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Bank efficiency and industry growth during financial crises

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ABSTRACT

Financial crises pose many problems for growth, and in this time of increasing financial instability it is important to fully understand why this happens. Many papers have analyzed the relationship between growth and a country's level of financial development using private credit, which leads to several unexpected problems. However, very few have used bank efficiency to gauge the development of the financial sector. The aim of this paper is to analyze the effect of bank efficiency on value-added growth of industries that were most dependent on external financing during the financial crisis. Specifically, it uses the data envelopment analysis (DEA) method to measure the efficiency of the banking sector across countries, according to the empirical strategy offered by Rajan and Zingales (1998). Our main result shows that bank efficiency relaxed credit constraints and increased the growth rate for financially dependent industries during the crisis. This finding shows the great but overlooked importance of bank efficiency in mitigating the negative effects of financial crises on growth for industries that are most dependent on external financing.

1. Introduction

The subprime mortgage crisis of 2009 reminds us how the banking sector plays an important role in the real economy. Many papers have analyzed and identified a positive relation between a country's level of financial development and its growth rate. However, this extensive literature on finance and growth primarily uses private credit as a measure of a country's level of financial development. The use of this measure poses two problems. First, Hasan et al. (2009) showed that private credit measures only the quantity of funds of the financial sector and should not be used to measure the quality a country's level of financial development. Second, Rousseau and Wachtel (2011) found a weak relationship between the level of financial development measured by private credit and growth for developed economies.

In this paper, we investigate for the first time how bank efficiency alleviated the effects of financial friction on economic growth during the 2009 financial crisis. The paper uses the Data Envelopment Analysis (DEA) method to measure bank efficiency for a sample of 38 countries taken from Barth et al. (2013). These authors have shown that this non-parametric method has several advantages. First, it does not require a particular functional form, and does not impose a specific structure of the shape of the efficiency frontier. Second, Banker and Natarajan (2008) also showed that the DEA approach performs better than parametric methods when estimating individual decision-making unit productivity. We then study the effect of this measure on industrial growth for 36 industries that were dependent on external finance. More

specifically, we investigate the relationship between a country's bank efficiency and the extent of credit availability for these industries during the financial crisis. Growth is the annual growth rate in real value added across industries and countries during the period 2009, when the crisis spread from the U.S. to other countries. Financial dependence is computed at the industry level using data on U.S. industrial firms. Our first result shows that bank efficiency relaxed credit constraints, permitting externally dependent industries to grow faster during the crisis. Indeed, the reasoning behind this paper is as follows. More efficient banks do a better job of funneling available credit to more externally dependent industries. Thus, bank efficiency positively affects the supply of credit granted to firms, which in turn increases the growth rate in real value added for industries most dependent on external financing. Specifically, if we take an industry at the 75th percentile of external financial dependence and another industry at the 25th percentile of external financial dependence, we find that the difference in growth rate between these two industries is 2.41 percentage points higher in the former. This effect is quite large relative to mean annual industry value-added growth in our sample (−4.559%). In order to disentangle the impact of bank efficiency from other factors that might be correlated with this measure, we control for other interactions between external financial dependence with measures of financial development, bank concentration and competition, cross-border banking (international and local claims), domestic and international public debt, bank supervision, net interest margin, banking crisis measures, bank supervision, macroeconomic policies

(trade, real GDP, monetary policy, exchange rate and inflation) and other government policy intervention measures put in place during the crisis. Our result continues to hold, and also remains robust to the use of several measures of external financial dependence, such as working capital needs and Tobin's Q. It is also robust to the use of several econometric methods, such as weighted least squares and the rank method.

Our paper is related to several strands in the existing literature on the topic. First, a few papers have previously investigated the link between bank efficiency and a number of economic outcomes. Ramcharran (2016) empirically estimated the efficiency of bank loans to small and medium enterprises (SME) in India during the period 1979–2013. He found that increasing the productivity of bank loans (i.e. efficiency) increases the performance of SME in India. This paper is different from ours in two main respects. First, he used a parametric production function, namely the log-quadratic production function, to determine the efficiency of the banking sector instead of the non-parametric DEA approach, as we do in this paper. Second, the study focuses on one country, whereas our paper includes 38 countries and uses industry growth as a measure of economic growth. In the same vein, Wijesiri et al. (2015) use a bootstrapped DEA method to measure the efficiency of microfinance institutions (MFIs) in Sri Lanka and find that these institutions are financially and socially inefficient. Havranek et al. (2016) investigate the link between bank efficiency and the pass-through channel of Czech loan and deposit products. They show that efficient banks smooth loan rates, but there is no relationship between bank efficiency and loan markups. Even though this paper uses the same method, namely the DEA approach to measure bank efficiency, it does not look at the link between a country's level of bank efficiency and its industry growth. The study conducted by Belke et al. (2016) is the one that is closest to our study. Specifically, they analyze the impact of bank efficiency and regional growth across Europe in normal and crisis times. They show that bank efficiency is positively and significantly related to regional growth in both periods. Despite these interesting results, they use a parametric production function to estimate banking sector efficiency across countries. This is problematic since Barth et al. (2013) show that parametric function forms impose a specific structure on the shape of the efficiency frontier. In addition, their sample only includes European countries, and does not use industry growth or external financial dependence to avoid the problems related to omitted variables and causality. Using a DEA-based meta-frontier, Gulati and Kumar (2016) assess the impact of finance on the Indian banking sector efficiency, finding that the global financial crisis decreased its efficiency. However, this paper focuses on only one country (India) and uses a different DEA-based meta-frontier approach to measure the bank efficiency. Finally, Barth et al. (2013) use the DEA method to measure bank efficiency and find that strict bank supervision negatively and significantly impacts bank efficiency for a sample of 72 countries during the period 1999–2007.

Second, our paper adds to the empirical literature on the relationship between growth, banking crises and financial frictions (Braun and Larrain, 2005; Raddatz, 2006; Kroszner et al., 2007; Dell'Ariccia et al., 2008). For example, Braun and Larrain (2005) find that industries that are more dependent on external financing are hit harder during recessions. For Raddatz (2006), larger liquidity needs create higher volatility, and financially underdeveloped countries experience deeper crises, a finding in line with our main result. Kroszner et al. (2007) use the same approach to investigate the growth impact of bank crises on industries and show that sectors that are highly dependent on external finance tend to experience a substantially greater contraction of value added during a banking crisis in countries with deeper financial systems than in countries with shallower financial systems. However, these papers all use private credit as a measure of the level of financial development. Dell'Ariccia et al. (2008) studied the effects of banking crises on growth in industrial sectors and found that in sectors more dependent on external finance, value added, capital formation, and the

number of establishments grew slower than in sectors less dependent on external finance. Recently, Laeven and Valencia, (2013a, 2013b) analyzed the impact of bank recapitalization on growth during the recent financial crisis. They found that the growth of firms dependent on external financing is disproportionately positively affected by bank capitalization policies. Our paper uses the same approach, but at the industry level, and adds bank efficiency as a measure of a country's level of financial development. Finally, Cetorelli and Goldberg (2011) show that cross-border banking operations were a driving factor behind the 2009 financial crisis. To test if our results are not affected by their finding, we use several measures of cross-border banking interacted with external financial dependence as controls. The remainder of the paper is organized as follows. Section 2 outlines the basic methodology, Section 3 presents the empirical investigation, and Section 4 concludes.

