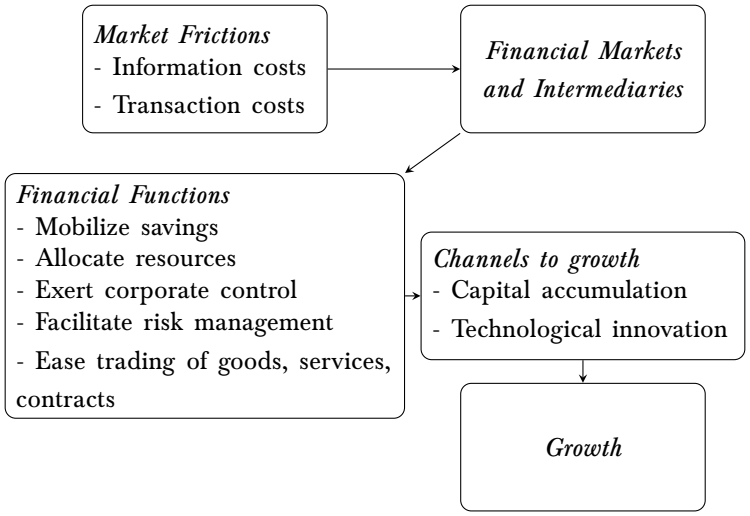

Figure 1: Theoretical Links Between Finance and Growth

Source: Levine (1997).

However relevant the theoretical approach may be to analyze how financial development and output growth are related, the main focus of the literature studying these links is empirical. King and Levine (1993) build on previous work on the relationship between the financial sector and growth. They study 77 countries over the period ranging from 1960 to 1989, systematically control for other factors affecting long-run growth, examine the capital accumulation and productivity growth channels, construct additional measures of the level of financial development and analyze whether the level of financial development predicts long-run economic growth, capital accumulation, and productivity growth. Theirs and other empirical studies tend to point towards a statistically and economically significant effect of financial development and most often describe it as a prerequisite to economic takeoff. Estimates from Levine (1997) suggest that if in 1960 Bolivia had increased its financial depth from 10 percent of GDP to the mean value for developing countries in 1960 (23 percent), then the country would have grown about 0.4 percent faster per annum, so that by 1990 real per capita GDP would have been about 13 percent larger than it was.

Additionally, Patrick (1966) notes a sequence of causality such that finance causes growth earlier (*supply [of finance] leading*) and growth causes finance (*demand [of finance] leading*) in later stages of economic development. While the financial system is indispensable to channeling funds from traditional sectors in early stages of growth, quick expansion requires the financial sector to further develop as companies can no longer finance their investment policy internally.

Beyond this first-moment analysis, a substantial strand of research has focused on studying second-moment implications for output growth of the size of the financial sector. Micro-founded theoretical underpinnings on the detrimental effects of an incomplete financial sector date back to the work of Stiglitz and Weiss (1981) who point out that the financial sector may attract high-risk borrowers through adverse selection. Kiyotaki and Moore (1997) show that capital market imperfections can amplify the effects of temporary productivity shocks and make them more persistent, through their effect on the net wealth of credit-constrained borrowers. Acemoglu and Zilibotti (1997) show that the lack of diversification due to indivisible investment in early stages of development result in a high level of output growth volatility in this stage. They point out that this lack of diversification also gives a substantial role to "chance" in economic development. In the same vein, Allen and Gale (1997) show there is underinvestment in safe assets when there is no financial sector. Aghion and Banerjee (2004) introduce a framework for analyzing the influence of the financial sector on growth volatility in small open economies where the firms face tighter credit constraints at lower levels of financial development. They conclude that countries that are undergoing financial development may become more unstable, at least in the short run. Bacchetta and Caminal (2000) develop a macroeconomic model where the main channel through which financial sector size affects macroeconomic volatility is the agency costs of borrowing. They find that a larger financial sector is able to dampen productivity shocks, thus reducing output growth volatility. Beck and Majnoni (2006) extend this model and argue that a larger financial sector can amplify monetary shocks, as opposed to productivity shocks.

The empirical literature attempting to capture the relationship between macroeconomic

volatility and financial depth[2] is abundant. One of the first attempts was performed by Easterly et al. (2000), who find a U-shaped relationship between output growth volatility and financial depth. Their analysis suggests that output growth volatility is minimized when private credit represents approximately 100 percent of GDP. More recently, Dabla-Norris and Srivisal (2013) apply a System GMM-estimation procedure to support a negative relationship between financial depth and volatility of output growth. Similarly, Denizer et al. (2000) find that countries with deeper financial sectors may be subject to lower volatility in macroeconomic aggregates (GDP, consumption and investment). Furthermore, some other papers find no significant relationship between financial depth and macroeconomic volatility, among them Acemoglu et al. (2003) and Beck and Majnoni (2006).

Besides financial depth, other financial determinants of GDP growth volatility are studied as well. For instance, Terrones et al. (2003) find a positive correlation between GDP growth volatility and financial openness and trade. Rodrik (1996) shows that external risk exposure is strongly correlated with higher volatility in aggregate income and consumption. Finally, Loayza and Raddatz (2006) find that open economies tend to be more stable when they have deeper financial markets.

