Journal of Banking and Finance 82 (2017) 217–228

Contents lists available at ScienceDirect

Journal of Banking and Finance

journal homepage: www.elsevier.com/locate/jbf

Real effects of bank capital regulations: Global evidence

Yota D. Deli [a], Iftekhar Hasan [b,c,*]

[a] Adam Smith Business School, University of Glasgow, Glasgow, G12 8QQ, UK
[b] Fordham University, 45 Columbus Avenue, New York, NY 10023, USA
[c] Bank of Finland, PO Box 160, 00101 Helsinki, Finland

ARTICLE INFO

Article history:
Received 12 February 2015
Accepted 22 November 2016
Available online 9 December 2016

JEL classification:
G21
G28
E6
O4

Keywords:
Capital regulations
Bank capital
Loan growth

ABSTRACT

We examine the effect of the full set of bank capital regulations (capital stringency) on loan growth, using bank-level data for a maximum of 125 countries over the period 1998–2011. Contrary to standard theoretical considerations, we find that overall capital stringency only has a weak negative effect on loan growth. In fact, this effect is completely offset if banks hold moderately high levels of capital. Interestingly, the components of capital stringency that have the strongest negative effect on loan growth are those related to the prevention of banks to use as capital borrowed funds and assets other than cash or government securities. In contrast, compliance with Basel guidelines in using Basel- and credit-risk weights has a much less potent effect on loan growth.

1. Introduction

Next to monetary and fiscal policy, the promotion of safety and soundness of financial intermediaries has become the third major pillar of public policy. The flagship of financial regulation is the set of regulations on bank capital, as a means to mitigate the risk of bank failures and associated systematic adverse macroeconomic developments. This paper analyzes the effect of the full gamut of capital regulations (termed capital stringency) on loan growth, using a global sample of banks from a maximum of 125 countries over the period 1998–2011.

The theoretical debate on the relation between capital regulations (almost exclusively referring to capital requirements) and loan growth highlights that there are both negative and positive effects, with the former seemingly dominating the debate (for recent studies, see Berrospide and Edge, 2010; Cohen, 2013; Labonne and Lamé, 2014; Bridges et al., 2015; De Nicolo, 2015). Higher capital requirements would, in principle, lead banks to downward manage their risk-weighted assets to meet the requirement. This would essentially imply a downward shift in lending, especially if banks do not have high enough capital buffers and face either difficulty or high cost in raising new capital. The same argument can be made for other rules and regulations leading to increased capital stringency, as these regulations increase the burden and cost of raising capital and lead banks to curtail their risk-weighted assets. To the extent these effects pass to the real economy, higher capital stringency implies lower levels of investment and hurts economic growth.

In contrast, more stringent capital regulation can be credit growth-enhancing if it successfully shields the banking sector against crises that have a negative impact on the economy. The premise is that by increasing capital stringency, banks will curtail their more risky projects and rebalance their portfolios toward more prudent ones. Through the associated decline in the probability of bank defaults, higher-quality lending will expand in the medium- to long-run, leading to a Pareto improvement in the market for loans, investment, and economic growth.

There are two novel elements in our study. First, we use the implications of the literature on capital requirements and credit growth, but turn the spotlight on the rather neglected effects of other types of capital stringency. De Nicolo (2015) is to our knowledge the only study providing a global analysis on the effect of capital requirements (rules on risk-weighted assets, measured by the equity to asset ratio) on credit growth, but in this study the effect of the overall capital stringency (introduced by Barth et al., 2013a,b) and its several subcomponents is not examined. Besides compliance with rules on risk-weighted assets, we also examine

* Corresponding author at: Fordham University, 45 Columbus Avenue, New York, NY 10023, USA.
E-mail addresses: Yota.Deli@glasgow.ac.uk (Y.D. Deli), ihasan@fordham.edu (I. Hasan).

http://dx.doi.org/10.1016/j.jbankfin.2016.11.022
0378-4266/

the effects of (i) the exclusion from risk-based capital ratio of loan losses, unrealized securities losses, and foreign exchange losses; and (iii) rules on the sources of initial and recapitalization of banks. To this end, our findings are directly relevant to both the lively policy debate on the impact of further raising capital requirements and to the unexplored effects of other important aspects of capital stringency.

Second, by looking at virtually all countries and associated regulatory practices, we provide the first global perspective on the nexus between general capital stringency and its individual components and loan growth. This analysis allows insightful suggestions from the large variation in the regulatory systems between countries, better identification of causal relations, differences in the results between groups of countries and across time, and associated policy implications.

We first examine the effect of general capital stringency on loan growth. This indicator encapsulates ten different regulatory laws on the three broader regulatory tools discussed above (Barth et al., 2013a,b). These ten different policies receive an equal weight to construct a single general index of *capital stringency*. Subsequently, we decompose *capital stringency* to its components to examine the separate effects of each one of these capital regulations on loan growth.

Our identification method builds on previous studies on the effects of macroeconomic variables on loan growth (e.g., Jimenez et al., 2012; Delis, 2012). We use bank-level panel data and assume that banks with different levels of capital and/or liquidity will be able to buffer the adverse effects of capital regulation on loan growth. Thus, we obtain inference from the interaction term between capital stringency (or its components) and the capital or liquidity of individual banks at the time there is a change in capital stringency. Given the additional inclusion in our model of a large set of bank-level, regulatory, and macroeconomic variables, as well as elimination of bank fixed effects via first differencing, this practice insulates our empirical model from demand-side and other macroeconomic explanations of the estimates.

We find that capital stringency has a negative effect on loan growth only for the banks with very low levels of capital. Specifically, a bank with a basic equity capital ratio close to the average in our sample (10%) needs to raise this ratio only by approximately 1% to completely buffer the negative effect of a one point increase in the level of the capital stringency index. This level of capital buffer is quite lower for banks that also have higher levels of liquidity compared to the average bank in our sample. Moreover, the negative effect of capital stringency almost completely disappears for a bank with an average level of capital if we exclude the period of the global financial crisis.

Our baseline results are robust to a number of re-specifications and sensitivity tests. One important sensitivity test, for the elimination from our model of demand-side explanations of our findings, is the introduction of a triple interaction term of capital stringency, bank capital, and a measure of bank importance in the financing of economic activity. We expect that if we failed to thoroughly control for demand-side elements affecting the relation between capital stringency and credit provision, the coefficient estimates identified as supply-side forces will be weaker in the bank-based financial systems because in these systems there are limited alternative sources of finance and stronger demand for bank credit. However, we do not find a strong effect.

To better understand which types of economies are affected by the more stringent capital requirements, we follow the analysis of Bekaert et al. (2007) who suggest that financial development and openness of the economy in particular play an important role on the growth opportunities of an economy. We document significant cross-country heterogeneity in our results with banks operating in countries more financially developed and open being able to raise capital more easily.

Further, by using three-year averages of our variables, we show that the negative effect of capital stringency further weakens in the medium- to long-run, but results do not turn positive as our theoretical priors would predict. This finding is also robust to taking longer-term averages of our variables. Thus, an increase in the general capital stringency index does not seem to have permanent effects on loan growth. This is in contrast to De Nicolo (2015), who suggests that the long-term effect of an increase in capital ratios on bank loans is significant and relatively large.