2. Methodology

To study the relationship between bank efficiency, financial dependence and growth during the 2009 financial crisis, we first estimate the following econometric specification, following Rajan and Zingales (1998):

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\begin{aligned}
\text{Growth}_{j,k} = {} & \text{Constant} + \beta_1^*\text{Country Indicators}_k + \beta_2^*\text{Industry Indicators}_j \\
& + \beta_3^*\text{Size}_{j,k} + \beta_4^*\text{Financial dependence}_j \times \text{Efficiency Index}_k \\
& + \text{Controls}_{j,k} + \epsilon_{j,k}
\end{aligned}
$$

where j and k denote industry and country, respectively. Growth is the annual growth rate in real value added of industry j in country k during 2009. Financial dependence measures industry j's dependence on external financing, and efficiency quantifies bank efficiency in country k. Size is measured by the logarithm of the total assets of industry j. The country and industry indicators are based on the IFS country classification code and the International Industry Classification Code, respectively.

Rajan and Zingales (1998) used data from U.S. firms to compute an industry's need for external financing as a benchmark, which allowed them to identify an industry's technological demand for external financing. They then used this measure to test whether the industries most dependent on external financing grow faster in countries with well developed financial markets. As argued by these authors, this method suggests that the cross-industry variance in financial dependence is similar across countries. For example, they stated that if "the pharmaceutical industry requires a large initial scale and has a higher gestation period before cashflows are harvested than the textile industry in the U.S., it also requires a large initial scale and has a higher gestation period in Korea." However, several papers have questioned these assumptions. For example, Claessens and Laeven (2005) and Fishman and Love (2007) proposed to control for growth opportunities and Tobin's Q as controls. In the same vein, Raddatz (2006) argued that the results obtained using external financial dependence can be driven by a change in working capital financing. For this reason, we also introduce the interaction term between bank efficiency and capital needs in our estimations. Most importantly, Laeven and Valencia, (2013a, 2013b) indicate that an industry-level measure of a firm's growth opportunities should not be constructed using the U.S. as a benchmark. The reason for this is that growth opportunities vary across countries and industries. We also use the interaction term between bank efficiency and Tobin's Q, a proxy of an industry firm's growth opportunities. Thus, we include the Tobin's Q and capital needs as an extension of our baseline model. Finally, we re-estimate our econometric equation using regional sub-samples, i.e. European versus non-European countries, since 20 out of the 38 countries in our sample are European.

Another main advantage of this approach is that it treats for

potential omitted variable bias compared to cross-country specifications. The introduction of country and industry dummies in the regression allows us to treat for possible systematic demand effects that are not captured by our measure of financial dependence. Finally, we eliminate the U.S., which is our benchmark for measuring external financial dependence for a potential endogeneity. We also drop countries with only one or two observations, such as the Czech Republic and Nigeria. Our data are thus composed of 38 countries, of which 20 are European, and 36 industries for a total of 1368 country-industry observations. The final sample was chosen according to the availability of industry level and bank efficiency data. However, to avoid selection bias in our results, we use the database of Laeven and Valencia, (2013a, 2013b) on banking crises and include countries that were severely hit by the 2009 financial crisis, as well as those in which the financial sector was largely unaffected.[1]

2.1. Data

Growth rate in real value added and financial dependence. Growth is the annual growth rate in real value added as a percentage during the year 2009. The external finance dependence denotes Rajan and Zingales' (1998) measure of intensity reliance on external financing, defined as one minus industry cash flow over the industry investment of large, publicly traded U.S. firms in the 1980s. In terms of a robustness test, we use external dependence computed over the period 1980–2006, taken from Laeven and Valencia, (2013a, 2013b). Table 11 shows external financial dependence measures across U.S. industries over the period 1980-1989.

Bank efficiency measure. Bank efficiency is measured over the period 1999-2007, using data taken from Barth et al. (2013), who used the data envelopment analysis (DEA) method.[2] Specifically, they showed the advantage of a non-parametric method compared to a parametric model, as the latter requires one to assume a particular function form, thereby imposing a specific structure on the shape of the efficiency frontier. Importantly, this paper looks at the productive efficiency of the banking sector for different countries. The non-parametric DEA method envelops the multiple input data (deposits, labor and physical capital) and output data (total loans and securities) in a sample of 4050 banks over the period 1999–2007, taken from the Bankscope database. They then computed the bank efficiency as an average over country-time and found it to be quite stable during the period 1997–2007. This time-average is indicative of actual bank efficiency as of 2009 for each country in the considered sample. For more details, we have added standard deviations of the measure of bank efficiency across countries.[3] Most importantly, the coefficient obtained for bank efficiency does no longer suffers from the problem of functional form. The bank efficiency score lies between 0 and 1, and a higher value obtained with the DEA method indicates higher efficiency in the banking sector. A lower value means lower efficiency. For details about the DEA model estimation, see Appendix A.

To overcome endogeneity problems in our estimation during our period of interest, namely the financial crisis in 2009, our external financial dependence measure is computed over the 1980s and 1980–2006, while bank efficiency is computed during the period 1999–2007. All periods are prior to the financial crisis.

Our specifications use the following control variables taken from the World Bank WDI[4]: inflation rate, trade, market and stock market

capitalization. Private credit provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. Inflation, consumer price index, as measured by the consumer price index and using the Laspeyres formula, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Trade is calculated as the sum of exports as a percentage of GDP and imports as percentage of GDP. Market capitalization, listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles. We control our results for total capitalization, defined as the sum of private credit/GDP and stock market capitalization/GDP. We also control for real GDP growth. Specifically, the introduction of the interactions between external financial dependence and market and stock market capitalizations as controls allows us to replicate the results obtained by Rajan and Zingales (1998).

