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Journal of Macroeconomics 24 (2002) 233–253

Journal of MACROECONOMICS

www.elsevier.com/locate/econbase

The impact of financial system development on business cycles volatility: cross-country evidence

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Received 21 September 2000; accepted 2 May 2001

Abstract

This paper reveals cross-country evidence on how the development of the financial system affects business cycle's volatility. The link between credit markets and economic activity has been the focus of extensive literature, but no cross-country empirical study relating the volatility of economic fluctuations with the development of the financial system has yet been performed. More developed financial systems should imply a reduced impact of asymmetric information problems, as financial institutions become more capable of identifying projects with higher probability of failure. Using a generalized method of moments technique on cross-section set, this paper shows that countries with more developed financial systems have smoother economic fluctuations.

JEL classification: E32; E44; G15

The existing literature on credit markets has shown how the features of the financial system work to amplify and propagate fluctuations in economic activity. Nevertheless, empirical studies on the development of the financial system have essentially focused on its impact on savings, investment and growth (see, for example, King and Levine (1993), Fry (1995), Levine (1997) and Neusser and Kugler (1998)). This paper provides cross-country evidence that more developed financial systems have less

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0164-0704/02/$ - see front matter
PII: S0164-0704(02)00021-6

volatile economic fluctuations. Developed financial systems are more capable of screening potential borrowers, which should reduce the likelihood that projects with greater probability of failure are externally financed. Thus, smoother business cycles should be associated with financial systems characterized by reduced credit markets imperfections.

Consider, for example, the aftermath of a business cycle downturn; firms tend to behave extremely carefully, as the memory of the previous "crash" affect their expectations regarding the future state of the economy. The financial structures are then characterized as "sound" and the economy is stabilized. As this stable environment allows profits to start rising, expectations are revised, and firms start taking riskier positions. Firms' leverage increases, but some of these firms may become more exposed than others; financial structures become weak, if the growth in debt commitments of the more exposed firms becomes greater than the increase in their profits. Banks may eventually start refusing the refinancing of loans, leading the more exposed firms to face increasing difficulties and to even go bankrupt. The economy moves again toward the downturn of the business cycle, with the surviving firms revising their expectations and, again, most firms undertaking less risky behavior. Business cycles arise endogenously from the firms' heterogeneous behavior regarding risk, debt financing and investment (see Minsky (1986), Rajan (1994) and Suarez and Sussman (1997)).

The importance of the financial sector is evident in this context. Developed financial systems tend to be more efficient in identifying those firms that wrongly overstate the extent of the boom, and are able to refuse extending credit to them to start with. The role of the financial system is essential because, in the end, the behavior of those firms is constrained by the banks' willingness to back them up with credit allowances, rescheduling, etc. Business cycles will be smoother the more financial institutions effectively use the available information about potential borrowers and market tendencies.

The "balance sheet" view of the credit channel provides an alternative explanation for the link between the fluctuations in economic activity and the financial system development, which yields similar empirical implications (see, among others, Bernanke and Gertler (1995), Hubbard (1997) and Bernanke et al. (1998)). Although the "balance sheet" approach requires either a nominal or a real shock for business cycles to occur, the existence of a "financial accelerator" amplifies these shocks to economic activity. According to this view, a shock to monetary policy affects the size of the external finance premium by worsening agency problems. A contractionary monetary policy weakens the balance sheet position of firms: as interest rates rise in response to a tight monetary policy, the interest payments on the firms' debt increase, which reduces their cash flows. Asset prices also fall, decreasing the value of the firms' collateral. In addition, consumers' spending reduces as interest rates rise, reducing firms' revenues. Thus, while revenues are falling, the costs remain relatively fixed, reducing firms' net worth and creditworthiness. The fall in net worth increases agency costs by worsening the potential conflict of interest between borrowers and lenders. Consequently, the external financing premium amplifies the shocks to economic activity by magnifying the fluctuations in borrowing, spending and investment.

According to the balance sheet view, not only the size of the nominal shock affects the volatility of business cycles, but also the degree of credit market imperfections. In countries with more developed banking systems, banks are better able to gather and process information about debtors, which implies reduced agency and verification costs, or reduced credit markets imperfections. Since credit market imperfections work to amplify the shocks to the economy, reducing the extent of these imperfections should reduce the volatility of the cycles.

Thus, regardless of whether business cycles arise endogenously or as a result of an exogenous shock, fluctuations in economic activity are expected to be smoother the more efficient financial institutions are in screening potential borrowers and monitoring their performance. This paper shows that, after controlling for other factors that may affect the fluctuations in economic activity, countries with more developed financial systems exhibit less volatile business cycles. [2]

Estimating the degree to which credit market imperfections amplify the fluctuations in economic activity is important because volatile business cycles have often been linked to substantial welfare losses. Business cycles volatility has been associated with lower growth rates in output and in investment (Barro, 1991; Ramey and Ramey, 1994). Moreover, the impact of cycles' volatility is considered to be even worse in the presence of imperfect information, leading to substantial decreases in employment and output (see Aizenman (1997) and Aizenman and Powell (1997)).

This paper differs from the existing empirical literature on business cycles in two ways. First, cross-country evidence on the determinants of business cycles has not focused on the impact of the development of the financial system (see, among others, Backus et al. (1992) and Karras and Song (1996)). Second, time series studies on business cycles either have focused on how the length of the cycle has changed over time [3] (see Watson (1994) for a literature survey) or have ignored the link between cycle volatility and financial development (see Ramey and Ramey (1994) and Basu and Taylor (1999)).