Looking at the components of capital stringency, we find that the adoption of Basel-type risk-weighted capital ratios and credit-risk weights negatively affects loan growth, but again banks with moderately high levels of capital can insulate their lending from these policies. This finding is in line with the literature on the negative nexus between capital requirements and lending (e.g., Bridges et al., 2015; De Nicolo, 2015), but notes that the relevant effects are not as potent as previously thought.

In contrast, the most important negative effect comes from the adoption of very stringent rules concerning the initial disbursement or subsequent injections of capital. Specifically, if regulation allows only cash or government securities to be used for the capitalization of banks, the average bank needs to almost double its equity capital to leave its loan growth unaffected. Given that this would be a very costly option, banks would most probably decide to significantly curtail their loans. Thus, it is the way banks capitalize their asset that has a negative effect on growth. This finding also shows that in the absence of such rules, the effect of other types of capital stringency on loan growth would be limited. Finally, we do not find significant effects from the exclusion from the risk-based capital ratio of loan losses, unrealized securities losses, and foreign exchange losses.

Besides the literature on the relation between capital requirements and loan growth, our analysis and findings relate to a large number of theoretical and empirical papers on the real effects of capital requirements. VanHoose (2008) and Athanasoglou et al. (2014) review this literature and suggest that the theoretical and empirical findings are mixed. For example, Blum and Hellwig (1995) theoretically show that bank capital regulation may reinforce macroeconomic fluctuations. Van den Heuvel (2008) shows that bank capital requirements result in a consumption-based welfare loss of up to 1% per annum. On the other hand, Admati et al. (2010) discuss thoroughly why raising new capital is not overly expensive for banks, which implies negligible macroeconomic effects.

The rest of the paper is structured as follows. Section 2 describes the empirical model, the identification method, and the data and variables used for the empirical analysis. Section 3 discusses the empirical results. Section 4 offers policy implications and concludes the paper.

2. Empirical identification and data

2.1. Econometric identification

Our empirical analysis first considers the short-term effect of capital stringency on credit expansion of individual banks and subsequently the equivalent long-term responses. To this end, we consider the following reduced-form specification:

$$L_{b,i,t+1} - L_{b,i,t} = a_0 + a_1\left(L_{b,i,t} - L_{b,i,t-1}\right) + a_2 CS_{i,t} + a_3 B_{b,i,t} + a_4 CS_{i,t} * B_{b,i,t} + a_5 X_{b,i,t} + \lambda_t + \nu_b + u_{b,i,t} \quad (1)$$

where L is the stock of loans of bank b operating in country i in year t; CS is the regulatory capital stringency in country i and year t; B is a set of bank characteristics (bank capital and liquidity as we discuss below) that allow identification of supply-side

effects of capital stringency on loan growth; X is a vector of other bank- or country-level control variables; λ and v are year and bank fixed effects, respectively; and u is the remainder disturbance. We run most of our empirical tests using annual data (short-term responses), but we also consider longer-term responses using the equivalent model for three-year averages of the data.

An important problem in identifying a causal effect of capital stringency on loan growth is the potential existence of unobserved variables that are correlated with both *CS* and loan growth.[1] These variables could be either unobserved bank characteristics like the demand faced for bank loans, or country-specific characteristics like other types of financial regulations, general (country-level) loan demand conditions, and elements of financial development.

We reduce this omitted-variable bias by taking a number of steps. First, the estimation of Eq. (1) in differences to eliminate bank fixed effects allows capturing the time invariant bank characteristics affecting loan growth. Thus, we obtain identification from the within-bank variation in loan growth before and after a change in capital stringency. Second, we use a full set of control variables for bank characteristics, other types of regulations, country-specific financial development, and the phase of the business cycle.

Third, we rely on an extensive literature suggesting that empirical identification of policy effects in loan-growth equations can be obtained from bank-level panel data and the interaction of a policy variable with certain bank characteristics (e.g., Kashyap and Stein, 2000; Jimenez et al., 2012; Delis, 2012). The main argument of this literature is that banks with strong availability of capital and/or liquidity should be able to, at least partially, reduce the negative effects of capital requirements on loan growth. This would imply a negative coefficient on a_2 in Eq. (1) and a positive coefficient on a_4.

This type of analysis also reduces the potential effects of unobserved demand-side variables affecting loan growth. For example, the literature on the credit channel of monetary policy uses interaction terms between e.g. the monetary instrument and bank capital to identify changes in loan supply from changes in loan demand. In our analysis, capital regulation is by its own nature a policy primarily affecting the business model of banks (loan supply) and not so much the model of borrowers (loan demand). Still, the interaction term in Eq. (1) should further purify the coefficients of main interest from demand-side forces, because the level of capital buffers and liquidity at the time of a change in bank regulations is decided within the business model of banks.

Fourth, in an even more restrictive model, we introduce a triple interaction term between capital stringency, bank capital, and bank importance. The idea for this test follows from the premise that if there are still unobserved demand-side forces biasing our estimates in Eq. (1), then these would be more potent in countries where alternative sources of finance are relatively scarce. Thus, the coefficient on the triple interaction term would be statistically and economically significant. Essentially, this is a placebo test against the demand-side explanation of our findings.

Eq. (1) represents a dynamic panel data model, and thus we estimate it using the GMM for dynamic panels proposed by Blundell and Bond (1998) and discussed in an applied setting by Roodman (2009).[2] For efficiency-related reasons, we use the two-step estimator with robust standard errors, which are adjusted with Windmeijer's (2005) correction procedure. The GMM also allows instrumenting the control variables (using lags) and reduce the potential endogeneity of these variables that could in turn bias the results on the coefficients of main interest. We test the validity of these instruments using a standard Hansen test and verify that our models do not suffer from autocorrelation.

2.2. Data and variables

We use bank-level data from Bankscope for a maximum of 125 countries over the period 1998–2011.[3] Table 1 provides a collective, formal definition of the variables in the empirical analysis and Table 2 provides summary statistics.

Capital stringency is measured at the country-year level using an aggregate indicator that summarizes the laws and regulations on the capitalization of banks. The data for *capital stringency* are from the survey by Barth et al. (2013a,b) and earlier versions. In the empirical analysis, we consider the effect of both the *capital stringency* indicator and its ten subcomponents on loan growth, the latter obtained at the bank-year level from Bankscope.

The ten components of capital stringency are: *Basel risk-weights, credit risk-weights, market risk-weights, deducted loan losses, deducted securities, deducted foreign exchange losses, revaluation gains, initial stringency 1, initial stringency 2*, and *initial stringency 3*. Each of these components answers to a different question concerning the commitment of the banks and regulators on specific types of capital stringency (see Table 1). Evidently, despite the adoption of the Basel guidelines by a large number of countries, the global difference in the level of overall capital stringency remains considerable (Barth et al., 2013a,b). The ten components can broadly be grouped into regulations referring to (i) compliance with specific rules concerning risk-weighted assets (the first three components); (ii) exclusion from risk-based capital ratio of loan losses, unrealized securities losses, and foreign exchange losses (second three components); and (iii) rules on the sources of initial and recapitalization of banks (last four components).