1.2 A Model of Financial Development, Financial Sector Quality and Growth

In this section, we present a dynamic macroeconomic model that accounts for two stylized facts about financial development and moral hazard. Building on the model of Bacchetta and Caminal (2000), we shortly put forward the main elements of the model and explain our extensions to their model in this section. More specifically, we make the additional assumption that the moral hazard problem is a function of the size of the financial sector and of its quality in a given country. Our results imply that the volatility of a country's output growth rate depends on the size and the quality of the financial sector.

[2]Financial depth captures how big a financial sector is relative to the economy as a whole. It encompasses information about the size of financial markets, banks, and other financial institutions relative to the aggregate output of the economy.

As our framework is very close to that of the original authors, we present the notation briefly without extensively discussing specific issues. A more thorough discussion can be found in the original paper by Bacchetta and Caminal (2000).

1.2.1 Entrepreneurs

In this model there are two types of entrepreneurs, a high and a low type. The high type has more capital at his disposal than he needs to run his firm so he can invest his extra capital at a real interest rate r. The low type faces a credit constraint but can borrow at rate ϕr, where $\phi \geqslant 1$ represents agency costs. The entrepreneurs can produce according to a neoclassical production function, $f(k) = k^{\lambda}$, so that both entrepreneurs will invest until their marginal benefit from investing equals their marginal cost:

$$\begin{cases} f'(k^h) &= r \\ f'(k^l) &= \phi r \end{cases} \tag{1}$$

Both entrepreneurs can invest their capital in different types of projects. The projects which the entrepreneurs eventually end up investing in are private information and thus are not contractible, which leads to a potential moral hazard problem.[3] We assume the same functional forms as Bacchetta and Caminal (2000):

$$y = \begin{cases} \mu(\alpha) f(k) & \text{with probability } \alpha \\ 0 & \text{with probability } 1-\alpha \end{cases} \tag{2}$$

In Bacchetta and Caminal (2000, Appendix A), it is proven that when using $\mu(\alpha) = \alpha^{-1}[1 + (1 - z_t)\ln\alpha]$,[4] both the low type and high type entrepreneurs will choose $\alpha = 1$ if they can borrow at ϕr and invest at r, respectively.[5] We add in our model that the parameter z_t — which parameterizes the costs of moral hazard — is a function[6] of the

[3] This potential moral hazard problem will be important for the later results of our model, as it will depend on the size and quality of the financial sector.

[4] Note that α is restricted to lie in $[\underline{\alpha}, 1]$, $0 < \underline{\alpha} < 1$ and the function $\mu(\alpha)$ is such that $\mu(1) = 1$ and $0 \leqslant \alpha\mu(\alpha) < 1$ for any $\alpha \in [\underline{\alpha}, 1)$.

[5] Moreover, Bacchetta and Caminal (2000, Appendix A) shows that the low type entrepreneurs would not take the first best contract (r, k^h) if it was offered.

[6] Note that this function can thus also depend on the interaction term $F_t Q_t$.

size of the financial sector, F_t, and of the quality of the financial sector, Q_t:

$$z_t = g(F_t, Q_t) = g\left(\frac{b_t^l}{f(k_t^h) + f(k_t^l)}, Q_t\right) < 1; \tag{3}$$

where b_t^l is the total amount of money borrowed by the low type entrepreneurs. Note that here we define the size of the financial sector to be the ratio of loans to the low type entrepreneurs over total output in the economy. In order to get useful results, we need to impose additional structure on the relationship between the moral hazard costs and the size and quality of the financial sector. We can safely assume that the higher the quality of the financial sector is, the smaller the extent of the moral hazard costs, so we have $\partial_Q z_t = \partial_Q g(F_t, Q_t) < 0$. A high-quality financial sector, which in our definition is a more stable, trustworthy and more efficient financial sector, should logically dampen informational asymmetries thus decreasing the extent of the moral hazard problem. However, it is less clear what the effect of a larger financial sector is on the extent of the moral hazard problem. On the one hand, a larger financial sector can lead to more specialization, allowing for more efficient monitoring and therefore a smaller moral hazard problem. On the other hand, a larger financial sector might lead to increasing bankers' confidence, less risk aversion and more numerous bankers lacking discernment in lending practice, so that the moral hazard problem may increase overall. Therefore, we cannot *a priori* put a sign on $\partial_F z_t = \partial_F g(F_t, Q_t)$.

1.2.2 Consumers

On the consumption side of the model, the same low- and high-type entrepreneurs are also the low- and high-type consumers who want to maximize their utility. As in Bacchetta and Caminal (2000), we have an overlapping generations environment with two periods, and the problem for the high types[7] is:

$$\begin{aligned} \max_{c_t, b_t} U^h &= \max_{c_t, b_t} \left[\min \left\{ c_t^h, \frac{1-\gamma^h}{\gamma^h} b_t^h \right\} \right] \\ \text{subject to } c_t^h + b_t^h &\leqslant f(k_{t-1}^h) + r_t(b_{t-1}^h - k_{t-1}^h); \end{aligned} \tag{4}$$

[7] The problem for the low-type consumers is entirely analogous.

b_t^h stands for bequest to the following generation, and the γ_h is a parameter for the generosity of the individual.[8]