Section 1 of this paper describes the data used. Section 2 briefly explains the detrending method applied, while Section 3 analyzes the results of these tests. Section 4 concludes.

[2] There could be situations in which financial development actually increases business cycles volatility. If markets become more competitive as the financial system develops, for instance, then banks may tend to behave more aggressively in order to keep its market share and may lax their credit standards (see, for example Friedman (1993) and Weinberg (1995)). Since the results found in this study largely support the idea that business cycles volatility falls with financial system development, it is likely that the effect of reduced asymmetric information outweighs any increased volatility that would occur due to greater competition among banks.

[3] The development of the financial system does not necessarily affect the length of the business cycle. For instance, in the presence of uncertainty and investment irreversibility, recessions are expected to last longer than booms: firms would be more reluctant to believe the economy is in the upturn of the business cycle and to start investing. For this reason, this paper focuses on the cross-country volatility of the cycles, not on their length.

1. Data

The data set includes forty countries' time-series data for the period ranging from 1960 to 1997. [4] Unless otherwise stated, country specific information was obtained from several editions of the International Financial Statistics Yearbook (IFS) and from the OECD Statistical Compendium (1998). Where data inconsistency was found among different editions of the IFS, the data was spliced, retaining the values of the most recent edition (2000).

1.1. Indicators of the financial system development

The concept of "financial system development" adopted here refers to the efficiency of financial institutions in processing information, monitoring and managing risk. Nevertheless, it is virtually impossible to accurately measure how the financial markets' ability to overcome asymmetric information problems changes over time. Thus, the indicators used in this study constitute only proxies for financial development. They measure the size of the financial sector, the importance of specific financial institutions and how credit is allocated to the private sector (see King and Levine (1993) and Neusser and Kugler (1998)).

The first variable used proxies for the size of the formal financial intermediary sector (see McKinnon (1973)). It is calculated as the ratio of a country's liquid liabilities to its GDP (henceforth referred to as LLY). As stated above, this variable does not fully reflect the efficiency of the services provided by the financial sector, such as risk management, monitoring and information processing. However, in the present context, it is more likely that larger financial systems are more efficient in performing these tasks than smaller ones. The size of the financial sector is represented by the median value of LLY over three decades, and if more resources are directed to the financial sector in one country than in another country, then this sector is expected to be more profitable (and, thereby, more efficient) in the first country than in the latter.

King and Levine (1993) have suggested the use of three additional indicators: one that reflects the importance of deposit money banks and two that measure how credit is allocated to the private sector relative to the public sector. The variable BANK is the ratio of the assets of deposit money banks to the total assets of the financial system (the total assets equal to the sum of the assets of deposit money banks and the domestic assets of the central bank). Those authors argue that commercial banks are more likely to provide the type of financial service highlighted in theoretical models: risk management, acquisition and use of information about investment, allocation of resources, monitoring of managers and savings mobilization.

There are two problems with this measure, however. First, as pointed out by King and Levine (1993), deposit money banks are not the only financial institutions that

[4] See Appendix A for a list of all variables used and Appendix B for the macroeconomic volatility and the financial system development indicators of each country.

provide the kind of service emphasized by the theoretical models. Second, there is no reason to believe a priori that central banks would not be able to provide those services efficiently (the authors simply assume that this is the case). This variable is included in the tests implemented here to allow comparisons with existing studies, but careful interpretation of its effect is important.

The variables PRIVATE and PRIVY, in turn, reflect how much credit is allocated to the private sector. King and Levine (1993) maintain that financial systems that provide credit mostly to government-owned enterprises are not likely to evaluate credit as efficiently as those systems that allocate credit to the private sector.

PRIVATE is the ratio of the claims to the non-financial private sector divided by the total domestic credit (excluding credit to domestic money banks), while PRIVY is the ratio of the claims to the non-financial private sector divided by the GDP. The same criticism stated above applies here. One cannot assume that financial systems that channel credit to state-owned enterprises are less developed. Lending to public enterprises may be optimal for banks, especially if there is some implicit guarantee that the government will honor those debts in any event. Again, these variables are only included to allow comparison with the empirical literature on the development of the financial system. A negative link between these variables and business cycles volatility implies that the prevalence of private credit yields reduced economic activity volatility.

Finally, an alternative measure of financial depth is used: the growth rate of the financial sector real GDP (DEPTH). This indicator attempts to take into account not only the activities of money banks, but also the activities of other financial institutions (excluding the central bank). Note that LLY and DEPTH are considered to be better proxies for the development of the financial system, while the other variables mostly provide evidence on which kind of financial structure yields less volatility.

In addition to the financial development indicators described above, dummy variables for each country's financial system type are also included in the tests. [5] Authors have pointed out that some countries' financial systems rely more on "universal banks" (German model of financial intermediation or bank-based finance), while in other countries stock markets and banks with limited functions have a more prominent role (see, for example, Hellwig (1991) and Black and Moersch (1998)).

It is not clear, however, which kind of financial system type is associated with reduced moral hazard and adverse selection problems. "Universal banks" entail greater economies of scope, as they deal with different types of financial instruments. Bank-based finance also involves economies of scale associated with monitoring. In addition, "Universal banks" facilitate long-term lending, since they often hold shares in the companies they lend to. However, banks' ownership positions often lead to poor

[5] The dummies assigned to each country relied on the study of Black and Moersch (1998). Since these authors classified only OECD countries, the dummies for the other countries used in the tests performed here were derived based on institutional differences among countries and on the data about market capitalization and bank credit obtained from Levine and Zervos (1996), which use a sample period similar to Black and Moersch (1998).

corporate control. Incentive problems may arise when banks exert ownership control over firms, preventing outsiders from removing inefficient management (see Black and Moersch (1998)).