As discussed above, the bank characteristics to be interacted with *capital stringency* and its components (named B in Eq. (1)) are *bank capital* (measured by the ratio of equity capital to total assets)[4] and *bank liquidity* (ratio of liquid assets to total assets). These are the variables used in most of the related literature to identify supply-side effects of macroeconomic determinants on bank-level outcomes (e.g., Kashyap and Stein, 2000; Jimenez et al., 2012; Delis, 2012; Elyasiani et al., 2014).

For the control variables (X in Eq. (1)) we first use at the bank level the natural logarithm of total assets to control for bank size and the ratio of loan-loss provisions to total loans to control for credit risk.[5] Further, an important set of control variables includes the level of financial development in each country and other types

[1] Given that the right-hand side variables explain future loan growth and we account for dynamics in loan growth in Eq. (1), reverse causality is a less significant problem.

[2] Note that we write Eq. (1) in differences only with respect to the dependent variable (and its lag), but the rest of the variables are in levels. The reason is that we examine the effect of the right-hand side variables on loan growth (and not the level of lending). This is not to be confused with the procedures of the Blundell and Bond (1998) estimator, which uses both levels and differences in the estimation procedure (see Roodman, 2009). Thus, Eq. (1), exactly as written, is estimated using the software modules for the Blundell and Bond estimator.

[3] We restrict our analysis to the period up to 2011 due to availability of data for capital regulations.

[4] Perhaps a more informative measure of capital would be the Basel-related measure based on risk-weighted assets. However, there are severe data constraints in using this measure and such an analysis would imply dropping more than 90% of our sample, yielding clear sample selection problems and a much more limited scope for our analysis. Further, even where data exists, there is heterogeneity in the definition of risk-weighted assets between countries. For these reasons, most of the literature using an international sample of banks relies on the basic capital ratio (e.g., Delis, 2012).

[5] Perhaps a better measure of credit risk is the ratio of non-performing loans to total loans. Unfortunately, this measure is available for fewer banks in Bankscope and thus we prefer the provisions-based measure to avoid a significant reduction in the number of observations and country coverage. We do, however, examine the sensitivity of our results to the inclusion on the non-performing loans ratio.

Table 1
Variable definitions and sources.

Variable	Description	Source
A. Dependent variable		
Loan growth	Annual growth in gross loans by bank.	Bankscope
B. Main explanatory variables		
Capital stringency	Shows the general capital stringency of the banking systems and is the sum of the above ten components.	Barth et al. (2003, 2013a,b)
Basel risk weights	Dummy that takes the value one if the answer to the question "Is the bank capital ratio risk-weighted in line with Basle guidelines?" is yes and zero otherwise.	Barth et al. (2003, 2013a,b)
Credit risk weights	Dummy that takes the value one if the answer to the question "Does the ratio vary with a banks' credit risk?" is yes and zero otherwise.	Barth et al. (2003, 2013a,b)
Market risk weights	Dummy that takes the value one if the answer to the question "Does the ratio vary with market risk?" is yes and zero otherwise.	Barth et al. (2003, 2013a,b)
Deducted loan losses	Dummy that takes the value one if the answer to the question "Before minimum capital adequacy is determined which items are deducted from capital?" is the market value of loan losses and zero otherwise.	Barth et al. (2003, 2013a,b)
Deducted securities	Dummy that takes the value one if the answer to the question "Before minimum capital adequacy is determined which items are deducted from capital?" is unrealized securities losses and zero otherwise.	Barth et al. (2003, 2013a,b)
Deducted foreign exchange losses	Dummy that takes the value one if the answer to the question "Before minimum capital adequacy is determined which items are deducted from capital?" is unrealized foreign exchange losses and zero otherwise.	Barth et al. (2003, 2013a,b)
Revaluation gains	Dummy that takes the value one if the answer to the question "What fraction of revaluation gains is allowed as part of capital?" is lower than 0.75 and zero otherwise.	Barth et al. (2003, 2013a,b)
Initial stringency 1	Dummy that takes the value one if the answer to the question "Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities?" is no and zero otherwise.	Barth et al. (2003, 2013a,b)
Initial stringency 2	Dummy that takes the value one if the answer to the question "Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?" is yes and zero otherwise.	Barth et al. (2003, 2013a,b)
Initial stringency 3	Dummy that takes the value one if the answer to the question "Can initial disbursement of capital be done with borrowed funds?" is no and zero otherwise.	Barth et al. (2003, 2013a,b)
C. Control variables		
Bank importance	The ratio of private credit provided by banks to stock market capitalization. Stock market capitalization as a share of GDP. Stock market capitalization equals the value of listed shares divided by GDP.	Beck et al. (2000)
Activity restrictions	The score for this variable is determined on the basis of the level of regulatory restrictiveness for bank participation in: (1) securities activities, (2) insurance activities, (3) real estate activities, and (4) bank ownership of non-financial firms. These activities can be unrestricted, permitted, restricted or prohibited and are assigned the values of 1, 2, 3 or 4, respectively. This index takes a value from 0 to 16, with larger values denoting more stringent activity restrictions.	Cihak et al. (2012) and Barth et al. (2000, 2003, 2008).
Supervisory power	Index of the powers of the supervisor of the banking sector, reflecting whether the supervisory agency has the authority to take specific actions to prevent and correct problems in the banking sector. Takes values from 0 to 14, with higher values reflecting more supervisory powers.	Cihak et al. (2012) and Barth et al. (2000, 2003, 2008).
Market discipline	This index shows the degree to which banks are forced to disclose accurate information to the public and whether there are incentives to increase market discipline. Higher values indicate higher disclosure requirements and more incentives to increase market discipline. It takes values from 0 to 9.	Cihak et al. (2012) and Barth et al. (2000, 2003, 2008).
Bank capital	The ratio of total equity to total assets.	Bankscope
Bank liquidity	The ratio of liquid assets to total assets.	Bankscope
Bank loan-loss provisions	The ratio of loan-loss provisions to total loans.	Bankscope
Bank size	The natural logarithm of total assets.	Bankscope
GDP growth	Annual rate of GDP growth.	WDI
Gross fixed capital formation	Gross fixed capital formation as a share of GDP. Gross fixed capital formation includes land improvements, plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.	WDI
Financial development	Currency plus demand and interest-bearing liabilities of banks and other financial intermediaries (i.e. liquid liabilities) divided by GDP. This is the broadest available indicator of financial intermediation, since it includes all three financial sectors.	Beck et al. (2000)
Trade openness	Imports plus exports as a share of GDP.	Penn World Tables
Government spending	Level of government expenditure as a share of GDP.	WDI
Rule of law	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately −2.5 to 2.5.	Worldwide Governance Indicators
Interest rate freedom	Index for credit market freedom. Interest rate controls and the magnitude of negative real interest rates if present. Countries with interest rates determined by the market, stable monetary policy, and positive real deposit and lending rates received higher ratings. When interest rates were determined primarily by market forces and the real rates were positive, countries were given a rating of 10. A zero rating was assigned when the deposit and lending rates were fixed by the government and real rates were persistently negative by double-digit amounts or hyperinflation had virtually eliminated the credit market.	Economic Freedom of the World Project
Interest rate	The lending interest rate adjusted for inflation as measured by the GDP deflator.	WDI
Inflation	The GDP deflator.	WDI

Table 2
Summary statistics.
The table reports the number of observations and basic summary statistics for the variables used in the empirical analysis. Panel A reports the summary statistics for the cross-sectional (cross-country) sample. Panel B.