1.2.3 Equilibrium

From Bacchetta and Caminal (2000), there is a unique solution to this model, where $1 - z_t < \lambda < 1$.[9] From the entrepreneurs' problem, we get that both types of entrepreneurs are maximizing when

$$f'(k_{t-1}^h) = r_t \tag{5}$$

$$f'(k_{t-1}^l) = r_t \frac{\lambda}{1 - z_t}\left(1 - \frac{b_t^l}{k_t^l}\right); \tag{6}$$

so we can write the first equilibrium condition as follows:

$$\frac{f'(k_t^l)}{f'(k_t^h)} = \left(\frac{k_t^h}{k_t^l}\right)^{1-\lambda} = \frac{\lambda}{1 - z_t}\left(1 - \frac{b_t^l}{k_t^l}\right). \tag{7}$$

Moreover, solving the consumers' problems yields the following two equilibrium conditions:

$$b_t^h = \gamma^h[f(k_{t-1}^h) + r_t(b_{t-1}^h - k_{t-1}^h)] \tag{8}$$

$$b_t^l = \gamma^l[f(k_{t-1}^l) + r_t(b_{t-1}^l - k_{t-1}^l)]; \tag{9}$$

where the market clearing condition[10] is as follows:

$$B_t = \beta b_t^h + (1 - \beta) b_t^l = \beta k_t^h + (1 - \beta) k_t^l. \tag{10}$$

As Bacchetta and Caminal (2000) show, this economy has a unique equilibrium provided that γ^h and γ^l are "sufficiently different."

[8] It is necessary for the equilibrium of the model to exist that $\gamma^h > \gamma^l$, as argued in Bacchetta and Caminal (2000). This implies that in the model, high-type consumers should be by assumption more generous towards their offspring than the low-type consumers.

[9] For the explicit derivations of this equilibrium, we refer to Bacchetta and Caminal (2000).

[10] Note that β herein stands for the proportion of high type entrepreneurs, and thus $1 - \beta$ as the proportion of low type entrepreneurs.

1.3 Preliminary Results

1.3.1 Predictions of the Model

In this theoretical model, output growth volatility decreases with the quality of the financial sector. To see this, consider a multiplicative and unanticipated positive shock to the production function,[11] i.e. $Y_{t+1} = \zeta_{t+1} f(k_t)$ for both types of entrepreneurs, where $\zeta_{t+1} > 1$. Both the bondholdings of the consumers increase, as both types unexpectedly produce more output, which can be seen from equations (8) and (9). However, the output (and thus bondholdings) of the low type increases more than proportionally than the output of the high type, since the marginal productivity of capital of the low type entrepreneurs is larger than that of the high type entrepreneurs, see condition (6). Clearly, since the increase in productivity is larger for the low type entrepreneur when z_t is larger, the impact of the productivity shock will be larger whenever z_t is larger. The model therefore predicts the following outcomes:

Result 1 The effect of a productivity shock on the total output of the economy depends on the derivative of z_t with respect to F_t. This leads to an ambiguous effect of the financial sector size on the volatility of the financial sector.

Result 2 The effect of a productivity shock on the total output of the economy decreases with Q_t, so that in countries with a high quality financial sector, the effect of productivity shocks is dampened. Therefore, we can conclude that volatility decreases with financial sector quality.

More specifically for Result 1, if the effect of a larger financial sector size on the moral hazard costs is negative, we expect volatility to decrease with financial sector size. Symmetrically, whenever the costs of moral hazard increase together with the size of the financial sector, output growth volatility should rise as well.

[11] The effects of a monetary shock might render different results, as explained in Beck and Majnoni (2006).

1.3.2 Motivation for the Empirical Part

The assumption regarding the effect of the size of the financial sector plays a crucial role in the model and to a large extent determines its predictions. Although our assumption on how financial sector quality translates into a more severe moral hazard issue is reasonable, the way the size of the financial sector affects informational asymmetry is not so obvious. Many, such as Hahm and Mishkin (2000), would argue that a larger financial sector reduces the moral hazard problem by giving more bargaining power to financial intermediaries, thus forcing entrepreneurs to reveal more information on the quality of the project. Others, such as Dell'Ariccia (2001), would respond that as it develops, the financial sector may also create barriers to entry, forcing new entrants to endorse riskier projects, resulting in a more heterogeneous pool of projects (in terms of quality) to be financed. Closely related to this question is the still unresolved debate on the effect of financial development and the potential systemic risk it generates on moral hazard.

In any case, the size of the financial sector can have either an increasing or a decreasing effect on output growth volatility depending on the hypothesis we are willing to support. A radical solution to this conundrum would be to drop the assumption that the moral hazard costs depend on how large the financial sector is. This does not seem to be a satisfying solution. Since we have no way to predict the resulting effect ex-ante, instead of trying to justify an arbitrary assumption, we now proceed to sign the effect using empirical evidence.

2 Financial Development, Growth Volatility and Financial Sector Quality: Empirical Evidence

The central contribution of our empirical analysis lies in exploiting the idea that macroeconomic growth volatility depends not only on the size of the financial sector, but that its shape may also be influenced by the sector's quality. We show that this theoretical and intuitive finding holds in real world data as well.

We start by explaining the nature of the data we collected and the variables used in the analysis in Section 2.1. Next, in Section 2.2, we proceed to explain the econometric methodology used in estimating the relation between growth volatility and financial depth. Finally, we present our empirical findings in Section 2.3.