Market-based finance, on the other hand, encourages better supervision of management (active stock markets stimulate great dispersion of information about firms than in countries dominated by bank-based finance). This study includes dummy variables for countries relying on bank-based finance (BNKBASED) and for those relying on market-based finance (MKTBASED). Most countries, however, have been classified as "other", since the features of their financial systems are not clearly associated with only bank-based or market-based finance. [6]

1.2. Instrumental variables

A set of instrumental variables is used to control for the possibility that both the level of financial system development and the degree of business cycles volatility are being caused by a third variable, such as economic growth or better policy management by the government. As in Levine (1997), these instrumental variables are related to the legal origin of each country and were obtained from La Porta et al. (1998). Information related to the legal origin of a country can be considered exogenous because most countries had their legal system set either by imposition (through colonization), by direct or subtler imitation. A legal system that enforces contracts and protects creditors' rights should yield a more developed financial system.

Two variables related to each country's legal system are then used as instruments for the indicators of financial system development: one representing the degree of creditors rights' protection and another representing each countries' tradition for law and order.

The "creditor rights" variable is an index aggregating information of four other variables. CREDITOR is the sum of the following dummy variables:

- Reorganization: this variable indicates whether creditors are able to restrict reorganization procedures (it takes the value of one if such restriction exists, and zero otherwise).
- Automatic stay: it takes the value of one if the reorganization procedure does not prevent creditors from repossessing the loan collateral, and zero otherwise.
- Secured creditors: this dummy variable equals one if secured creditors have priority in the distribution of the remaining resources of a bankrupt firm, and zero if non-secured creditors (such as the government or employees) are prioritized.

[6] The analysis of the test results will focus on the regressions run without these dummy variables for two reasons. First, the decision to classify a system as of German type, Anglo-American type or "other" is not clear-cut, and, in most countries, empirical evidence suggests that bank and stock market development occur concurrently (thus, the variable DEPTH would be more informative than these dummy variables). Second, some countries have been gradually moving towards some intermediate hybrid system, which combines features of both German and Anglo-American financial systems.

- Management: this variable takes the value of one if the management of a debtor company is substituted during the reorganization process by an official appointed by the creditors or by courts, and zero otherwise.

The greater the value of this index, the more protected creditor rights are by the legal system.

The existence of laws does not necessarily imply that enforcement exists. Thus, the other instrumental variable used accounts for each country's tradition of law and order. The RULELAW variable ranges from one to ten, with the lower scores implying less tradition of law and order.

1.3. Control variables

In addition to the instrumental variables, and in order to measure the relative importance of the development of the financial system in reducing business cycles volatility, other variables usually considered to be determinants of the economic activity volatility are also included in the regressions.

The volatility of the Solow residual (σ_{SOL}) is often used in empirical studies on business cycles to proxy for the technological shocks Real Business Cycles theories suggest as the main determinant of business cycles volatility. As in Backus et al. (1992) and Karras and Song (1996), the residual is defined as the change in the log of real GDP minus $(1-\alpha)$ times the change in the log of employment, where α is the capital share of output. [7]

Four variables control for the effects of macroeconomic policies. The "fiscal policy" variable aims at testing whether fiscal policy has any stabilizing effect: GOV is calculated as the ratio of government consumption expenditure to GDP. Regarding the stance of monetary policy, three alternative indicators are used: the average inflation rate of each country during the relevant period (MPI), the "money supply volatility" (σ_{M1}), and the degree of central bank independence (CBI). [8]

International trade and exchange rate policies are also often linked to the volatility of economic fluctuations. Thus, this study includes an indicator for each country's openness and degree of exchange rate flexibility. OPENNESS is measured as the ratio of total trade to GDP (total trade equals the sum of exports and imports). Note that the impact of this variable is theoretically ambiguous: while an economy

[7] α is set equal to 0.36, as suggested by those authors. There are problems with this approach to calculate the Solow residual. First, it assumes that all countries have a Cobb-Douglas production function with constant returns to scale and with the same labor share, which is very unlikely. A second, but minor problem is that it does not take into account α times the change in capital stock (see Backus et al. (1992) for their explanation). Nevertheless, the lack of data renders alternative approaches unfeasible for the moment.

[8] Some authors have argued that greater central bank independence should yield reduced business cycles volatility (see, among others, Rogoff and Sibert (1988) and Alesina and Summers (1993)). The data on this variable was obtained from Cukierman (1992) and Cukierman and Lippi (1999).

with less trade barriers may be more exposed to shocks from abroad, they may also be able to smoothly adjust to domestic shocks by "exporting" them. EXCFLEX, in turn, is calculated as the absolute value of the change in the exchange rate, which is defined as SDRs per unit of national currency. The expected impact of exchange rate flexibility on business cycles volatility is also ambiguous; depending on whether the shock has a fiscal or monetary origin, a fixed or flexible exchange rate will lead to greater or lower output volatility.

Finally, a measure of long-term growth is also added. LTGROW is estimated as the growth rate in the trend component of the log of real GDP per capita. This measure is included as suggested by Ramey and Ramey (1994), who found a strong negative link between output volatility and long-term output growth.

The tests are run using the volatility of output, investment and consumption as dependent variables. The behavior of investment volatility is of particular interest since, as explained above, both the balance sheet channel view and the endogenous view establish a direct link between the volatility of economic fluctuations and financial system development by emphasizing the investment activity of firms.