Variable	Observations	Mean	Std. dev.	Min.	Max.
Loan growth	74,875	0.08	0.27	−7.41	6.01
Capital stringency	78,241	6.87	1.15	3.00	10.00
Basel risk weights	81,101	0.84	0.36	0.00	1.00
Credit risk weights	80,423	0.50	0.50	0.00	1.00
Market risk weights	78,848	0.53	0.50	0.00	1.00
Deducted loan losses	79,779	0.59	0.49	0.00	1.00
Deducted securities	79,406	0.85	0.35	0.00	1.00
Deducted foreign exchange losses	79,435	0.79	0.41	0.00	1.00
Revaluation gains	79,731	0.92	0.27	0.00	1.00
Initial stringency 1	81,031	0.85	0.36	0.00	1.00
Initial stringency 2	80,992	0.35	0.48	0.00	1.00
Initial stringency 3	81,018	0.65	0.48	0.00	1.00
Bank importance	79,166	0.98	0.51	0.00	2.72
Market discipline	87,794	5.68	0.90	2.00	9.00
Supervisory power	87,815	11.09	2.26	1.00	14.00
Activity restrictions	87,723	8.97	2.48	1.00	16.00
Bank capital	89,014	0.10	0.08	−2.58	1.00
Bank liquidity	89,014	0.18	0.16	−0.05	1.00
Bank loan-loss provisions	86,448	0.01	0.67	−5.70	180.54
Bank size	89,019	12.87	1.67	7.70	21.51
GDP growth	82,146	2.25	3.24	−17.96	34.50
Gross fixed capital formation	81,519	20.29	3.36	2.44	57.71
Financial development	78,602	0.86	0.48	0.00	4.78
Trade openness	81,997	59.74	39.88	15.84	445.91
Government spending	88,756	51.12	20.76	0.00	99.30
Rule of law	82,151	1.11	0.89	−1.89	2.01
Interest rate freedom	73,133	8.31	0.87	0.50	10.00
Interest rate	69,938	5.16	6.74	−72.56	93.92
Inflation	82,146	3.40	7.49	−32.81	556.94

of bank regulations. Specifically, we use a measure of bank importance, which is calculated as the ratio of private credit provided by banks to stock market capitalization (data are from Beck et al., 2009, 2013). The higher is this ratio, the higher is the relative importance of bank-based finance (in a given country and year) compared to market-based finance of economic activity. Importantly, we also control for financial development (measured by the ratio of liquid liabilities to GDP), especially given the common trends between higher capital stringency and increased financial development. Also, to prevent *capital stringency* from capturing the effects of other types of banking regulations, we use the database of Barth et al. (2013a,b) to control for activity restrictions placed on banks (termed *activity restrictions*), the powers of the official supervisory authority (*supervisory power*), and the applicability of market-discipline related regulations (*market discipline*).[6] We also use the interest-rate regulations variable from the Economic Freedom of the World Project to measure credit-market freedom.

Moreover, we control for the general macroeconomic conditions prevailing in each country using *GDP growth* and investment growth (*gross fixed capital formation*). Information for these two variables is from the World Development Indicators (WDI). We also use trade openness (measured by the sum of exports and imports as a share of GDP), the level of government expenditure as a share of GDP, and the real interest rate and the inflation rate (to control for the monetary conditions prevailing in each country).

In turn, we use a number of institutional indices to explain loan growth. We resort to the variable characterizing the quality of the legal system and the enforcement of laws (*rule of law*) from the Worldwide Governance Indicators. We experiment with many other relevant indices (e.g., the ones from the International Country Risk Guide, the Freedom House, and the Polity IV project), but we find that most are insignificant determinants of loan growth in our sample or are highly correlated with *rule of law*.

3. Estimation results

3.1. Effect of general capital stringency

We begin our empirical analysis by using annual data to examine the short-term response of *loan growth* to *capital stringency*. To identify the GMM models, we use as instruments the second lags of all right-hand side control variables. This practice also reduces endogeneity concerns stemming from bias in the estimation of control variables.[7] As indicated in the lower part of our tables, the use of these instruments yields values on the AR2 and Hansen tests that easily reject the null hypotheses of second-order autocorrelation and invalid instruments, respectively.

In Table 3 we report six variants of Eq. (1) based on the use of different control variables and identification through interaction terms with *bank capital* or *bank liquidity*. All equations include year fixed effects (bank fixed effects are eliminated by the GMM). We mean-center the variables involved in the interaction terms to directly interpret the estimates on the main term as the effect of e.g. *capital stringency* for the bank with an average level of *bank capital*.

In column (1) we report the results with controls for bank characteristics, other types of bank regulations, financial development, and economic growth. The results on the main term of *capital stringency* show that a one point increase in this variable decreases loan growth by 3.5%. However, the interaction term shows that even for moderate levels of *bank capital*, the negative effect of capital stringency vanishes. Specifically, by taking the derivative

[6] Comprehensive definitions are provided in Table 1. See also Claessens and Laeven (2004), Beck et al. (2006), Cihak et al. (2012) and Barth et al. (2013a,b).

[7] As we suggest in the previous section, the main reason for using these instruments is not to identify the causal effect of capital stringency (which is identified through the interaction terms), but rather to deal with the dynamic nature of our model.