To test the sensitivity of our results, we use bank concentration, measured as the share of assets of the three largest banks in terms of total banking system assets. Its value lies between 0 and 1, where 0 indicates low bank concentration and 1 high bank concentration.[5] This variable controls for the results obtained by Cetorelli and Gambera (2001), who found that bank concentration increases growth for industries that are most dependent on external financing by facilitating access to credit for younger firms. Also, Diallo and Koch (2017) found that bank concentration is negatively related to growth for countries close to the world technology frontier. In terms of bank competition, we use three measures, namely the Boone indicator, the Lerner index and the adjusted Lerner index.[6] The introduction of these variable allows us to control for the results of Claessens and Laeven (2005). They used the same strategy and found a positive relationship between bank competition measured by the Panzar and Rosse (1987) approach and growth across countries for industries that are most dependent on external financing.

Since Cetorelli and Goldberg (2011) found that bank globalization had a significant effect on the transmission of the financial crisis to emerging countries, we evaluate the relationship between measures of bank globalization and our measure of bank efficiency. Most importantly, we use total international claims (as a percentage of GDP) and local claims in local currency (as a percentage of GDP) as controls. These two variables are computed as of 2007 and come from the Bank of International Settlements (BIS) Statistics. Specifically, we use consolidated international banking statistics. According to BIS, these statistics facilitate the management and monitoring of banks' risk exposures, whereas the locational banking statistics are complement of monetary and credit aggregates. Also, Cetorelli and Goldberg (2011) used this database since it contains information on the positions of banks from BIS countries according to counter-parties around the globe.[7] Finally, we introduce outstanding domestic public debt securities to GDP (%) and outstanding international public debt securities to GDP (%), also taken from the BIS. More precisely, the domestic public debt securities is measured as the total amount of domestic public debt securities issued in domestic markets as a share of GDP. It covers long-term bonds and notes, treasury bills, commercial paper and other short-term notes. The international public debt securities is also measured as the amount of public international debt securities, as a share of GDP. It covers long-term bonds and notes and money market instruments placed on international markets. Since Barth et al. (2013) find a strong and positive effect of official supervisory power on bank efficiency, we use this variable interacted with external financial

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[1] Laeven and Valencia (2012) defined a systemic banking crisis if two conditions are met: (i) significant signs of financial distress in the banking system (significant bank runs, losses, and/or banking liquidation) and (ii) significant banking policy intervention measures in response to significant losses in the financial sector.

[2] See Appendix A.

[3] Standard deviations can be seen in Table 9.

[4] The World Development Indicators are publicly available at http://www.worldbank.org/.

[5] Concentration and supervisory power measures are taken from the 2013 Global Financial Development Database (GFDD) of the World Bank Group.

[6] Data come from the Global Financial Development Database of the World Bank Group (2013).

[7] Publicly available at http://www.bis.org/statistics/bankstats.htm.

dependence as a control. Specifically, supervisory power indicates the power of the supervisor vis-à-vis banks taken from Beck et al. (2006). This variable is constructed from 14 dummy variables following Barth et al. (2004) and Barth et al. (2006) and indicates whether bank supervisors can take specific actions against bank management, bank owners, and bank auditors both in normal and bad times. We also use the net interest margin defined as the accounting value of a bank's net interest revenue as a share of its interest-bearing (total earning) assets interacted with external financial dependence as a control, since Beck et al. (2010) argue that higher levels of net interest margins or overhead costs indicate lower levels of banking efficiency.[8]

In order to take into account the effect of government policy intervention measures during the crisis, as in Laeven and Valencia, (2013a, 2013b), we add assets announced and used, bank guarantees and liquidity support taken from the same authors, and all interacted with the measure of external financial dependence as controls. According to Laeven and Valencia, (2013a, 2013b), government intervention variables are computed over the period September 2008-March 2009 and are all normalized by countries' GDP over the year 2008. Asset purchases are assets acquired by the Central Bank, from bank institutions, including loans from the Treasury to banks, but excluding government bonds. Liquidity support is measured by the change in gross claims of the monetary authorities to financial institutions as a percentage of GDP. Bank guarantees creditors measures coverage of deposits and/or other liabilities, existing or new. For more details about these measures, see also Laeven and Valencia, (2013a, 2013b). In terms of macroeconomic variables, we control for changes in monetary policy over the period August 2008-March 2009, exchange rate depreciation over the period August 2008-March 2009, the change in monetary base/GDP over the period 2008q3-2009q1, the local currency exchange to USD (end-2009), inflation and real GDP growth.

Finally, we use the interaction terms between bank efficiency and working capital needs, as well as Tobin's Q, as controls for growth opportunities. Tobin's Q is taken from Laeven and Valencia, (2013a, 2013b) and is computed as the ratio of the market value of equity of total assets. We use capital needs, taken from Laeven and Valencia, (2013a, 2013b) who follow Raddatz (2006), using the industry median ratio of inventories to sales, plus the ratio of receivables to sales, minus accounts payable to cost of goods sold over the period 2000 to 2006, prior to the financial crisis. We also control for other industry characteristics such as leverage and fixed assets. Leverage is measured as the debt-to-asset ratio, while fixed assets is the ratio of fixed assets to total assets. To control for the results of Kroszner et al. (2007), who found that sectors most dependent on external financing tend to experience a greater contraction of value added during banking crises in countries with deeper financial systems, we use the dummy variable banking crisis, interacted with our measure of external financial dependence. More details about the variables' definitions, units, period at which they are computed, and sources can be found in Appendix B.

Table 1 shows the summary statistics of our variables. The average growth rate in real value added over the period 2009 is −4.559%. However, we observe a high dispersion between the firm at the 25th percentile, which grows at −25.218%, and the firm at the 75th percentile, which grows at 14.364%. The average of bank efficiency is 0.798. The countries with the lowest banking efficiency values are Lithuania (0.470), the Philippines (0.51), Pakistan (0.56) and Peru (0.57). The countries with highest banking efficiency are the United Kingdom (0.940), Switzerland (0.920), Belgium (0.920), and Luxembourg (0.910). During this period, industries required an average of 44.2% external financing. Market capitalization, private credit and total capitalization are on average 148.523%, 105.224%, and

253.748%, respectively. Bank concentration is on average 65.4%, with a minimum value of 0.291 (Luxemburg) and a maximum value of 0.944 (Sweden). The Boone indicator, Lerner and adjusted Lerner indices are on average −0.467, 0.233, and 0.180, respectively.

In addition, the average of financial dependence is 0.414, with a minimum and maximum of −0.451 and 1.491, respectively. The minimum corresponds to Tobacco industry, while the maximum to Drugs industry in terms of external financial needs. The variable supervisory power has an average of −0.516, with a minimum of −3.048 (Singapore) and a maximum of 1.001 (Belgium). The negative values are explained by the fact that Beck et al. (2006) used the first principal component of the 14 dummy variables, with higher values indicating a higher authority for bank supervisors. Finally, the average of industry size is 5.052, while the minimum is −7.73 and the maximum is 12.620. The negative is due to the fact size is measured by the logarithm of total assets of an industry in a given country. Tables 10 and 11 show countries' banking efficiency scores and external financial dependence across U.S. industries over the period 1980–1989, respectively.