Although the focus of the present study is on output and investment volatility, consumption volatility may be affected by the development of the financial system. Since consumers also externally finance their purchases, improved credit screening provided by developed financial systems should also reduce consumption volatility by smoothing the lending cycles.

2. Detrending the time series

The business cycle component of the output, investment, consumption, Solow residual, M1 and output per capita time series need to be estimated before running the econometric tests. This paper uses a Band-Pass filter (BP filter) to isolate the business cycle component of these time series.

Linear detrending was the methodology applied by the early empirical research to separate the different components of the business cycles. Since this approach has proven to create spurious cycles when dealing with series that are not "trend stationary", alternative methodologies have been suggested, such as first differencing and moving average filters. The use of first differencing is also often criticized because it alters the timing relationship between the variables, and it puts a greater weight on very short run fluctuations.

The HP filter was widely used in business cycles research during the 1980s and early 1990s. Even though this filter improves on the first differencing methodology, it still weights heavily toward high-frequency fluctuations. Moreover, when using this filter, the cyclical component of the data exhibits unusual behavior near the end of the sample.

More recent research on business cycles has turned to the use of BP filters (see, for example, Stock and Watson (1998), Hornstein (1998) and Basu and Taylor (1999)). These filters are moving-averages designed such that the researcher can determine ex ante the periodicities of the business cycles: BP filters eliminate the components of

the data with frequencies out of a pre-specified range. The BP filter used addresses important aspects when designing an optimal filter (see Baxter and King (1999)). [9] First, it removes unit roots, rendering the time-series stationary; second, it does not alter the timing relation of the variables; third, it isolates the business cycle frequencies without re-weighting components; fourth, it constitutes an optimal approximation to the ideal band-pass filter; [10] finally, it generates business cycles components that are independent of the length of the sample period.

According to Baxter and King (1999), the BP filter is specially indicated when dealing with annual data: although the performance of the HP filter is very similar to that of the BP filter in tests involving quarterly data, the HP filter has a very poor performance when dealing with annual data.

Stock and Watson's (1998) analysis of NBER's business cycles chronology have shown that the shortest cycle in the United States has been six quarters and the longest has been 39 quarters (90% of the cycles identified by the NBER chronology fall in such range). The standard approach is then to set the filter such that for annual data, which is the case of this research, a business cycle is no shorter that two years and no longer than eight years.

3. Tests results

A generalized method of moments (GMM) technique is used in the tests conducted here for two reasons. First, the GMM is more efficient than two-stage-least squares in the presence of heteroscedasticity, which is very common in cross-section data. Second, the GMM allows testing for the validity of the instrument variables. [11]

The first step when running the cross-section regressions is to calculate the median of the time series variables for each country over the 1960–1997 period. Note that for the detrended variables (output, investment, consumption, M1 and the Solow residual), the standard deviation of the business cycle component of these series is used instead of the median, since one is concerned with the volatility of these variables, not their level.

The estimated equations have the following format:

$$\sigma_{\mathrm{m}} = \beta_1 + \beta_2 \mathrm{FDEV} + \beta_3 \sigma_{\mathrm{SOL}} + \beta_4 \mathrm{MPOL} + \beta_5 \mathrm{GOV} + \beta_6 \mathrm{OPENNESS} + \beta_7 \mathrm{EXCFLEX} + \beta_8 \mathrm{LTGROW} + \epsilon,$$

[9] The Gauss programs necessary to run the filter were obtained from M. Watson's Homepage at www.wws.princeton.edu:80/~mwatson/ddisk/hom.zip.

[10] The ideal filter is a moving average with infinite order. The approximation uses a quadratic loss function for discrepancies between the exact and the approximate filter.

[11] The kernel option used was "Bartlett", the bandwidth selection was based on the Andrews Method and the iteration and convergence criteria used were the default options of E-Views.

where σ_m equals the standard deviation of the business cycle component of the output, investment or consumption series; FDEV equals BANK, DEPTH, LLY, PRIVATE or PRIVY; [12] and MPOL equals MPI, σ_{M1} or CBI.

The instrumental variables used are CREDITOR, RULELAW and all the control variables. This implies the assumption that, except for the financial system development indicators, all the control variables are exogenous. Consequently, the tests results should be interpreted as to whether changes in the level of the exogenous component of each indicator of financial system development explain the changes in the level of the dependent variable volatility.

The analysis of the cross-section results focuses on the regressions including average inflation as the indicator of monetary policy. [13] Two reasons motivated this choice. First, the results remain unchanged regardless of which proxy for the stance of monetary policy is included (both the financial development indicators signs and significance levels remain largely unaltered). Second, regarding the CBI indicator, there have been disagreements on whether Central Banks' policies can actually be independent and how to measure this independence (see, for instance, Posen (1995) and Forder (1998)). This issue becomes a more serious problem when dealing with such a heterogeneous sample of countries, like in the present study.

Three main results emerge from the cross-section regressions. First, countries with more developed financial system tend to have less volatile fluctuations in economic activity. Second, the volatility of the Solow residual is consistently positively related to business cycles volatility and, with some exceptions, the coefficient on this variable is statistically significant at least at the 5% confidence level. Third, in all cross-section and panel data regressions, the instruments chosen are considered informative.