Table 3
General capital stringency and credit growth
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of Eq. (1). The dependent variable in all regressions is the bank-level loan growth from year *t* to year *t*+1, over the period 1997–2011. All variables are defined in Table 1. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure), and include year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Lagged loan growth	0.075***	0.089***	0.075***	0.093***	0.074***	0.088***
	(5.224)	(5.766)	(5.277)	(6.092)	(5.155)	(5.650)
Bank capital	0.237	0.473*	0.199	0.391*	0.475	1.078**
	(1.416)	(1.707)	(1.186)	(1.672)	(1.084)	(2.029)
Bank liquidity	0.200***	0.134*	0.186***	0.161**	0.298**	0.396*
	(3.602)	(1.840)	(3.276)	(2.091)	(1.985)	(1.806)
Capital stringency	−0.035**	−0.045**	−0.034**	−0.048***	−0.082**	−0.089**
	(−2.276)	(−1.960)	(−2.319)	(−2.861)	(−1.968)	(−2.108)
Capital stringency * bank capital	0.291**	0.401***			0.311**	0.360***
	(2.057)	(3.148)			(2.484)	(3.577)
Capital stringency * bank liquidity			0.142***	0.182***	0.182**	0.190**
			(2.983)	(2.957)	(2.124)	(2.110)
Bank capital * bank liquidity					1.425	1.742
					(0.720)	(0.957)
Capital stringency * bank capital * bank liquidity					0.851**	0.868***
					(2.462)	(2.867)
Market discipline	0.015*	0.071***	0.021*	0.032	0.009	0.075***
	(1.728)	(3.005)	(1.764)	(1.132)	(0.858)	(2.918)
Supervisory power	−0.048***	−0.018**	−0.043***	−0.040***	−0.050***	−0.020**
	(−6.655)	(−2.051)	(−4.510)	(−4.084)	(−6.517)	(−2.256)
Activity restrictions	−0.038***	0.001	0.025***	−0.002	0.031***	0.000
	(−4.724)	(0.067)	(2.688)	(−0.143)	(3.706)	(0.014)
Bank loan-loss provisions	−0.305	0.217	−0.220	0.324	−0.221	0.236
	(−1.454)	(0.932)	(−0.953)	(0.942)	(−1.052)	(0.935)
Bank size	−0.099***	−0.037***	−0.115***	−0.034**	−0.105***	−0.035**
	(−7.950)	(−2.726)	(−6.096)	(−2.059)	(−7.707)	(−2.461)
Bank importance	0.051	−0.263**	0.061	−0.229*	0.056	−0.209
	(1.366)	(−2.033)	(1.643)	(−1.831)	(1.500)	(−1.580)
GDP growth	0.021***	0.043***	0.022***	0.039***	0.020***	0.046***
	(6.056)	(5.443)	(6.338)	(4.937)	(5.446)	(5.303)
Gross fixed capital formation		0.039***		0.039***		0.040***
		(5.180)		(4.880)		(5.487)
Financial development	0.243**	0.289**	0.484**	0.423**	0.477***	0.458***
	(2.265)	(2.361)	(2.073)	(2.082)	(2.856)	(2.715)
Trade openness		0.003***		0.004***		0.003***
		(3.495)		(4.045)		(3.714)
Government spending		0.005***		0.007***		0.005***
		(3.234)		(3.669)		(3.202)
Rule of law		1.868**		1.765**		1.563**
		(2.481)		(2.446)		(2.269)
Interest rate freedom		0.100***		0.072***		0.102***
		(4.745)		(3.084)		(4.720)
Inflation		−0.009*		−0.011**		−0.011**
		(−1.776)		(−2.113)		(−2.231)
Observations	58,524	41,275	58,524	41,275	58,524	41,275
Number of banks	9473	7956	9473	7956	9473	7956
AR2	0.128	0.236	0.133	0.281	0.111	0.220
Hansen	0.251	0.183	0.266	0.170	0.303	0.192

of *loan growth* with respect to *capital stringency*, we find that the average bank in our sample needs to increase its basic equity capital ratio by an additional 2% (calculated by subtracting the average of 0.10 in our sample from 0.035/0.291 = 0.12) to completely buffer the effect of an increase in *capital stringency*. In column (2), where we additionally control for the rest of the macroeconomic variables, the equivalent required increase in bank capital is only 1%. We use this specification as our baseline model to form policy implications.

In columns (3) and (4) we repeat the analysis of the first two columns with *bank liquidity* interacted with *capital stringency*. The results are quite similar with those reported in the first two columns, with the most liquid banks being able to buffer the negative effect of an increase in capital stringency. However, in contrast to the results in the first two columns, a more substantial liquidity injection is required for the average bank in our sample to mitigate the adverse effects of capital stringency.

Given that capital is the main policy variable in banking, we further refine our results by including in columns (5) and (6) the triple interaction term between *capital stringency, bank capital*, and *bank liquidity*. This analysis provides a more restrictive model against demand-side omitted variables because it includes both types of bank characteristics as interactive terms. In line with the results of the previous specifications, we find that both higher levels of capital and liquidity contribute to mitigating the adverse effects of increase capital stringency. Working with the results of the specification with the full set of control variables (column 6) and using the mean value of bank liquidity in our sample (equal to 0.18), we calculate the level of bank capital at which the negative effect of capital stringency is reversed to again be approximately 11%.

Table 4
General capital stringency and credit growth: Excluding the crisis period.
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of Eq. (1). The dependent variable in all regressions is the bank-level loan growth from year t to year $t+1$, over the period 1997–2007. All variables are defined in Table 1. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure). The regressions replicate those of Table 3 in terms of control variables and also include year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Lagged loan growth	0.058***	0.095***	0.056***	0.086***	0.060***	0.089***
	(4.044)	(5.646)	(3.842)	(4.486)	(4.225)	(5.345)
Bank capital	0.078	−0.199	−0.024	−0.238	−0.267	−0.565
	(0.389)	(−0.785)	(−0.123)	(−0.781)	(−0.491)	(−0.674)
Bank liquidity	0.149**	0.305**	0.137**	0.440***	0.113*	0.538**
	(2.450)	(2.271)	(2.267)	(3.093)	(1.795)	(2.253)
Capital stringency	−0.026*	−0.027*	−0.025*	−0.028*	−0.036*	−0.024*
	(−1.854)	(−1.897)	(−1.779)	(−1.797)	(−1.922)	(−1.864)
Capital stringency * bank capital	0.253**	0.265**			0.248***	0.274*
	(2.481)	(2.591)			(3.530)	(1.790)
Capital stringency * bank liquidity			0.109***	0.137***	0.147**	0.117
			(2.905)	(3.190)	(2.196)	(1.624)
Bank capital * bank liquidity					1.239	1.860
					(0.617)	(0.592)
Capital stringency * bank capital * bank liquidity					0.665**	0.633**
					(2.372)	(2.014)
Observations	46,734	33,917	46,734	33,917	46,734	33,917
Number of banks	8971	7588	8971	7588	8971	7588
AR2	0.133	0.207	0.125	0.216	0.140	0.201
Hansen	0.250	0.155	0.207	0.143	0.276	0.158

In a nutshell, the results from the baseline specifications of Table 3 show that only a very moderate increase in the basic equity capital ratio is sufficient to completely eliminate the negative effect of an increase in regulatory capital stringency on loan growth. Capital stringency changes in our sample from approximately 6.06 in 1997 to approximately 7.71 in 2011, which is an increase of 1.65 points. For this increase, and again using the results in column (2) of Table 3, bank capital needs to increase by 1.65% points to completely buffer the effects. Evidently, the basic capital ratio increased from an average of about 8% in 1997 to an average of about 11% in 2011, which more than covers the negative effects of increased capital stringency, while in this period our data show an average 8% annual expansion in lending. We may conclude from this analysis that increased stringency in bank capital regulations does not have a strong negative effect on loan growth.

A better measure of credit risk is the ratio of non-performing loans to total loans, although this measure is available for fewer banks. As a robustness check, we use *non-performing loans* instead of *provisions* (see Table A1 of Appendix A) and we observe that the results are similar to those of Table 3.