2.1 Data and Methodology

To investigate the relationship between financial development and output growth volatility, we use the following baseline regression:

$$V_{i,t} = \alpha V_{i,t-1} + \gamma_1 FD_{i,t} + \gamma_2 FD_{i,t}^2 + \beta X_{i,t} + u_t + \mu_i + \varepsilon_{i,t}; \tag{11}$$

where $V_{i,t}$ is a measure of output growth volatility of country i at time t; $FD_{i,t}$ is a measure of financial depth of country i at time t; $X_{i,t}$ denotes a set of control variables; u_t denotes time fixed effects; μ_i represents country specific fixed effects and $\varepsilon_{i,t}$ is an idiosyncratic error term. As is now customary in the literature[12], our data for each country was transformed into five-year non-overlapping period averages. The final panel contains data from 1981 to 2010 (six five-year periods) for the 103 countries detailed in Table 1 on page 25. The source and description of the variables and controls used is presented in Table 2 on page 26. The used proxy for financial depth is private credit to GDP ratio. This proxy directly reflects the action of the financial sector in the economy and is close to the measure for financial depth used in the theoretical model in Section 1.2. However, we find that our final results are robust to using alternative

[12] See Acemoglu et al. (2003), Berkes et al. (2012) and Dabla-Norris and Srivisal (2013) for instances of this practice.

proxies.[13]

To steer clear of endogeneity-related issues we include several variables in our regression as controls. To account for the effects of economic size and macroeconomic policies, we include the beginning of period real GDP per capita, respectively the standard deviation of real exchange rates and inflation. Other included controls are the growth rate of GDP per capita and growth rate of GDP per capita, squared.[14] We also include structural variables to capture exposure to shocks such as financial openness, measured by foreign assets plus foreign liabilities relative to GDP as suggested by Kose et al. (2009).[15] Finally, the last added controls are the ratio of exports plus imports over GDP, which measures trade openness, and the Polity Index, which captures the type of a government's political regime. On a side note, reverse causality is unlikely to be an issue in this case: it indeed seems difficult to argue that growth volatility impacts financial development.

Table 4 presents macroeconomic aggregates for different levels of income in our sample. Three stylized facts on economic growth volatility can be observed from this table. First, as also found by Acemoglu and Zilibotti (1997), our data suggests that rich countries enjoy less volatility overall. Second, the countries in our sample do not exhibit absolute convergence, as poorer countries do not grow faster than richer ones. Finally, countries with higher income also have deeper financial markets.

To see whether the relationship is nuanced by financial sector quality, we divide our sample of countries into two subgroups: "countries with a high quality sector" and "countries with a low quality sector". For this distinction we use investment rating grades on sovereign debt published by Fitch ratings as a proxy. As our goal is not to explore how the evaluation of the financial sector health's and a country's rating correlate, we will refer to the extensive literature establishing the tight links between the two, e.g., Acharya et al. (2012) and Delaeter et al. (2011). Investment grade rat-

[13] Alternative proxies for financial depth are total banking assets to GDP, bank deposits to GDP and liquid liabilities to GDP. However, these measurements are highly correlated with private credit to GDP, as can be seen in Table 6. It is therefore no surprise that our results are robust to using these alternative proxies for financial depth.

[14] We expect the coefficient of the linear term to have negative sign, as recessions are usually associated with higher volatility. The inclusion of the quadratic term allows to control for the fact that high and positive GDP growth can also be associated with higher volatility.

[15] This measure of financial openness has the advantage of being less prone to measurement error in comparison to the gross flows.

ing corresponds to a rating equal to or above BBB-. Any country with a debt rating below BBB- is considered non-investment grade. Our identification strategy uses this grade as a cut-off point. By including real exchange rate growth volatility and inflation as covariates, we attempt to partial out the effects of macroeconomic policy so that a country's Fitch rating reflects the quality of its financial sector as accurately as possible. Table 3 on page 27 summarizes which countries stand on the boundary of the investment grade cut-off. It is important to note that data on Fitch ratings starts in 1994 and that many countries are rated by Fitch for a short period of time. Given that our panel data contains information from 1981 we exploit Fitch's data in two ways. First, we use observable Fitch credit ratings to make predictions about financial sector quality before between 1981 and 1994. Second, we consider the last three five-year period of our data (from 1996 to 2010). As will be shown, our results are robust to the employed method. Table 5 on page 28 presents the mean of several variables and splits up countries into two groups: those with an investment grade rating and those with a non-investment grade rating. It can be readily seen that there is a high correlation between having an investment grade rating and having a higher GDP per capita. During the 1996-2000 and 2001-2005 periods, the investment grade group enjoyed higher mean GDP per capita growth than countries with non-investment grade ratings, together with lower GDP per capita volatility on average. This is consistent with Ramey and Ramey (1995), who find a negative partial correlation between growth and volatility of growth. The picture is different for the 2006-2010 period (which includes the financial crisis), during which investment grade countries (mostly high income countries) were more adversely affected. These countries had higher mean GDP growth volatility and lower mean GDP growth during this period compared to non-investment grade countries. One can also notice a sharp decrease in the mean of private credit to GDP ratio for countries with non-investment ratings through time. However, this is likely to be mainly a consequence of an increase in the number of non-investment rating countries being rated as such.