3.1. Output volatility results

All indicators of financial development are negatively related to output volatility (see Table 1). The coefficients of PRIVY and DEPTH are statistically significant at the 5% level of confidence, while the coefficients of BANK, LLY and PRIVATE are significant at the 10% level. The size of the coefficients is also economically relevant. Take, for example, the case of Germany, whose output volatility equaled to 0.017—the sample median—during the 1960–1997 period. Holding the other factors constant, a 10% increase in the ratio of the country's liquid liabilities relative to GDP (LLY) would reduce the output volatility by approximately 6.8%. If BANK were 10% greater, output volatility would decrease by 20%, while if PRIVATE or PRIVY would increase 10%, output volatility would reduce by 15.9% or 6.7%, respectively. Finally, if the size of the financial system GDP (DEPTH) were to increase by 10%, output volatility would fall by 2.7%.

[12] The financial development indicators are used one at a time for two reasons. First, the lack of additional instrument variables unable the inclusion of all indicators in the regressions at once. Second, these financial variables are correlated with one another (thus, including all variables at once is redundant).

[13] The regression results including the other indicators of monetary policy are available upon request.

Table 1
Dependent variable: volatility of output

	FDEV = BANK	FDEV = LLY	FDEV = PRIVATE	FDEV = PRIVY	FDEV = DEPTH
Constant	0.029* (1.826)	0.010 (1.612)	0.027 (1.733)	0.007 (1.669)	−0.012* (−2.109)
FDEV	−0.036* (−1.864)	−0.021* (−1.874)	−0.034* (−1.783)	−0.015** (−2.253)	−0.086** (−2.546)
MPI	0.00002 (0.537)	−0.00001 (−0.405)	−0.00001 (−0.501)	−0.00001 (−0.359)	0.001 (1.599)
GOV	0.019 (1.669)	0.009 (0.904)	−0.013 (−0.837)	0.004 (0.569)	0.028*** (10.134)
S_{SOL}	1.300***	1.294***	1.182***	1.323***	1.389***
	(4.161)	(6.744)	(7.162)	(7.622)	(7.040)
OPENNESS	0.007	0.004	0.010	0.003	−0.012***
	(1.335)	(0.905)	(1.486)	(0.731)	(−6.381)
EXCFLEX	−0.042	−0.011	0.007	−0.006	−0.287**
	(−1.161)	(−0.865)	(0.632)	(−0.596)	(−2.960)
LTGROW	−0.086	−0.016	−0.013	−0.047	0.415***
	(−0.904)	(−0.176)	(−0.151)	(−0.571)	(11.050)
#Observations	40	40	40	40	13
J-statistic	0.00003	0.002	0.001	0.002	0.0002
$n \times J$-statistic	0.001	0.080	0.058	0.084	0.003
$c^2_{05}(1)$	3.841	3.841	3.841	3.841	3.841

Note: FDEV = financial development indicator.
Numbers reported in parenthesis are the *t*-statistics.
*, ** and *** denote significancy levels of 10%, 5% and 1%.
Weighting matrix: white covariance (the GMM estimates are robust to heteroskedasticity of unknown form).
Instruments: CREDITOR, RULELAW and all regressors except the financial development indicator.

Overall, openness is positively related to output volatility, a result consistent with Karras and Song (1996). Long-term growth, in turn, seems to reduce the fluctuations in output, an outcome also found by Ramey and Ramey (1994). Average inflation, exchange rate volatility and fiscal policy do not have a consistent pattern across the output regressions. None of these variables, however, are statistically significant. Thus, although the signs of the coefficients are largely in line with previous studies, the significance levels of these controls variables fall when including the indicators of financial development in the regressions.

Note that in the DEPTH regression, except for the monetary policy indicator, all other control variables are statistically significant, and the coefficient signs are not consistent with those in the other regressions. The results of the DEPTH regressions should be taken carefully, however, since the data on this variable was available for only thirteen countries. [14] Henceforth, the analysis of the control variables will not consider the DEPTH regressions.

The volatility of the Solow residual is consistently positively related to output volatility and statistically significant at the 1% confidence level. The residual is also economically significant: holding other factors constant, a 10% increase in the volatility of the residual would lead output volatility in Germany to increase by at least 13.2% and at most 15.5%. This empirical relevance of the Solow residual does not necessarily constitute supporting evidence for the Real Business Cycles theory, however. As explained above, the calculation of the Solow residual relies on strong assumptions regarding the type of production function and its parameters. Moreover, the residual may be capturing not only technology shocks, but also other determinants of productivity, such as quality of human capital, on-the-job training and vintage effects (see, for example, Hall (1989) and Hall and Jones (1998)).

When including the dummy variables for the type of financial system, the results remain largely unchanged (see Table 2). All financial development indicators remain negatively related to output volatility. LLY, PRIVY and DEPTH are still statistically significant (at the 10%, 5% and 1% confidence levels, respectively), but PRIVATE is no longer significant. The volatility of the Solow residual also remains statistically significant. Both the bank-based finance and the market-based finance dummies are neither statistically significant, nor they present consistent coefficient signs across the regressions.

Note that the specification of the regression including the financial system dummies ignores the possibility of endogeneity between the financial structure of a country and the volatility of its business cycles. As with the financial development indicators, the financial system of a country is largely influenced by government policies (see, for example, Chirinko (1998)). Thus, a more accurate regression analysis would require the inclusion of instrument variables for the financial structure dummies. Since the relation between financial system type and volatility is both theoretical and empirical ambiguous, and the inclusion of the variable DEPTH already proxies for the development of both bank and stock markets, the analysis

[14] See Appendix B for the countries included in the regressions containing DEPTH.