We carry out an extensive set of sensitivity tests on these main results. First, in the specifications of Table 4, we exclude the time period after the eruption of the global financial crisis (i.e., we exclude the period from 2008 onward).[8] The concern with the inclusion of the crisis period is that, despite controlling for relevant variables, there could still be an endogenous relation between capital stringency, bank capital availability, and other elements of the regulatory and macroeconomic environment. The source of this endogeneity can be traced, inter alia, in other unobserved policy responses to the crisis or to unobserved local factors contributing to the capital and liquidity crunch during the crisis period.

In general, the results show that even lower levels of capital (see columns 1 and 2) and liquidity (see columns 3 and 4) are required to completely buffer the negative effect of capital stringency on loan growth. Specifically, according to the results in column (2), a bank with an equity capital ratio very close to our sample's average can completely offset the negative effect of *capital stringency* and, according to the results in column (4), the same holds for a bank with a liquidity ratio approximately equal to 20% (and bank capital equal to our sample's mean value). These findings are intuitive given that the higher availability of capital and liquidity in normal economic periods provides ample room for capital and liquidity management to stimulate loan growth and banks are not reluctant to use capital buffers to this end.

Second, we analyze whether our results are different between bank- and market-based economies. We expect that if we failed to thoroughly control for demand-side elements affecting the relation between capital stringency and credit provision, the coefficient estimates identified as supply-side forces will be weaker in the bank-based financial systems because in these systems there are limited alternative sources of finance and stronger demand for bank credit. To test this premise, we introduce the triple interaction term between *capital stringency, bank capital*, and *bank importance*. We find (column 1 of Table 5) that this term is statistically insignificant, implying that we do not identify differences in our baseline results in systems where borrowers rely more on bank credit and thus potentially having more inelastic demand for bank loans.

There could, however, exist other country-specific sources of heterogeneity in our results, without these sources being specifically related to demand-side explanations of our findings. For example Bekaert et al. (2007) stress the importance of financial openness and financial development on economic growth and show that in more integrated economies, growth opportunities are better aligned with actual growth, with financial openness being quite important. In general, the effect of market regulations on loan growth may be quite different in open economies than in segmented economies, because both the supply and demand for credit may have international components and banks may raise capital more easily.

To examine the role of financial development and openness in the relation between capital stringency and loan growth, we introduce (in different specifications) triple interaction terms including *financial development* and *trade openness*. We expect that the more

[8] For expositional brevity, we report from this point onward only the estimates on the variables of main interest.

Table 5
General capital stringency and credit growth: Interactions with bank importance, financial development, and trade openness
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of Eq. (1). The dependent variable in all regressions is the bank-level loan growth from year *t* to year *t*+1, over the period 1997–2007. All variables are defined in Table 1. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure). The regressions include the full set of control variables also included in Column (2) of Table 3 and year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1) Bank importance	(2) Financial development	(3) Trade
openness			
Lagged loan growth	0.079***	0.084***	0.085***
	(5.246)	(5.817)	(5.166)
Bank capital	0.779**	0.343	−0.406
	(2.010)	(0.436)	(−0.399)
Capital stringency	−0.023	0.434***	0.124
	(−0.472)	(4.485)	(1.060)
Capital stringency * bank capital	0.507	−2.547***	−1.686
	(1.558)	(−3.019)	(−1.428)
Bank importance	11.418**	9.998***	7.091***
	(2.441)	(3.864)	(2.621)
Bank capital * bank importance	−15.035		
	(−0.722)		
Capital stringency * bank importance	−1.691		
	(−0.694)		
Capital stringency * bank importance* bank capital	3.617		
	(0.250)		
Bank capital * financial development		0.618	
		(0.451)	
Capital stringency * financial development		−0.469***	
		(−4.972)	
Bank capital * capital stringency * financial development		2.894***	
		(2.761)	
Trade openness			−0.020
			(−0.938)
Bank capital * trade openness			0.196
			(1.143)
Capital stringency * trade openness			−0.028*
			(−1.721)
Bank capital * capital stringency * trade openness			0.370**
			(2.184)
Constant	0.484*	1.030***	0.599*
	(1.697)	(3.258)	(1.696)
Observations	40,915	40,915	40,915
Number of banks	7847	7847	7847
AR2	0.346	0.288	0.224
Hansen	0.109	0.115	0.123

financially developed or open an economy is, the easier will be for the banks to buffer the negative effects of an increase in capital stringency.[9] The results in columns (2) and (3) of Table 5 are in line with these expectations. In particular, in both specifications the triple interaction term is positive indicating indeed that banks operating in more financially developed or more open economies face smaller constraints to raise capital and, accordingly, do not limit their lending capacity. Thus, our findings suggest that an important prerequisite for the increase of capital stringency is at least a certain level of financial development and openness.

Third, we consider whether any identified responses are short-lived and weaken with time. The main argument of the proponents of increased capital regulation is that higher capital reduces the risk of bank default and, in the medium- to long-run, the intermediation margin would decline. In turn, this process would stimulate economic growth via the expansion in quality lending (e.g., Bridges et al., 2015).

To test this hypothesis in our framework, we take three-year averages of the data and repeat the exercise of Table 3. The results (reported in Table 6) show a much weaker response of loan growth to the interaction term of *capital stringency* with *bank capital* (columns 1 and 2) or *bank liquidity* (columns 3 and 4) or with both (columns 5 and 6). Where there is statistical significance at the 10% level (mainly in the first two columns), the levels of capital required to completely offset the adverse effects of increased capital stringency are very close to our sample's mean values. Thus, we conclude that in the medium- to long-run the very modest short-term negative effects of capital stringency on loan growth further weaken. In a nutshell, we do not identify any reversal toward a positive effect of capital stringency in the long run. In unreported regressions, we also use five-year averages of the data to examine whether the effect of capital stringency turns positive in the longer term, but we do not find such effects (the statistical significance of the estimates further weakens).

As a final sensitivity test, we consider the inclusion of interaction terms of bank capital and/or liquidity with all the country-year level variables included in the empirical analysis. The aim of these specifications is to further shut down alternative channels through which demand- or supply-side forces affect our results. For example, by interacting capital and/or liquidity with *interest rate* we better control for the credit channel of monetary policy transmission, while the respective interaction terms with *financial development* and *GDP growth* better control for Tobin's q theory and other wealth effects. We report the main results in Table 7. Ev-

[9] See Jokivuolle et al. (2015).