2.2 Estimating the Financial Development – Growth Volatility Relation

Given that our specification includes a lagged dependent variable and country specific fixed effects, our regressions are estimated using a difference GMM approach. We use the two-step procedure from Arellano and Bond (1991) with the Windmeijer (2005) finite sample correction. To instrument the autoregressive term, we use the second and third level of the dependent variable. In every regression we present the second-order autocorrelation test, the Hansen test and an F-test statistic to check for potential weak instruments.

The results from our GMM regressions are presented in Tables 7 and 8, pages 29 and 30 respectively. While Table 7 includes all the covariates already discussed, Table 8 includes fewer covariates by dropping those with p-values greater than 0.1.[16] The advantage of dropping non-significant variables is to be able to use more observations, since our panel data is not (strongly) balanced due to some missing observations. We address six different specifications in each table; each specification of Table 7 is directly comparable to its counterpart in Table 8. In all the regressions, the second-order autocorrelation test accepts the null of no autocorrelation, the Hansen test of over-identifying restrictions accepts the null (suggesting that instruments are valid) and the first-stage F-statistic rejects the null of weak instruments.[17]

Our first specification includes all the available data (all years and countries). The estimates suggest an inverse U-shaped relationship between financial depth and per capita output growth volatility. Once insignificant covariates are dropped we observe that the level of private credit over GDP that maximizes GDP growth volatility comes out at approximately 190 percent of income. Moreover, we find a U-shaped relationship between output growth and output growth volatility and a negative relationship between initial GDP and output growth volatility. It is important to note that these results presented in the first column of Table 7 are directly comparable to those obtained

[16] The covariates dropped are not jointly significant either.

[17] The first-stage F-statistic of excluded instruments was computed using only the second lag of the dependent variable as an additional instrument (the exactly identified case) to show that the second lag is sufficient to reject the null of weak instruments (for all specifications the 10 percent maximal IV size critical value is 16.38).

by Dabla-Norris and Srivisal (2013). Where we find an inverse U-shape relationship between growth volatility and financial depth, Dabla-Norris and Srivisal (2013) find a linear negative relationship. Given that similar[18] time periods, countries and covariates were used, we believe it might be the GMM framework employed in their paper that causes different results. The main difference between the employed methodologies is that they use system GMM while we use difference GMM.[19]

The second specification only considers countries that have never received a non-investment rating by Fitch. Under the assumption that the quality of the financial sector has a high persistence[20], this specification allows us to estimate our regression for countries with a good quality financial sector for all years. As before, the results show an inverse U-shaped relationship between output volatility and financial depth. Moreover, once insignificant regressors are dropped, the measure of financial depth that maximizes output volatility stands at approximately 125 percent of GDP. Another observation for this group of countries is that volatility in real exchange rate depreciation is positively associated with output volatility, so that macroeconomic policy might have an influence on macroecononomic volatility.

Our third specification focuses on countries with a low quality financial sector. Here, we only consider countries that never received an investment grade (up to 2010) and countries that never were graded by Fitch (these countries usually are those with the poorest quality financial sectors). Surprisingly, we find no relationship between financial depth and macroeconomic volatility in this group of countries, suggesting that a qualitative financial sector is necessary for the inverse-U relationship between volatility and financial depth to hold.

Specifications 4 to 6 make no assumptions about financial sector quality in years prior to rating. Since the Fitch rating data is only available from 1994, and therefore less macroeconomic data can be used, the number of five-year periods is reduced. The

[18] Dabla-Norris and Srivisal (2013) divide their data into five-year periods from 1974 to 2008 and we divide ours into five-year periods from 1981-2011. The controls used in their papers are almost the same. The only differences are that we include GDP growth squared (which turns out to be significant in many specifications) and they include government balance over GDP (which is never significant in their regressions), which we do not use due to the unavailability of data. For comparison reasons, we asked the authors for their data but they did not provide it. Therefore, the difference in data used might be one of the reasons for the slightly different results.

[19] Since our instruments are not weak, difference GMM seems like a better methodology.

[20] This can be observed in the data, see also Table 3 page 27.

fourth specification only includes countries with high quality financial sectors. For this, we consider only countries that achieved an investment grade in each of the three five-year periods. Our results are robust and match those of the second specification. Once the non-significant covariates are dropped, we find that the level of private credit that maximizes output volatility is approximately 135 percent of output. Nevertheless, real exchange rate volatility no longer is statistically significant.

Figure 2 on page 19 plots the predicted level of GDP growth per capita volatility implied by the estimates of private credit over GDP obtained in the fourth specification from Table 8 and setting other covariates equal to zero. As one can see, the estimates suggest an inverse U-shaped relationship between the variables of interest. Moreover, the figure allows us to see that even though point estimates suggest that volatility is maximized when private credit equals 135 percent of GDP, the 95 percent confidence interval locates such a threshold between 103 percent and 147 percent of GDP.

The fifth and sixth specifications only take into account low quality financial sectors. While the fifth specification only considers countries which received non-investment grades in all three five-year periods, specification 6 also considers that countries without any grades have low quality financial sectors. Both specifications lead to the same result as specification 3, suggesting that there is no relationship between financial depth and macroeconomic volatility in countries with low quality financial sectors.

As a robustness check we exclude the 2008 financial crisis (the last five-year period in our dataset). The results remain unaffected. We also add an interaction term of financial depth with quality (binary variable constructed with Fitch ratings) and again our results still hold.