Table 2
Dependent variable: volatility of output (financial system dummy included)

	FDEV = BANK	FDEV = LLY	FDEV = PRIVATE	FDEV = PRIVY	FDEV = DEPTH
Constant	0.034	0.013	0.033	0.011*	−0.014***
	(1.539)	(1.557)	(1.634)	(1.850)	(−8.225)
FDEV	−0.042	−0.022*	−0.040	−0.016**	−0.062***
	(−1.584)	−1.835	(−1.663)	(−2.277)	(−7.301)
MPI	0.00002	−0.000005	−0.000004	−0.000002	0.002***
	(0.577)	(−0.236)	(−0.303)	(−0.109)	(9.710)
GOV	0.021	0.010	−0.015	0.005	0.034***
	(1.506)	(0.986)	(−0.841)	(0.623)	(21.937)
σ_{SOL}	1.270***	1.225***	1.092***	1.237***	0.765***
	(3.256)	(5.259)	(5.086)	(5.810)	(6.861)
OPENNESS	0.007	0.004	0.010	0.002	−0.008***
	(1.303)	(0.795)	(1.546)	(0.539)	(−9.280)
EXCFLEX	−0.049	−0.014	0.007	−0.010	−0.318***
	(−1.106)	(−0.938)	(0.530)	(−0.800)	(−10.498)
LTGROW	−0.124	−0.067	−0.056	−0.115	0.320***
	(−0.998)	(−0.573)	(−0.601)	(−1.133)	(11.940)
MKTBASED	0.002	−0.002	−0.001	−0.002	0.003***
	(0.732)	(−1.367)	(−0.243)	(−1.323)	(10.073)
BNKBASED	0.003	0.003	0.003	0.004	0.008***
	(0.554)	(0.662)	(0.938)	(1.064)	(7.313)
#Observations	40	40	40	40	13
J-statistic	0.0004	0.001	0.0003	0.0004	0.067
$n \times J$-statistic	0.015	0.025	0.012	0.015	0.871
$\chi^2_{.05}(1)$	3.841	3.841	3.841	3.841	3.841

Note: FDEV = financial development indicator.
Numbers reported in parenthesis are the t-statistics.
*, ** and *** denote significancy levels of 10%, 5% and 1%.
Weighting matrix: white covariance (the GMM estimates are robust to heteroskedasticity of unknown form).
Instruments: CREDITOR, RULELAW and all regressors except the financial development indicator.

hereafter focuses on the regressions which excludes the dummy variables for financial structure.

3.2. Investment volatility results

The results for the volatility of investment reveal the same pattern as those of output volatility (see Table 3): all indicators of financial development are negatively related to the volatility of investment. DEPTH, LLY and PRIVY are statistically significant at least at the 5% confidence level, while PRIVATE is significant at the 10% level.

As in the output regressions, the economic importance of these variables' coefficients is also sizable. Take now the case of Portugal, whose investment volatility of 0.056 constitute the sample median: a 10% increase in LLY would reduce investment volatility by approximately 19.7%; the same percentage increase in PRIVATE or PRIVY would decrease investment volatility by approximately 32.6% or 8.8%, respectively. Thus, the greater the size of the financial system and the more credit is directed to the private sector, the lower the volatility of investment activities is.

As in the output regressions, the degree of openness is consistently positively related to investment volatility. Increases in the level of government expenditures, lower average inflation levels and reduced exchange rate volatility, in turn, seem to decrease investment volatility. Long-term growth, in contrast, does not exhibit a consistent pattern in the investment regressions. Again, none of these variables are statistically significant.

The volatility of the Solow residual, which remains positively related to investment volatility, is no longer statistically significant. The results of the DEPTH regression stand again in contrast with the regressions that include the other financial development indicators. All variables are statistically significant, and, except for DEPTH and the volatility of the Solow residual, the signs of all variables are the opposite of those found in the other regressions.

3.3. Consumption volatility results

The coefficients on the financial development indicators are also negative when running the regressions with consumption volatility as the dependent variable (see Table 4). The coefficient on PRIVY is significant at the 5% confidence level, while the coefficients on BANK and LLY are significant only at the 10% confidence level. The coefficients on DEPTH and PRIVATE, in turn, are not statistically significant. Thus, financial development seems to contribute less to consumption volatility than it does to output and investment volatility.

Still, the economic significance of the financial development indicators remains relevant. Consider the case of Netherlands, whose consumption volatility equals to the sample median (0.021). If BANK, LLY or PRIVY were 10% above their current level, the volatility of consumption would fall by 58.4%, 25.6% or 15.8%, respectively.

The volatility of the Solow residual, openness and exchange rate flexibility are all positively related to consumption volatility, while average inflation and long-term