Table 6
General capital stringency and credit growth: three-year time intervals.
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of Eq. (1). The panel of banks is averaged over three-year time intervals, over the period 1997–2013 (four three-year periods and one four-year period in the earliest years of the panel). The dependent variable in all regressions is the bank-level loan growth from the three-year period t to the three-year period $t+1$. All variables are defined in Table 1. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure). The regressions replicate those of Table 3 in terms of control variables and also include year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Lagged loan growth	0.365***	0.276***	0.342***	0.274***	0.344***	0.248***
	(5.086)	(3.876)	(4.606)	(3.782)	(4.252)	(3.560)
Bank capital	0.078	0.199	0.024	0.238	0.267	0.565
	(0.389)	(0.785)	(0.123)	(0.781)	(0.491)	(0.674)
Bank liquidity	0.149**	0.305**	0.137**	0.440***	0.113*	0.538**
	(2.450)	(2.271)	(2.267)	(3.093)	(1.795)	(2.253)
Capital stringency	−0.016*	−0.020*	−0.017*	−0.019*	−0.016*	−0.024*
	(−1.754)	(−1.837)	(−1.779)	(−1.797)	(−1.922)	(−1.864)
Capital stringency * bank capital	0.161*	0.187*			0.148	0.174*
	(1.841)	(1.951)			(1.530)	(1.790)
Capital stringency * bank liquidity			0.109	0.106	0.107	0.117
			(1.305)	(1.190)	(1.296)	(1.624)
Bank capital * bank liquidity					1.239	1.860
					(0.617)	(0.592)
Capital stringency * bank capital * bank liquidity					0.665	0.633
					(1.372)	(1.014)
Observations	15,095	11,091	15,095	11,091	15,095	11,091
Number of banks	6916	6060	6916	6060	6916	6060
AR2	0.380	0.404	0.332	0.407	0.346	0.401
Hansen	0.310	0.255	0.331	0.222	0.384	0.275

Table 7
General capital stringency and credit growth: Including interaction terms with all country-year variables.
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of Eq. (1). The dependent variable in all regressions is the bank-level loan growth from year t to year $t+1$, over the period 1997–2011. All variables are defined in Table 1. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure), and include year fixed effects. The regressions replicate those of Table 3 in terms of control variables and also include interaction terms with all the country-year control variables and bank capital and/or liquidity. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Lagged loan growth	0.063***	0.092***	0.068***	0.085***	0.065***	0.086***
	(3.860)	(5.457)	(4.330)	(5.145)	(3.931)	(5.310)
Bank capital	0.131	0.391*	0.120	0.206	0.128	0.249
	(1.133)	(1.788)	(0.100)	(0.715)	(1.214)	(1.327)
Bank liquidity	0.132**	0.104*	0.167**	0.140**	0.113*	0.538**
	(2.140)	(1.871)	(2.267)	(2.093)	(1.795)	(3.253)
Capital stringency	−0.030**	−0.027*	−0.036**	−0.042**	−0.036*	−0.031**
	(−1.964)	(−1.892)	(−2.365)	(−2.437)	(−2.355)	(−2.064)
Capital stringency * bank capital	0.275***	0.257***			0.260***	0.284***
	(3.064)	(2.991)			(3.607)	(2.790)
Capital stringency * bank liquidity			0.165***	0.170***	0.205**	0.223*
			(3.211)	(3.230)	(2.449)	(1.856)
Bank capital * bank liquidity					1.416	1.807
					(0.705)	(0.919)
Capital stringency * bank capital * bank liquidity					0.824**	0.916**
					(2.362)	(2.155)
Observations	46,734	33,917	46,734	33,917	46,734	33,917
Number of banks	8971	7588	8971	7588	8971	7588
AR2	0.144	0.233	0.156	0.228	0.149	0.217
Hansen	0.227	0.165	0.221	0.125	0.274	0.146

idently, changes in the results compared to those of Table 3 are minimal and, therefore, we can dismiss these alternative explanations of our main findings.

3.2. Decomposing general capital stringency into its components

In this subsection, we decompose capital stringency into its ten components to pinpoint the sources of the (modest) effects of general capital stringency on loan growth. We work in the same way with the regressions including the general capital stringency index and estimate Eq. (1) by interacting each capital stringency component with bank capital (results in Table 8) or liquidity (results in Table 9). Thus, each of the ten specifications separately includes one of the ten components of capital stringency, and a control variable for the rest of the nine components to avoid a relevant omitted-variable bias.

Table 8
Credit growth and capital stringency components: Interaction terms with bank capital.
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of regressions on a panel of banks across countries over 1997–2013. The dependent variable in all regressions is the bank-level loan growth from year *t* to year *t*+1, over the period 1997–2011. The variables are defined in Table 1. Columns (1)–(10) include the components of the capital stringency variable as these are defined in Table 1 and provided in the first line of the Table. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure). The regressions include the full set of control variables also included in Column (2) of Table 3 and year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *i*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1) Basel risk weights	(2) Credit risk weights	(3) Market risk weights	(4) Deducted loan losses	(5) Deducted securities	(6) Deducted for. ex. losses	(7) Revaluation gains	(8) Initial stringency 1	(9) Initial stringency 2	(10) Initial stringency 3
Lagged loan growth	0.067***	0.065***	0.060***	0.083***	0.084***	0.089***	0.076***	0.085***	0.084***	0.097***
	(5.705)	(4.827)	(4.428)	(6.122)	(6.258)	(6.099)	(4.390)	(6.340)	(5.679)	(6.887)
Stringency component	−0.050***	−0.053***	−0.007	0.001	0.004	0.000	0.003	−0.048***	−0.010	−0.042**
	(−3.173)	(−3.301)	(−0.566)	(0.114)	(0.348)	(0.063)	(0.349)	(−3.105)	(−0.768)	(−2.426)
Bank capital	0.202	0.265**	0.229*	0.221*	0.208	0.179	0.171	0.270**	0.286**	0.244*
	(1.533)	(2.049)	(1.895)	(1.705)	(1.500)	(1.205)	(1.154)	(2.101)	(2.371)	(1.958)
Stringency component * bank capital	0.401**	0.446**	0.111	0.121	0.123	0.112	0.041	0.244*	0.024	0.275**
	(2.305)	(2.455)	(1.016)	(1.287)	(1.294)	(1.272)	(0.550)	(1.952)	(0.391)	(2.410)
Observations	41,275	41,275	41,275	41,275	41,275	41,275	41,275	41,275	41,275	41,275
Number of banks	7956	7956	7956	7956	7956	7956	7956	7956	7956	7956
AR2	0.205	0.212	0.314	0.271	0.127	0.407	0.139	0.205	0.320	0.217
Hansen	0.126	0.130	0.155	0.145	0.202	0.106	0.146	0.245	0.204	0.181