3. Results

This section presents the results of our specifications. The dependent variable is the annual growth rate in real value added over the period 2009. In each specification, we introduce the intercept, as well as country and industry indicators. We use clustered standard errors by country and industry to treat for heteroskedasticity problems in our regressions.[9]

We first present our results by regressing our measure of bank efficiency on growth using simple OLS without fixed effects, as shown in Table 2. The coefficient associated with bank efficiency enters negatively and statistically significantly different from zero at the 10% level in column (1). Column (2) introduces industry size and industry fixed effects, and the coefficient of bank efficiency remains negative and significant. The introduction of country fixed effects renders the coefficient associated with bank efficiency insignificant, as shown in column (3). Our main result is presented in column (4), where we regress growth rate in terms of real value added on the interaction term between bank efficiency and external financial dependence, and control for size and fixed effects. The coefficient associated with industry size is positive and significant at the 1% level. This suggests that industry size had a positive and significant direct effect on growth during the crisis. The interaction term between bank efficiency and external financial dependence enters positively and statistically significant at the 5% level. This finding implies that bank efficiency matters for improved growth in industries that are more financially dependent on external finance. The regression in column (4) allows us to find the difference in growth in real value added between industries. The difference in growth during the crisis between an industry at the 75th percentile and the 25th percentile of external financial dependence is 2.41 percentage points higher for the former. Bank efficiency thus makes banks more resilient to financial crisis. This effect is quite large relative to mean annual industry value-added growth in our sample (−4.559%). The mechanism through which bank efficiency affects growth is the "credit-channel." During the 2009 financial crisis, bank efficiency positively affected the supply of credit granted to firms, which in turn enhanced the growth rate in terms of real value added. Our main result stipulates that bank efficiency alleviated the negative effects of the financial crisis on growth. To test the robustness of this result, we present new estimates in columns (5)–(7). More precisely, in column (5), we report the regression of growth rate in terms of value added and bank efficiency, financial dependence, and their interaction,

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[8] The data come from the 2013 Global Financial Development Database (GFDD) of the World Bank Group, and are publicly available at http://www.worldbank.org/.

[9] We report a sensitivity analysis for different clusters of the standard errors. See Table 9 for more details.

Table 1
Summary statistics.

Variables	Obs	Mean	Std. Dev.	Min.	Max.	25th Perc.	75th Perc.
Growth	1368	−4.559	34.669	−99.624	98.732	−25.218	14.364
Size	1368	5.052	2.443	−7.733	12.620	3.895	6.395
Lev	1368	0.484	0.258	0.015	4.283	0.318	0.618
Bank efficiency	1368	0.798	0.102	0.470	0.940	0.760	0.870
Financial dependence 1980	1368	0.442	0.414	−0.451	1.491	0.136	0.767
Financial dependence 1980-2006	1368	0.295	0.311	−1.757	0.934	0.104	0.503
Market capitalization	1368	148.523	120.748	13.570	471.350	59.130	157.920
Private credit	1368	105.224	43.178	13.020	194.740	93.610	139.400
Total capitalization	1368	253.748	147.554	50.240	610.750	165.430	292.160
Concentration	1368	0.654	0.138	0.291	0.944	0.562	0.735
Boone indicator	1368	−0.467	0.035	−0.582	−0.404	−0.493	−0.437
Lerner index	1368	0.233	0.064	0.124	0.341	0.172	0.282
Adjusted Lerner	1368	0.180	0.056	0.095	0.288	0.138	0.238
Supervisory power	1368	−0.516	1.254	−3.048	1.001	−1.155	0.720
Trade	1368	148.019	133.663	25.830	456.650	56.370	211.23
Real GDP growth	1368	−2.177	3.081	−17.955	6.771	−4.874	−0.770
Inflation	1368	3.237	2.855	−0.290	15.730	1.510	4.640
Liquidity support	1368	4.249	5.808	0	57.543	0	7.872
Bank guarantees	1368	71.424	85.640	0	295.2	3.300	115.600
Asset announced	1368	0.706	2.009	0	9.100	0	0
Asset used	1368	0.632	1.923	0	8.200	0	0
Crisis	1368	0.212	0.408	0	1	0	0

Table 2
Financial dependence, growth and bank efficiency.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size		1.039***	0.957***	0.968***		1.156***	0.961***
		(0.308)	(0.316)	(0.315)		(0.274)	(0.316)
Bank efficiency	−0.132*	−0.970*	−0.836		−0.349***	−0.388***	−0.962
	(0.068)	(0.560)	(0.603)		(0.097)	(0.097)	(0.607)
Financial dependence					−33.629**	−33.663***	−27.007**
					(12.972)	(12.876)	(12.57)
Bank efficiency×Financial dependence				0.348**	0.474***	0.486***	0.348**
				(0.154)	(0.159)	(0.158)	(0.154)
Industry indicators	No	Yes	Yes	Yes	No	No	Yes
Country indicators	No	No	Yes	Yes	No	No	Yes
Number of observations	1368	1368	1368	1368	1368	1368	1368
Number of countries	38	38	38	38	38	38	38
R²	0.001	0.060	0.119	0.121	0.007	0.014	0.121

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in terms of real value added of an industry during the period 2009.

*** Indicate significance at the 1% level.
** Indicate significance at the 5% level.
* Indicate significance at the 10% level.
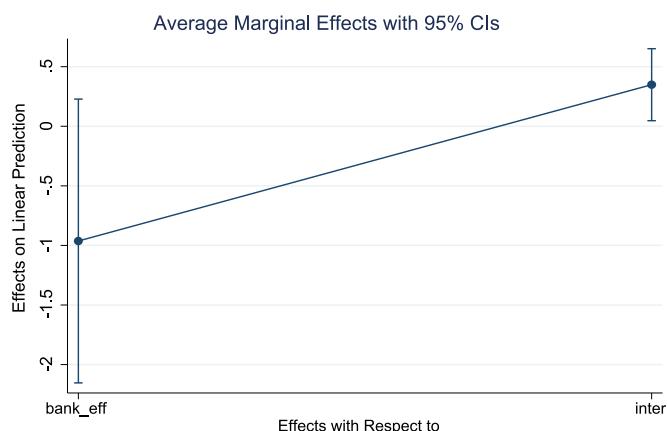
Fig. 1. Marginal effect of bank efficiency.
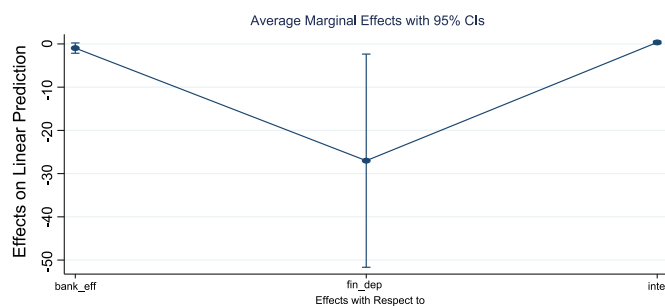
Fig. 2. Marginal effect of bank efficiency.