Table 3
Dependent variable: volatility of investment

	FDEV = BANK	FDEV = LLY	FDEV = PRIVATE	FDEV = PRIVY	FDEV = DEPTH
Constant	0.161*	0.079***	0.212**	0.065***	0.002
	(1.794)	(2.490)	(2.131)	(2.396)	(0.194)
FDEV	−0.171	−0.116**	−0.238*	−0.080**	−0.458***
	(−1.661)	(−2.111)	(−1.901)	(−2.274)	(−4.785)
MPI	−0.0002	−0.0002	−0.0002	−0.0002	0.002*
	(−0.518)	(−0.730)	(−0.646)	(−0.743)	(2.318)
GOV	−0.002	−0.039	−0.190	−0.065	0.066***
	(−0.022)	(−0.730)	(−1.642)	(−1.182)	(5.824)
S_{SOL}	3.154	2.848	1.712	2.979	2.696***
	(1.248)	(1.630)	(1.020)	(1.671)	(4.713)
OPENNESS	0.032	0.021	0.058	0.014	−0.016*
	(1.496)	(0.914)	(1.390)	(0.614)	(−2.315)
EXCFLEX	0.191	0.310	0.419	0.343	−0.784*
	(0.481)	(0.827)	(1.079)	(0.956)	(−2.136)
LTGROW	−0.448	−0.082	0.076	−0.243	0.641***
	(−0.932)	(−0.170)	(0.122)	(−0.531)	(4.806)
#Observations	40	40	40	40	13
J-statistic	0.015	0.006	0.005	0.007	0.066
$n \times J$-statistic	0.606	0.229	0.193	0.275	0.856
$c^2_{.05}(1)$	3.841	3.841	3.841	3.841	3.841

Note: FDEV = financial development indicator.
Numbers reported in parenthesis are the *t*-statistics.
*, ** and *** denote significancy levels of 10%, 5% and 1%.
Weighting matrix: white covariance (the GMM estimates are robust to heteroskedasticity of unknown form).
Instruments: CREDITOR, RULELAW and all regressors except the financial development indicator.

Table 4
Dependent variable: volatility of consumption

	FDEV = BANK	FDEV = LLY	FDEV = PRIVATE	FDEV = PRIVY	FDEV = DEPTH
Constant	0.092	0.027	0.074	0.017	−0.027**
	(1.606)	(1.100)	(1.245)	(0.958)	(−2.987)
FDEV	−0.126*	−0.076*	−0.110	−0.052**	−0.073
	(−1.837)	(−1.744)	(−1.500)	(−2.076)	(−1.100)
MPI	−0.0002	−0.0003	−0.0003	−0.0003	−0.0001
	(−0.759)	(−0.926)	(−0.841)	(−0.920)	(−0.082)
GOV	0.087	0.046	−0.017	0.032	0.063***
	(1.594)	(1.132)	(−0.264)	(0.838)	(7.914)
S_{SOL}	2.034	2.049	1.850	2.159	1.250***
	(1.074)	(1.533)	(1.431)	(1.614)	(4.011)
OPENNESS	0.028	0.020	0.035	0.015	0.001
	(1.385)	(0.945)	(1.476)	(0.779)	(0.164)
EXCFLEX	0.255	0.350	0.384	0.364	−0.360
	(0.667)	(0.912)	(1.003)	(0.972)	(−1.566)
LTGROW	−0.647	−0.392	−0.366	−0.499	0.784***
	(−1.423)	(−0.895)	(−0.832)	(−1.176)	(7.440)
#Observations	40	40	40	40	13
J-statistic	0.001	0.005	0.008	0.006	0.142
$n \times J$-statistic	0.052	0.2162	0.335	0.237	1.852
$c^2_{.05}(1)$	3.841	3.841	3.841	3.841	3.841

Note: FDEV = financial development indicator.
Numbers reported in parenthesis are the *t*-statistics.
*, ** and *** denote significancy levels of 10%, 5% and 1%.
Weighting matrix: white covariance (the GMM estimates are robust to heteroskedasticity of unknown form).
Instruments: CREDITOR, RULELAW and all regressors except the financial development indicator.

growth are consistently negatively related to consumption volatility. The fiscal policy indicator does not have a regular pattern. Again, none of these variables are statistically significant.

4. Conclusion

The overall result that emerges from the cross-country regressions is that economic fluctuations are less volatile the greater the size of the financial system of a country is, the more credit is provided to the private sector relative to the public sector and the more predominant deposit money banks are relative to the central banks.

Output, investment and consumption volatility are negatively related to all indicators of financial system development. Therefore, as defended by both the credit channel and the endogenous view, the reduction in the problems associated with information asymmetry brought about by a more developed financial system leads to smoother fluctuations in economic activity.

Policy measures that stimulate the development of the financial system may be consequently advised in order to achieve smoother business cycles. Since the instruments used are correlated with the financial development indicators, policies directed to increasing creditor rights' protection and, more importantly, to enforcing the rule of law will likely stimulate greater financial development.

The inclusion of dummy variables representing German or bank-based financial systems and Anglo-American or market-based financial does not affect the main result that financial system development is associated with reduced business cycles volatility. Nonetheless, both the theoretical and the empirical evidence are not conclusive with regards to which kind of financial system structure brings reduced asymmetric information problems and, thereby, lower business cycles volatility. Since the financial structure of a country and the volatility of its business cycles may be both endogenously determined by government policies, further research should focus on using appropriate instrument variables for financial system types.

The results have also shown that the Solow residual has a significant role in explaining cross-country variations in business cycles volatility. As argued before, this variable is likely capturing more than only technological shocks (e.g., quality of human capital, on-the-job training and vintage effects). Thus, future research should focus on finding proper measures for technological innovations and on identifying which other factors captured by the residual also have a significant impact on economic fluctuations.

Regarding the other control variables, though the signs of their coefficients in the present paper seem consistent with other business cycles studies, their significance levels largely disagree with previous findings. For instance, Karras and Song (1996) have found that openness is positively related to output volatility and statistically significant, while the current study found that, although openness tend to be positively related to output when running regressions that include the financial development indicators, its significance level vanishes. The same pattern is true for long-run growth: while Ramey and Ramey (1994) found that output volatility is negatively

correlated with growth and statistically significant, the results found here shows that the significance level falls when financial development indicators are included; moreover, the panel data output regressions show that increases in the growth of output per capita may actually be positively related to changes in output.