2.3 Empirical Findings

The effect of the financial sector size on macroeconomic volatility seems to hinge on the quality of the financial sector. Our results show that countries with a high quality financial sector have an inverse U-shaped relationship between financial sector size and GDP growth volatility, while countries with a poor quality financial sector do not exhibit any particular relationship. Thus, in countries with solid financial institutions, volatility in output growth increases as financial markets deepen up to a certain threshold, after

which volatility starts to decline. Our point estimates suggest such a threshold to be reached when private credit to GDP ratio is between 125 and 135 percent. Note that

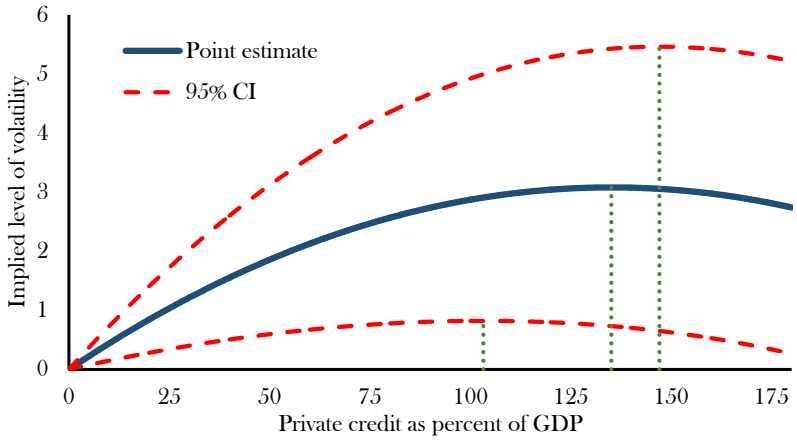

Figure 2: Financial Depth and GDP Growth Volatility

Note: For ease of interpretation, covariates other than private credit over GDP were set to zero.

evidence of an inverse U-shaped relationship between volatility and financial depth for the set of good quality countries is consistent with our theoretical findings. Indeed, the empirical results suggest that there may be an inverse-U relationship between moral hazard costs and the financial sector size.[21] The empirical findings are also consistent with the theoretical background offered by Acemoglu and Zilibotti (1997), who argue that there are two opposing channels through which an increasing financial sector affects growth volatility. On the one hand, deeper financial systems introduce greater diversification possibilities leading to lower risk and dampened fluctuations. On the other hand, in a country with a larger financial sector, agents take on more risky projects, and there is a facilitation of over-leverage — see Shleifer and Vishny (2009). Conversely, in countries with low financial sector quality we find no significant relationship between financial depth and macroeconomic volatility. This result suggests that papers that find no significant relationship between financial depth and macroeconomic volatility — namely Acemoglu et al. (2003) and Beck and Majnoni (2006) — could be explained by having relatively more low quality countries in their sample.

Finally, we stress that our results do *not* entail policy implications on how to reach a given level of economic development (as measured by GDP per capita) and determining

[21] In terms of the model in 1.2, this suggests that $\frac{\partial z_t}{\partial F_t} = g_F(F_t, Q_t)$ does not have a single sign, but is conditional on the financial sector size.

the appropriate size of the financial sector to support it. The relationship we find merely points out that financial development affects output growth volatility in a peculiar way. In particular, it exposes situations where the financial sector might be sub-optimally underdeveloped: the financial sector could be larger and potentially support output growth at the same (or even lower) level of macroeconomic volatility.

Conclusion

In this project we explored the effect of financial sector size and quality on output growth volatility, both from a theoretical and an empirical point of view. Our theoretical analysis builds on the model of Bacchetta and Caminal (2000). We use an alternative specification of moral hazard costs and make them depend on the size of the financial sector and its quality. Our hypothesis is that an increase in quality will reduce moral hazard costs while the effect of an increase in sector size is not possible to sign ex-ante. This motivated taking the model to the data with an aim to find evidence on the sign of these effects.

Our empirical findings suggest that in countries with high quality financial sectors there is a hump-shaped relationship between macroeconomic volatility and financial development. This result, which to our knowledge has not been documented before, is consistent with our theoretical model and the one proposed by Acemoglu and Zilibotti (1997). We find that for highly rated countries output volatility is maximized when private credit over GDP reaches between 125 and 135 percent of GDP. For countries with a bad financial sector the answer is not clear-cut, which suggests that the size of the financial sector might not be the key variable policymakers should consider to deal with output growth volatility.

Agents' preference for consumption smoothing in standard macroeconomic theory makes output growth volatility an undesirable outcome. In this context, it appears sub-optimal for countries to be to the left of the threshold that maximizes macroeconomic volatility. Indeed, it might be possible to achieve the same level of volatility, but with a larger financial sector that may fuel future economic development. Nevertheless, one must not forget the risk of having — paraphrasing Arcand, Berkes and Panizza — "too much finance". Individuals may value the level of consumption more than they dislike macroeconomic volatility. Arguing for an optimal level of financial development also requires us to thoroughly study the relationship between wealth and financial depth and consumer preferences over those — an endeavor that we leave for future lines of research.