but without size and fixed effects. In column (6), we introduce size, and column (7) adds country and industry fixed effects. As shown in this last column, the obtained estimates are similar to those found in column (4). Finally, in Figs. 1 and 2, we plot the margin effects of bank

Table 3
Financial dependence, growth and bank efficiency, controlling for the level of financial development and bank competition.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size	0.961***	0.961***	0.960***	0.968***	0.954***	0.956***	0.958***
	(0.316)	(0.316)	(0.316)	(0.315)	(0.317)	(0.316)	(0.317)
Bank efficiency×Financial dependence	0.348**	0.345**	0.327*	0.315**	0.340**	0.348**	0.353**
	(0.154)	(0.161)	(0.172)	(0.161)	(0.155)	(0.154)	(0.155)
Market capitalization×Financial dependence		0.001					
		(0.015)					
Total capitalization×Financial dependence			0.003				
			(0.013)				
Concentration×Financial dependence				0.089			
				(0.119)			
Boone×Financial dependence					0.244		
					(0.493)		
Lerner×Financial dependence						0.159	
						(0.254)	
Adjusted Lerner×Financial dependence							0.125
							(0.294)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1368	1368	1368	1368	1368	1368	1368
Number of countries	38	38	38	38	38	38	38
R^2	0.121	0.121	0.121	0.121	0.121	0.121	0.121

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in terms of real value added of an industry during the period 2009.
*** Indicate significance at the 1% level.
** Indicate significance at the 5% level.
* Indicate significance at the 10% level.

efficiency on industry growth for the whole distribution of financial dependence. It shows that the results are stem from the upper part of financial dependence, a finding in line with our result.

The measure of bank efficiency in a country may capture other aspects of financial development. Table 3 controls for these aspects. More precisely, our main result could simply be that countries with a high level of financial development have more efficient banking systems. Financial development could have offered alternative sources of industries that are more dependent on external finance during the recent global financial crisis. To disentangle bank efficiency from financial development measures we introduce the interaction term between market capitalization and external financial dependence in column (2) and the interaction term between total capitalization and external financial dependence in column (3) of Table 3. The coefficient of the interaction term between our measure of bank efficiency and external financial dependence is positive and significant at the 5% and 10% levels, respectively. This suggests that bank efficiency enhances the growth rate for financially dependent industries during a crisis. However, the interaction term between market and total capitalization, and external financial dependence, enters positively, a finding in line with Rajan and Zingales (1998), even though the coefficients are insignificant. In column (4), we introduce the interaction term between bank concentration and external financial dependence. The coefficient associated with industry size remains positive and significant at the 1% level. The interaction term between bank efficiency and external financial dependence is positively and significantly related to growth at the 5% level. However, the interaction term between bank concentration and external financial dependence is positive and insignificant. Our result is thus not due to bank concentration; instead, we find that the real growth rate in value added is disproportionately positively affected by bank efficiency for financially dependent industries.

Columns (5)–(7) control for bank competition using three measures, namely the Boone indicator, the Lerner index and the adjusted Lerner index. In all specifications, bank efficiency interacted with external financial dependence remains positive and statistically significantly different zero at the 5% level. This suggests that industries that are more financially dependent grow faster in financial systems that are more efficient. It also suggests that our main results do not suffer from possible endogeneity problems with bank concentration and competition measures.

In Table 4 we control our findings for bank globalization, bank supervision, net interest margin, and domestic and international public debt. Columns (1) and (2) add external financial dependence interacted with international and local claims, respectively. The sign and significance of our variable of interest remain unchanged, but the magnitude of the coefficient increases. We also control our results using the interaction term between supervisory power and external financial dependence in column (3). Again, the sign and significance of bank efficiency interacted with external financial dependence remain unchanged, even though it decreases in magnitude. Bank efficiency had a positive and significant effect on growth for financially dependent industries during the 2009 financial crisis. More specifically, using the coefficient in column (3), we show that the difference in growth during the crisis between an industry at the 75th percentile and the 25th percentile of external financial dependence is 0.52 percentage point higher for the former. This effect is largely relative to mean annual industry value-added growth in our sample (−4.559%). In column (4), we introduce the interaction terms between net interest margin and external financial dependence. As we can see below, our interest variable, namely the interaction term between bank efficiency and external financial dependence, enters positively and statistically significant at the 1% level. Finally, in columns (5) and (6) we add domestic

Table 4

Financial dependence, growth and banking efficiency controlling for bank globalization, supervision and net interest margin.

	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.640	0.655*	1.111***	1.207***	1.020***	0.999***
	(0.391)	(0.390)	(0.317)	(0.307)	(0.317)	(0.318)
Bank efficiency×Financial dependence	0.550**	0.540**	0.076***	0.111***	0.352**	0.316**
	(0.235)	(0.233)	(0.155)	(0.042)	(0.171)	(0.160)
International claims×Financial dependence	−20.976					
	(24.853)					
Local claims×Financial dependence		−20.030				
		(49.295)				
Supervisory power×Financial dependence			−1.830			
			(1.588)			
Net interest margin×Financial dependence				−0.972		
				(1.021)		
Domestic public debt×Financial dependence					−0.040	
					(0.109)	
International public debt×Financial dependence						−0.093
						(0.219)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1368	1368	1368	1368	1368	1368
Number of countries	38	38	38	38	38	38
R^2	0.118	0.118	0.041	0.066	0.114	0.114

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate of an industry during the period 2009.

*** Indicate significance at the 1% level.

** Indicate significance at the 5% level.

* Indicate significance at the 10% level.

and international public debt as controls. Our results remain robust to the introduction of these interaction terms interacted with external financial dependence.