Hence, the inclusion of financial development indicators is important when analyzing the determinants of business cycles volatility, since most of the effect that was previous attributed to other variables seems to be actually arising from differences in financial development across countries.

Acknowledgements

I would like to thank Tyler Cowen, Willem Thorbecke, Timothy Sugrue, Ahmet Tiryaki and Bryan Caplan for useful comments, and Maurice Kugler for the data provided.

Appendix A. Variables

σ_Y standard deviation of the business cycle component of the real GDP series

σ_I standard deviation of the business cycle component of the private investment series

σ_C standard deviation of the business cycle component of the real private consumption series

LLY liquid liabilities as a fraction of GDP [15]

BANK assets of deposit money banks as a fraction of the total assets of the financial system [15]

PRIVATE claims to non-financial private sector relative to the total domestic credit [15]

PRIVY claims to non-financial private sector as a fraction of the GDP

DEPTH the growth rate in the log of the financial sector real GDP over the relevant period

CREDITOR creditor rights index (sum of four dummy variables: reorganization, automatic stay, secured creditors and management). It ranges from 0 (low protection) to 4 (high protection)

RULELAW tradition for law and order. It ranges from 1 (less tradition) to 10 (greatest tradition)

σ_{SOL} standard deviation of the business cycle component of the Solow residual series

MPI average inflation rate

σ_{M1} standard deviation of the business cycle component of the M1 series

CBI index of the degree of central bank independence

GOV the ratio of government consumption expenditure to GDP [15]

[15] Median value over the relevant time period.

OPENNESS the ratio of total trade (the sum of exports and imports) to GDP [15]
EXCFLEX the absolute value of the change in exchange rate, which is defined as SDRs per unit of national currency [15]
YPC annual growth rate of the trend in the log of real GDP per capita series [15]

Appendix B. Data

Country	σ_Y	σ_I	σ_C	LLY	BANK	PRIVATE	PRIVY	DEPTH
Argentina	0.036	0.100	0.056	0.237	0.623	0.644	0.198	
Australia	0.011	0.038	0.007	0.489	0.932	0.647	0.291	0.038
Austria	0.013	0.037	0.011	0.723	0.955	0.810	0.718	
Belgium	0.018	0.051	0.036	0.439	0.930	0.462	0.244	0.058
Brazil	0.026	0.161	0.069	0.193	0.591	0.737	0.240	
Canada	0.013	0.042	0.011	0.348	0.897	0.836	0.436	0.037
Chile	0.036	0.103	0.050	0.255	0.463	0.629	0.342	
Colombia	0.017	0.087	0.017	0.191	0.643	0.821	0.150	
Denmark	0.013	0.050	0.019	0.500	0.927	0.897	0.485	0.011
Ecuador	0.032	0.079	0.037	0.233	0.335	0.844	0.168	
Egypt	0.024	0.077	0.036	0.549	0.527	0.287	0.192	
Finland	0.020	0.069	0.015	0.432	0.928	1.029	0.473	0.041
France	0.008	0.025	0.007	0.464	0.943	0.866	0.745	0.050
Germany	0.017	0.045	0.019	0.548	0.946	0.797	0.760	0.053
Greece	0.017	0.066	0.012	0.476	0.592	0.594	0.230	
India	0.021	0.034	0.024	0.371	0.659	0.499	0.222	
Indonesia	0.014	0.110	0.027	0.198	0.621	1.039	0.210	
Ireland	0.015	0.053	0.022	0.502	0.953	0.760	0.298	
Israel	0.061	0.122	0.094	0.647	0.825	0.605	0.560	
Italy	0.015	0.045	0.017	0.678	0.860	0.619	0.565	0.043
Japan	0.020	0.040	0.017	0.855	0.939	0.865	0.877	0.052
Kenya	0.038	0.072	0.043	0.301	0.757	0.647	0.193	
Malaysia	0.021	0.066	0.024	0.467	0.965	0.948	0.315	
Mexico	0.021	0.081	0.035	0.208	0.641	0.509	0.088	
Netherlands	0.013	0.030	0.021	0.706	0.973	0.782	0.639	
New Zeland	0.017	0.063	0.024	0.266	0.836	0.801	0.184	
Nigeria	0.060	0.269	0.163	0.190	0.998	0.496	0.094	
Norway	0.010	0.048	0.022	0.556	0.872	0.715	0.388	0.021
Pakistan	0.015	0.056	0.025	0.396	0.619	0.530	0.252	
Philippines	0.021	0.089	0.014	0.240	0.725	0.793	0.206	
Portugal	0.019	0.056	0.021	0.952	0.946	0.767	0.614	
South Korea	0.019	0.079	0.018	0.326	0.786	0.909	0.378	
Spain	0.011	0.041	0.017	0.748	0.891	0.739	0.696	
Sweden	0.012	0.045	0.009	0.570	0.903	0.777	0.423	0.016
Switzerland	0.018	0.053	0.011	1.097	0.984	0.902	1.098	
Thailand	0.016	0.051	0.018	0.370	0.817	0.776	0.103	
Turkey	0.021	0.065	0.030	0.224	0.664	0.613	0.163	
Uk	0.014	0.044	0.015	0.385	0.942	0.738	0.326	0.033
Uruguay	0.027	0.352	0.332	0.367	0.516	0.772	0.288	
US	0.014	0.048	0.014	0.646	0.933	0.807	0.633	0.034

Sample period: 1961–1997, except for Indonesia and Kenya: 1971–1997.

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