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Appendix

Table 1: Alphabetical List of Countries

Albania	Denmark	Kazakhstan	Peru
Algeria	Dominican Republic	Kenya	Poland
Angola	Egypt	Korea, Rep.	Portugal
Argentina	El Salvador	Kyrgyz Republic	Russian Federation
Armenia	Equatorial Guinea	Lao PDR	Rwanda
Australia	Estonia	Latvia	Saudi Arabia
Austria	Ethiopia	Lesotho	Senegal
Bahrain	Finland	Libya	Singapore
Bangladesh	France	Madagascar	Slovak Republic
Benin	Gabon	Malawi	Slovenia
Botswana	Gambia, The	Malaysia	Solomon Islands
Brazil	Germany	Mali	South Africa
Burkina Faso	Ghana	Mauritius	Spain
Burundi	Greece	Mexico	Switzerland
Cambodia	Guatemala	Morocco	Tanzania
Cameroon	Guinea-Bissau	Mozambique	Thailand
Canada	Haiti	Nepal	Togo
Cape Verde	Honduras	Netherlands	Tunisia
Chad	Hungary	New Zealand	Turkey
China	India	Niger	Uganda
Colombia	Indonesia	Nigeria	United Kingdom
Congo, Rep.	Iran, Islamic Rep.	Norway	United States
Cote d'Ivoire	Ireland	Oman	Uruguay
Croatia	Israel	Pakistan	Zambia
Cyprus	Italy	Papua New Guinea	Philippines
Czech Republic	Japan	Paraguay	

Table 2: List of Variables

Variables	Description	Source
GDP volatility	Standard deviation of per capita real GDP growth	IMF, WEO April 2014
GDP growth	Annual percentage growth of per capita real GDP	IMF, WEO April 2014
Log initial real GDP per capita	Natural log of real GDP per capita at the beginning of each period	IMF, WEO April 2014
Trade Openness	Sum of exports and imports of goods and services (% of GDP)	WB, World Development Indicators
Financial Openness	Foreign assets plus foreign liabilities (% of GDP)	External Wealth of Nations Mark II database
Polity Index	Index ranging from -10 (autocratic regimes) to +10 (democratic regimes).	POLITY IV
Inflation	Annual percentage growth of consumer price index	IMF, WEO April 2014
Volatility of Real Exchange Rate	Standard deviation of Real Exchange Rate	Calculated
Private credit	Private credit by deposit money banks and other financial institutions (% of GDP)	WB, Global Financial Development Database

Table 3: Countries Standing on the BBB- Grade Boundary

	BB+ Rated Countries	BBB- Rated Countries
2001	Colombia, Croatia, El Salvador, India, Mexico, Philippines and Slovak Republic	Bahrain, Croatia, Egypt, South Africa, Thailand, Tunisia and Uruguay
2002	Egypt, El Salvador, Kazakhstan, Philippines, Slovak Republic and Uruguay	Croatia, Egypt, Mexico, Slovak Republic, South Africa, Thailand and Uruguay
2003	Egypt, El Salvador, Kazakhstan, Philippines and Russian Federation	Croatia, Mexico, Slovak Republic, South Africa and Thailand
2004	Egypt, El Salvador, India, Kazakhstan and Russian Federation	Croatia, Kazakhstan, Mexico and Russian Federation
2005	Egypt, El Salvador and India	Croatia, Kazakhstan, Mexico and Russian Federation
2006	Egypt, El Salvador, Guatemala, India and Peru	Croatia and India
2007	Brazil, Colombia, Egypt, El Salvador, Guatemala and Peru	Croatia, India and Morocco
2008	Brazil, Colombia, Egypt, El Salvador, Guatemala and Peru	Brazil, Croatia, India, Kazakhstan, Latvia, Morocco and Peru
2009	Colombia, Egypt, El Salvador, Guatemala, Latvia and Turkey	Brazil, Croatia, India, Kazakhstan, Latvia, Morocco and Peru
2010	Colombia, Egypt, Guatemala, Indonesia, Latvia and Turkey	Brazil, Croatia, Greece, Hungary, India, Kazakhstan, Morocco and Peru

Table 4: Means of relevant variables between 1981 and 2010 by quartile of GDP per capita PPP in 1981

Quartiles	Std Dev of GDP Growth (%)	Annual GDP/cap growth (%)	Private credit/GDP (%)	Obs.
First	4.25208	1.69302	17.50916	23
Second	4.73646	1.15749	23.46528	22
Third	4.09753	1.86650	48.30134	23
Fourth	2.95674	1.28571	86.29365	23

Note: Countries excluded because of missing GDP per capita PPP data in 1981: Armenia, Cambodia, Croatia, Czech Republic, Equatorial Guinea, Estonia, Kazakhstan, Kyrgyz Republic, Latvia, Russian Federation, Slovak Republic and Slovenia.

Table 5: Descriptive Statistics: Investment Grade v. Non-Investment Grade

	Average of variables	1996-00	2001-05	2006-10
Investment grade	GDP/cap. growth volatility (%)	1.63	1.32	4.13
	GDP/cap. growth (%)	3.43	2.84	1.45
	GDP/cap. PPP ($)	18,944	22,629	26,194
	Private Credit/GDP (%)	75.88	94.98	105.7
	Number of countries (obs.)	32	37	43
Non-investment grade	GDP/cap. growth volatility (%)	4.05	2.66	2.8
	GDP/cap. growth (%)	1.65	2.59	3.48
	GDP/cap. PPP ($)	6,356	4,975	5,467
	Private Credit/GDP (%)	41.65	21.59	22.45
	Number of countries (obs.)	18	28	31

Table 6: Pooled Correlation for 103 Countries Between 1981 and 2010

	Private Credit	Assets	Deposits	Liquid Liabilities
Private Credit	1			
Assets	0.937	1		
	(2693)			
Deposits	0.883	0.919	1	
	(2671)	(2681)		
Liquid Liabilities	0.878	0.917	0.962	1
	(2656)	(2664)	(2642)	

Note: All aggregates are relative to GDP size.
Number of observations in parentheses.