In Table 5, we control for the level of economic development as measured by real GDP growth, the degree of openness measured by trade, inflation, exchange rate, changes in monetary policy and monetary base. Controlling for these variables reduces concerns about omitted variables. Columns (1) and (2) add the interaction terms between real GDP growth and external financial dependence, as well as trade and external financial dependence. Firm size remains positively and significantly related to growth at the 1% level. The interaction term between bank efficiency and financial dependence remains positive and significant at the 5% level. This suggests that bank efficiency has a positive and significant growth effect for financially dependent industries. Real GDP growth and trade positively affect growth for financially dependent industries, even though the coefficients are insignificant. Inflation and exchange rates are introduced in columns (3) and (4). Our variable of interest, namely the interaction between bank efficiency and external financial dependence, remains positive and significant at the 5% level. Monetary policy variables are shown in columns (5) and (6). We find that bank efficiency interacted with external financial dependence is statistically significantly different from zero at the 5% level. This suggests that bank efficiency plays a positive and significant role for growth in financially dependent industries during a crisis. We add all variables in column (7), and show that bank efficiency disproportionately increases the growth rate in terms of real value added for industries that were dependent on external financing during the crisis. Our main results remain robust due to the use of real GDP growth rate, trade, inflation and exchange rates, and monetary policy and base as controls, and validate at the same time our conclusion shows that bank efficiency makes countries more resilient to financial frictions.

To obtain the results featured above, we conducted some robustness checks using government intervention measures as controls, as shown in Table 6. We first control for the interaction terms between announced asset purchases and asset purchases used, and external financial dependence. The results are presented in columns (1) and (2). Bank efficiency interacted with external financial dependence is positively and significantly related to growth for financially dependent industries at the 5% level. This suggests that our result is not a function of bank policy intervention measures during the crisis. Indeed, bank efficiency exerts a positive and significant effect on the growth of industries that are more dependent on external financing. Next, we investigate two other measures used during the crisis by governments, namely bank guarantees and liquidity support. Controlling for the interaction term between bank guarantees and external financial dependence in column (3), we show that our variable of interest remains positive and significant at the 5% level. However, bank guarantees interacted with financial dependence enters negatively and insignificantly. Finally, column (4) adds liquidity interacted with external financial dependence as a control. The coefficient of the interaction term between bank efficiency and external financial dependence is positive and statistically significantly different from zero at the 5% level. This suggests that the real growth rate in terms of value added is disproportionately positively affected by bank efficiency for financially dependent industries.

It could also be that our result depends on whether the impact of the financial crisis on the banking sector is a function of the measure of bank efficiency, so we control our results for banking crises in Table 7. In column (1) we introduce the interaction term between the banking crisis variable and external financial dependence. Banking crisis is a dummy variable that takes the value 1 if the country experienced a

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Table 5
Financial dependence, growth and bank efficiency controlling for macroeconomic variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size	0.962***	0.959***	0.952***	0.973***	0.954***	0.966***	0.947***
	(0.316)	(0.318)	(0.314)	(0.316)	(0.316)	(0.316)	(0.318)
Bank efficiency×Financial dependence	0.354**	0.346**	0.417**	0.375**	0.370**	0.366**	0.487***
	(0.156)	(0.154)	(0.190)	(0.152)	(0.155)	(0.157)	(0.183)
Real GDP growth×Financial dependence	0.051						0.299
	(0.424)						(0.425)
Trade×Financial dependence		0.001					0.017
		(0.013)					(0.016)
Inflation×Financial dependence			0.510				0.425
			(0.756)				(0.821)
Exchange rate×Financial dependence				27.062			35.584
				(17.981)			(19.409)
Monetary policy×Financial dependence					−0.599		−0.797
					(1.003)		(1.104)
Monetary base×Financial dependence						−0.322	−0.255
						(0.453)	(0.521)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1368	1368	1368	1368	1368	1368	1368
Number of countries	38	38	38	38	38	38	38
R^2	0.121	0.121	0.121	0.122	0.121	0.121	0.123

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate of an industry during the period 2009. * Indicate significance at the 10% level.
*** Indicate significance at the 1% level.
** Indicate significance at the 5% level.

Table 6
Financial dependence, growth and bank efficiency using government interventions variables as controls.

	(1)	(2)	(3)	(4)
Size	0.959***	0.958***	0.964***	0.961***
	(0.315)	(0.315)	(0.317)	(0.316)
Bank efficiency×Financial dependence	0.329**	0.328**	0.355**	0.365**
	(0.161)	(0.159)	(0.154)	(0.171)
Assets announced×Financial dependence	0.352			
	(0.717)			
Assets used×Financial dependence		0.430		
		(0.735)		
Bank guarantees×Financial dependence			−0.005	
			(0.020)	
Liquidity support×Financial dependence				−0.076
				(0.334)
Industry indicators	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes
Number of observations	1368	1368	1368	1368
Number of countries	38	38	38	38
R^2	0.121	0.121	0.121	0.121

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate of an industry during the period 2009. * Indicate significance at the 10% level.
*** Indicate significance at the 1% level.
** Indicate significance at the 5% level.

systemic banking crisis in 2009 and 0 if not. The coefficient associated with this interaction term enters positively and statistically significantly different from zero at the 10% level. This suggests that our measure of bank efficiency is not affected by systemic banking crisis. In column (2), we include countries considered as having a borderline systemic banking crisis.[10] As we can see, our variable of interest remains positive and significant at the 10% level. This suggests that deeper bank efficiency enhances the growth rate in terms of real value added for industries that are more dependent on external financing during a crisis.

To continue to test the robustness of our results, we introduce an alternative measure of external financial dependence. This measure is calculated using the same method as Rajan and Zingales (1998), over the period 1980–2006. The results are shown in column (3) of Table 7, and we find that bank efficiency interacted with external financial dependence enters positively and statistically significantly different from zero at the 10% level. To verify that our result is not driven by the financial condition of industries, we then introduce, in column (4), the ratio of liabilities to total assets (leverage), and the ratio of fixed assets to total assets (fixed assets). Doing this, the interaction term between bank efficiency and external financial dependence remains positive and significant at the 5% level, while the coefficient associated with the fixed assets enters negatively and significantly at the 1% level. Finally, columns (5) and (6) control for Tobin's Q and working capital needs. Our main results remain robust and confirm that efficiency in the banking system matters for improved access to all forms of external financing during a crisis, regardless of whether we control for industry and country characteristics.

Considering that 20 out of the 38 countries are European, we also

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[10] These countries are France, Greece, Hungary, Portugal, Russia, Slovenia, Spain, Sweden and Switzerland. For more details, see Laeven and Valencia, (2013a, 2013b)

Table 7

Financial dependence, growth and bank efficiency controlling for banking crisis, external financial dependence measured over the period 1980–2006, industries variables (leverage and fixed assets) as well as Tobin's Q and capital needs.

	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.962***	0.962***	0.964***	0.975***	0.959***	0.966***
	(0.315)	(0.316)	(0.316)	(0.315)	(0.350)	(0.315)
Bank efficiency×Financial dependence	0.301*	0.340*		0.347**	0.314*	0.380**
	(0.160)	(0.181)		(0.154)	(0.177)	(0.166)
Banking crisis×Financial dependence	3.047					
	(3.878)					
Banking crisis border×Financial dependence		0.332				
		(3.883)				
Banking efficiency×Financial dependence (80-06)			0.367*			
			(0.208)			
Leverage				−2.964		
				(3.015)		
Fixed assets				−12.937***		
				(4.663)		
Bank efficiency×Tobin's Q					0.013	
					(0.008)	
Bank efficiency×Capital needs						−0.570
						(1.104)
Industry indicators	Yes	Yes	Yes	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1368	1368	1368	1368	1368	1368
Number of countries	37	37	37	37	38	38
R^2	0.121	0.121	0.120	0.124	0.127	0.119

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate of an industry during the period 2009.
  *** Indicate significance at the 1% level.
  ** Indicate significance at the 5% level.
  * Indicate significance at the 10% level.

Table 8

Financial dependence, growth and bank efficiency using sub-samples of countries, European versus Non-European countries.

	EU	Non-EU
Size	0.770*	0.980**
	(0.464)	(0.441)
Bank efficiency×Financial dependence	0.255	0.531**
	(0.238)	(0.262)
Industry indicators	Yes	Yes
Country indicators	Yes	Yes
Number of observations	720	648
Number of countries	20	18
R^2	0.140	0.121

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate in terms of real value added of an industry during the period 2009.
*** Indicate significance at the 1% level.
  ** Indicate significance at the 5% level.
  * Indicate significance at the 10% level.

investigate whether our results vary when looking at regional sub-samples. Specifically, we re-estimate our main results for European versus non-European countries. The results are presented in Table 8. Using the non-European countries as a sample we find that the interaction term between bank efficiency and external financial dependence remains positive and statistically significantly different from zero at the 5% level. Most importantly, the magnitude of the coefficient

increases and shows that bank efficiency significantly reduced the decline of real value-added growth for industries that are most dependent on external financing.

Finally, we investigate whether the effect of bank efficiency on industry growth for industries that are most dependent on external financing depends on different stages of economic development rather than geographical location. In doing so, we divide the sample in two types of countries: the first type includes countries with high level of economic development and the second consists of emerging econo-mies.[11] However, the interaction term between bank efficiency and financial dependence enters positively but insignificantly in both cases.[12]

4. Concluding remarks

This paper studies the relationship between bank efficiency, finan-cial dependence and economic growth during the 2009 financial crisis. Our study focuses on international evidence from 38 countries over a wide variety of industries. We first find that bank efficiency is positively and significantly related to growth in terms of real value added for financially dependent industries during the crisis. Our results remain robust to the use of several measures of external financial dependence and the use of control variables. We especially control for the level of

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[11] The emerging economies are: Argentina, Brazil, Croatia, India, Lithuania, Latvia, Poland, Russia, Slovenia, Thailand, Turkey, South-Africa, Kenya, Morocco, Pakistan, Peru and the Philippines
[12] These results can be obtained from the author upon request.

Table 9
Financial dependence, growth and bank efficiency using different clusters of the standards errors.

	(1)	(2)	(3)	(4)	(5)
Size	1.156***	1.156***	1.156***	0.961***	0.961***
	(0.280)	(0.316)	(0.405)	(0.329)	(0.457)
Bank efficiency	−0.388***	−0.388***	0.388***	−0.962***	−0.962***
	(0.095)	(0.112)	(0.134)	(0.069)	(0.527)
Financial dependence	−33.663***	−33.663***	−33.663*	−27.007***	−27.007
	(12.927)	(13.075)	(16.816)	(9.768)	(16.729)
Bank efficiency×Financial dependence	0.486***	0.486***	0.486**	0.348***	0.348
	(0.159)	(0.157)	(0.219)	(0.116)	(0.217)
Industry indicators	No	No	No	Yes	Yes
Country indicators	No	No	No	Yes	Yes
Cluster Country level		Yes		Yes	
Cluster Industry level			Yes		Yes
Number of observations	1368	1368	1368	1368	1368
Number of countries	38	38	38	38	38
R^2	0.014	0.0142	0.0142	0.121	0.121

Clustered standard errors by country and industry are in parenthesis, all regressions include a constant, country and industry fixed effects. The dependent variable is the annual growth rate of an industry during the period 2009.
*** Indicate significance at the 1% level.
** Indicate significance at the 5% level.
* Indicate significance at the 10% level.

Table 10
Bank efficiency scores.

Isocode3	Isocode2	Country	Efficiency score	Standard deviation
ARG	AR	Argentina	0.66	0.28
AUS	AU	Australia	0.81	0.05
AUT	AT	Austria	0.81	0.21
BEL	BE	Belgium	0.92	0.17
BRA	BR	Brazil	0.75	0.22
CAN	CA	Canada	0.88	0.15
CHE	CH	Switzerland	0.92	0.11
DEU	DE	Germany	0.87	0.21
DNK	DK	Denmark	0.76	0.22
ESP	ES	Spain	0.91	0.17
FRA	FR	France	0.89	0.19
GBR	GB	United Kingdom	0.94	0.14
GRC	GR	Greece	0.75	0.16
HKG	HK	Hong Kong	0.82	0.20
HRV	HR	Croatia	0.54	0.25
HUN	HU	Hungary	0.78	0.21
IND	IN	India	0.7	0.20
ITA	IT	Italy	0.83	0.17
KEN	KE	Kenya	0.56	0.23
LTU	LT	Lithuania	0.47	0.27
LUX	LU	Luxembourg	0.91	0.19
LVA	LV	Latvia	0.56	0.25
MAR	MA	Morocco	0.65	0.14
MYS	MY	Malaysia	0.76	0.12
NLD	NL	Netherlands	0.81	0.17
NZL	NZ	New Zealand	0.75	0.04
PAK	PK	Pakistan	0.56	0.24
PER	PE	Peru	0.57	0.24
PHL	PH	Philippines	0.51	0.21
POL	PL	Poland	0.59	0.23
PRT	PT	Portugal	0.84	0.19
RUS	RU	Russia	0.73	0.27
SGP	SG	Singapore	0.86	0.09
SVN	SI	Slovenia	0.65	0.27
SWE	SE	Sweden	0.79	0.19
THA	TH	Thailand	0.78	0.20
TUR	TR	Turkey	0.75	0.25
ZAF	ZA	South Africa	0.72	0.22

Table 11
External financial dependence, 1980–1989, across U.S. industries.