Table 7: Regression Analysis Summary — All Variables

	(1)	(2)	(3)	(4)	(5)	(6)
Private credit	0.0505***	0.0468**	0.0432	0.0274	0.0261	0.0318
	(0.0160)	(0.0230)	(0.0629)	(0.0207)	(0.0600)	(0.0367)
Private credit squared	−0.0001*	−0.0002**	0.0001	−0.0001*	0.0003	0.0003
	(0.0001)	(0.0001)	(0.0010)	(0.0001)	(0.0003)	(0.0002)
L.GDP volatility	0.1012	0.0591	0.1506***	−0.1238	0.2522	0.2127**
	(0.0904)	(0.1883)	(0.0531)	(0.1416)	(0.2719)	(0.1021)
GDP growth	−0.5532***	−0.6401***	−0.3468*	−0.9065***	−0.2827	−0.5444***
	(0.1556)	(0.1777)	(0.1863)	(0.2225)	(0.3418)	(0.1656)
GDP growth squared	0.0295***	0.0121	0.0255***	0.0294	−0.0264	0.0275***
	(0.0036)	(0.0239)	(0.0045)	(0.0296)	(0.0468)	(0.0042)
(log) Initial per capita GDP (PPP)	−1.0630	−0.7424	−0.8292	0.4389	−0.2202	−1.1684
	(0.8623)	(1.2831)	(0.7954)	(0.8207)	(1.6083)	(1.0292)
Trade openness	−0.0042	0.0068	−0.0078	0.0185	−0.0436	0.0162
	(0.0138)	(0.0130)	(0.0197)	(0.0205)	(0.0310)	(0.0207)
Financial openness	−0.0004	−0.0004	−0.0003	−0.0006	0.0202	−0.0004*
	(0.0004)	(0.0016)	(0.0004)	(0.0016)	(0.0155)	(0.0002)
Polity index	−0.0077	0.1193	0.0062	0.1413	−0.1219	−0.0268
	(0.0431)	(0.1184)	(0.0480)	(0.1440)	(0.1065)	(0.0763)
Inflation	0.0002	0.0415	0.0010	0.0512	0.0004	−0.0008
	(0.0010)	(0.0765)	(0.0010)	(0.0838)	(0.0015)	(0.0016)
Real exchange rate volatility	0.0065	0.1440***	0.0084	0.0866	0.0521	0.0084
	(0.0273)	(0.0378)	(0.0261)	(0.0784)	(0.0640)	(0.0246)
Observations	350	102	212	86	71	179
Number of countries	103	34	58	45	37	67
Number of time periods	4	4	4	3	3	3
Private credit threshold	225.91	131.23				
AR2-test p-value	0.34	0.55	0.34	0.40	0.63	0.43
Hansen-test p-value	0.92	0.69	0.92	0.26	0.36	0.92
First-stage F-statistic	141.64	25.30	127.81	63.75	20.65	95.68

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Regression Analysis Summary — Restricted Set of Variables

	(1)	(2)	(3)	(4)	(5)	(6)
Private Credit	0.0570***	0.0394**	0.0510	0.0456***	0.0109	0.0232
	(0.0139)	(0.0193)	(0.0557)	(0.0150)	(0.0531)	(0.0374)
Private Credit squared	−0.0002***	−0.0002**	−0.0001	−0.0002***	0.0004	0.0003
	(0.0001)	(0.0001)	(0.0008)	(0.0001)	(0.0004)	(0.0002)
L.GDP Volatility	0.1239	0.0931	0.1800***	−0.0981	0.5835	0.2475*
	(0.0846)	(0.1286)	(0.0523)	(0.0666)	(0.4873)	(0.1387)
GDP Growth	−0.5645***	−0.7008***	−0.3712**	−0.6779***	−0.3748	−0.5902***
	(0.1330)	(0.1727)	(0.1584)	(0.1558)	(0.4675)	(0.1487)
GDP Growth squared	0.0293***	0.0195	0.0255***	0.0137	−0.0285	0.0300***
	(0.0034)	(0.0211)	(0.0039)	(0.0215)	(0.0512)	(0.0033)
(log) Initial per Capita GDP (PPP)	−1.4619*					
	(0.8305)					
Real Exchange Rate Volatility		0.1518***				
		(0.0351)				
Observations	374	102	215	107	72	180
Number of countries	103	34	58	45	37	67
Number of time periods	4	4	4	3	3	3
Private credit threshold	189.53	124.78		135.11		
AR2-test p-value	0.33	0.53	0.41	0.98	0.42	0.46
Hansen-test p-value	0.94	0.66	0.95	0.58	0.58	0.90
First-stage F-statistic	145.19	29.18	51.91	147.28	30.72	39.28

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$