ISIC code	Sector	External financial dependence
314	Tobacco	−0.45
361	Pottery	−0.15
323	Leather	−0.14
3211	Spinning	−0.09
324	Footwear	−0.08
372	Nonferrous metal	0.01
322	Apparel	0.03
353	Petroleum refineries	0.04
369	Nonmetal products	0.06
313	Beverages	0.08
371	Iron and steel	0.09
311	Food products	0.14
3411	Pulp, paper	0.15
3513	Synthetic resins	0.16
341	Paper products	0.18
342	Printing and publishing	0.20
352	Other chemicals	0.22
355	Rubber products	0.23
332	Furniture	0.24
381	Metal products	0.24
3511	Basic excluding fertilizers	0.25
331	Wood products	0.28
384	Transportation equipment	0.31
354	Petroleum and coal products	0.33
3843	Motor vehicle	0.39
321	Textile	0.40
382	Machinery	0.45
3841	Ship	0.46
390	Other industries	0.47
362	Glass	0.53
383	Electric machinery	0.77
385	Professional goods	0.96
3832	Radio	1.04
3825	Office and computing	1.06
356	Plastic products	1.14
3522	Drugs	1.49

financial development, bank concentration and competition, cross-border banking, domestic and international public debt, bank supervision, net interest margin, the level of economic development mea-sured by real GDP growth rate, inflation, and trade. We also control our results for exchange rate, changes in monetary policy, and growth opportunities, as measured by the Tobin's Q and working capital needs as alternative measures of financial dependence. This paper contributes to the literature on financial frictions with new evidence on the

Table 12
Variables definitions and data sources.

Variables	Definitions	Sources
Growth	Annual growth rate in real value added in 2009	UNIDO
Size	Logarithm of total assets in 2009	UNIDO
Financial dependence	Industry dependence on external financing 1980 and 1980–2006	RZ and LV
Bank efficiency	Bank efficiency 199–2007	BLMSS
Private credit	Private credit provided by the banking sector	WDI
Inflation	CPI	WDI
Trade	Sum of exports and imports (% GDP)	WDI
Market capitalization	Market capitalization listed companies (% GDP)	WDI
Total capitalization	Sum of private credit and market capitalization (% GDP)	WDI
Bank concentration	Share of assets of the three largest banks/total assets	GFDD 2013
Boone	Boone indicator measures bank competition	GFDD 2013
Lerner	Lerner index measures bank competition	GFDD 2013
International claims	Total international claims (% GDP)	BIS
Local claims	Local claims in local currency (% GDP)	BIS
Public debt	Domestic public debt securities (% GDP)	BIS
Supervisory power	14 dummy variables that indicate whether bank supervisory can take specific actions against bank management, owners and auditors	BDL
Net interest margin	Accounting value of a bank's net interest revenue as a share of its interest-bearing (total earning)	GFDD 2013
Monetary policy	Change in monetary policy August 2008-March 2009	LV
Exchange rate	Exchange rate depreciation August 2008-March 2009	LV
Bank guarantees (percentage of GDP 2008)	Coverage of deposits and/or other liabilities, existing or new Sept. 2008-March 2009	LV
Liquidity support (percentage of GDP 2008)	Change in gross claims of the monetary authorities to financial institutions	LV(2013)
Asset purchases (percentage of GDP 2008)	Assets acquired by the Central Bank, from banking institutions, including loans from the Treasury to banks, but excluding government bonds	LV
Tobin's Q	Ratio of the market value of equity of total assets	LV
Capital needs	Industry median ratio of inventories to sales, plus the ratio of receivables to sales, minus accounts payables to cost of goods sold over the period 2000 to 2009	LV
Crisis	Dummy variable that takes the value of 1 if a country experienced a banking crisis and 0 if not	LV

importance of bank efficiency through the credit channel. Efficiency makes banks more resilient to shocks, thereby positively and significantly affecting the growth rate of industries that are more dependent on external financing.

In terms of policy recommendations, this paper stresses the importance of the quality of the financial sector, i.e. its efficiency, during financial crises. It encourages governments and policy-makers to reform their banking sectors by increasing bank efficiency in order to mitigate the negative impacts of crisis on their economies. This makes their economies more resilient to external shocks, foster economic growth, and increase prosperity.

Despite these interesting results, our analysis is limited to one year, 2009, which was quite an extraordinary year, both for the real economy across large parts of the globe, as well as for banking systems. The approach and analysis presented in this paper could be extended in two interesting ways. First, one could compare our results to the two other economic crises (1990:q3-1992:q2 and 2001:q1-2003:q1). Second, one could analyze the relationship between finance and growth using this new method to measure bank efficiency developed by Barth et al.

(2013) using larger sample periods. This will allow for calculations of a new measure of country-level bank efficiency that will take into account bank size or market share. We leave this for future research.

Appendix A. Bank efficiency measure

Bank efficiency using the DEA approach. This section draws from Barth et al. (2013). Suppose the sample size is n, and there are m inputs and s outputs for each bank. Let $x_j = (x_{j1}, x_{j2}, ..., x_{mj})$ as $m \times 1$ vector of inputs for bank j, $X = (x_1, x_2, ..., x_n)$ as $m \times n$ matrix of inputs, $y_j = (y_{j1}, y_{j2}, ..., x_{sj})$ as $s \times 1$ vector of outputs of bank j, and $Y = (y_1, y_2, ..., y_n)$ as $s \times n$ matrix of outputs, respectively. The outputs are total loans and securities, while the inputs include deposits, labor and physical capital. The data on outputs and inputs are taken from Bankscope and cover 4050 banks over the period 1999–2007. The variable returns to scale the DEA model can be written with the following n linear programming problems for each bank j ($j = 1, 2, ..., n$):

$$\max(\psi_j \geq 1 | x_j, y_j, X, Y) = \max(\psi_j \geq 1 | \psi_j y_j \leq Y\lambda_j, X\lambda_j \leq x_j, \lambda_j \geq 0, I'_1 \lambda_j = 1) \tag{1}$$

where I_1 denotes an $n \times 1$ vector of ones, ψ_j denotes a scalar parameter, and $\lambda_j = (\lambda_{1j}, \lambda_{2j}, ...\lambda_{nj})'$ denotes a $n \times 1$ non-negative vector of parameters.

The intuition of (1) is as follows. For each bank j, a virtual output $Y\lambda_j$ is constructed as a weighted output of all banks by choosing some non-negative weights, $\lambda_j \geq 0$, $I'_1 \lambda_j = 1$. It then seeks to expand the virtual output $Y\lambda_j$ as much as possible, subject to the input constraints of bank j,

$X\lambda_j \leq x_j$. The virtual output $Y\lambda_j$ is then compared with the actual output y_j of bank j. If the maximized virtual output $Y\lambda_j$ is higher than the actual output of bank j by a scalar factor $\psi_j > 1$, then bank j is inefficient. Otherwise, bank j is located at the efficiency frontier since $\psi_j = 1$. So, the input-oriented efficiency score is defined as $eff_j = \frac{1}{\psi_j}$ ($0 \leq eff_j \leq 1$) for bank j (See Table 12).

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