Table 9
Credit growth and capital stringency components: Interaction terms with bank liquidity.
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of regressions on a panel of banks across countries over 1997–2013. The dependent variable in all regressions is the bank-level loan growth from year *t* to year *t*+1, over the period 1997–2011. The variables are defined in Table 1. Columns (1)–(10) include the components of the capital stringency variable as these are defined in Table 1 and provided in the first line of the table. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure). The regressions include the full set of control variables also included in Column (2) of Table 3 and year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1) Basel risk weights	(2) Credit risk weights	(3) Market risk weights	(4) Deducted loan losses	(5) Deducted securities	(6) Deducted for. ex. losses	(7) Revaluation gains	(8) Initial stringency 1	(9) Initial stringency 2	(10) Initial stringency 3
Lagged loan growth	0.060***	0.069***	0.065***	0.079***	0.079***	0.077***	0.054***	0.063***	0.077***	0.088***
	(4.929)	(5.007)	(4.797)	(5.569)	(5.813)	(5.463)	(2.745)	(4.498)	(5.160)	(6.013)
Stringency component	−0.034**	−0.024	0.021	−0.005	-0.002	−0.003	−0.003	−0.056***	0.020	−0.039**
	(−2.289)	(−1.536)	(0.816)	(−0.371)	(−0.128)	(−0.258)	(−0.217)	(−3.348)	(0.238)	(−2.015)
Bank liquidity	0.165**	0.139*	0.158**	0.195***	0.202**	0.224**	0.157**	0.158**	0.146**	0.173**
	(2.164)	(1.902)	(2.106)	(2.265)	(2.388)	(2.462)	(2.060)	(2.087)	(1.971)	(2.188)
Stringency component * bank liquidity	0.165**	0.050	0.021	−0.090	−0.078	−0.073	0.005	0.172***	0.049	0.160***
	(2.476)	(0.624)	(0.989)	(−0.749)	(−0.529)	(−0.494)	(0.267)	(2.904)	(1.007)	(3.033)
Observations	41,275	41,275	41,275	41,275	41,275	41,275	41,275	41,275	41,275	41,275
Number of banks	7956	7956	7956	7956	7956	7956	7956	7956	7956	7956
AR2	0.246	0.210	0.288	0.206	0.235	0.192	0.197	0.256	0.249	0.213
Hansen	0.108	0.116	0.104	0.186	0.238	0.307	0.225	0.151	0.184	0.116

Evidently, the components of capital stringency that contribute to statistically significant main and interaction effects of capital stringency in the previous tables are: (i) in column (1) the adoption of the Basel guideline for the capital requirement (*Basel risk weights*); (ii) in column (2) the variation of the risk-based capital ratio with a bank's credit risk (*credit risk weights*); (iii) in column (8) the allowance of other sources of capital besides cash and government securities to be used as initial disbursement or subsequent injections of capital (*initial stringency 1*); and (iv) the allowance of borrowed funds to be used for initial disbursement of capital (*initial stringency 2*). These findings are robust to using interaction terms with either capital or liquidity with the exception of *credit risk weights*, which loses its statistical significance when interacted with *bank liquidity*.

The results of Tables 8 and 9 show that moderate levels of bank capital and liquidity are required to offset the impact of the adoption of Basel- and credit-risk weights (approximately 12% *bank capital* for both and 21% *bank liquidity* for Basel-risk weights). In contrast, it takes very large values of *bank capital* (20% and 15%) to buffer a change in the values on *initial stringency 1* and *initial stringency 3* from zero to one. This result reinforces our basic result of Section 3.1, suggesting that it is the restrictions a bank faces to raise capital that mainly drive the negative result of capital stringency on growth.

These results show that indeed certain components of increased capital stringency, especially related to the prevention of using assets other than cash and government securities as capital, do hurt loan growth and, potentially, investment opportunities. We should note, however, that only 4 out of the 125 countries take in the end year of our sample a value one in *initial stringency 1*, which is the variable mostly hurting loan growth. Thus, countries can indeed avoid excess losses in loan growth by at least allowing multiple

sources for the initial disbursement and subsequent injections of capital, while adopting Basel capital requirements to maintain a less risky banking sector. Also, the statistical insignificant results on the rest of the stringency components show that such policies do not hurt loan growth on average.

These results are in general robust to the re-specifications of Eq. (1) in line with the analysis on the capital stringency in Section 3.1. Specifically, the results are almost identical to those of Tables 8 and 9 when we disregard the crisis period, when splitting our sample to bank-based and market-based economies, and when we add interaction terms of bank capital or liquidity with all the country-year variables. When using the three-year averages, we find that the only source of capital stringency having a persistently strong negative effect on loan growth is *initial stringency 1*. This further highlights the need to relax constraints on the sources of bank capital besides cash and government securities to prevent long-term adverse effects of capital stringency on credit growth.

4. Discussion and policy implications

In this study we examine the effect of general capital stringency and its individual components on loan growth. We find that general capital stringency has a negative effect on loan growth, but this effect is quite low for well-capitalized banks and is completely offset for banks with an equity capital ratio equal to 11% (just 1% above the average in our sample) in our preferred specification. Among the components of the general index of capital stringency, the strongest negative effect comes from the prevention of banks from using assets other than cash and government securities as capital. In contrast, the Basel-related capital requirements have effects that are quite manageable for well-capitalized banks, especially if policy changes are implemented during normal economic periods. Finally, our results do not suggest any long-term effects of capital regulations on loan growth.

Our findings have at least three important policy implications. First and foremost, even though our results do not deviate from the general premise that compliance with Basel-type capital requirements lowers loan growth, we find that it is relatively easy for banks to buffer these effects without decreasing their loans. This is especially true, if there are no constraints on the assets that can be used as new capital. In turn, this encourages the abolition of rules and regulations regarding the sources of funds to be used as capital, especially in the recent periods when capital requirements increase in most countries. Thus, our results are suggestive of a policy mixture of increased capital stringency targeted at the risk-side of the banking activities and increased freedom in the use of alternative assets as capital.

Second, our results reinforce the arguments favoring implementation of more stringent risk-related capital regulation during good economic times. Evidently, the trend across most countries toward increased capital stringency before the global financial crisis (by adopting Basel's guidelines on capital requirements) had no apparent effect on credit availability. One could in fact credibly suggest that credit growth increased to unsustainable amounts leading to credit bubbles that increased the probability of bank defaults.

Third, we should note that we cannot undoubtedly suggest, based on our findings, that the even more stringent capital requirements of Basel III will not hurt the real economy through a reduction of bank credit. We did carry out an initial analysis to examine non-linear effects of further increases in capital stringency (especially related with higher capital requirements), but the results are not suggestive of such effects. However, the guidelines of Basel III include regulations that are not formally modeled by existing indices and we must be cautious about this initial set of results. Therefore, we leave this for future research once relevant data become available.

Appendix A

Table A1
General capital stringency and credit growth: using non-performing loans.
The table reports coefficients and *t*-statistics (in parentheses) from the estimation of Eq. (1). The dependent variable in all regressions is the bank-level loan growth from year t to year $t+1$, over the period 1997–2011. All variables are defined in Table 1. All regressions are estimated with two-step GMM for dynamic panels and robust standard errors (adjusted with Windmeijer's correction procedure), and include year fixed effects. AR2 is the *p*-value of the Arellano–Bond test for order-2 autocorrelation and Hansen is the *p*-value of the Hansen test for overidentifying restrictions. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

	(1)	(2)
	Baseline	Baseline
Lagged loan growth	0.103***	0.101***
	(7.348)	(7.233)
Bank capital	−0.032	0.609**
	(−0.154)	(1.998)
Capital stringency	−0.039**	−0.033
	(−2.010)	(−1.512)
Bank capital * capital stringency	0.557***	0.567***
	(3.577)	(3.582)
Market discipline	0.059***	0.039
	(3.217)	(1.592)
Supervisory power	−0.020***	−0.023***
	(−3.068)	(−3.040)
Activity restrictions	−0.018	−0.012
	(−1.529)	(−0.977)
Bank liquidity	0.216***	0.437***
	(3.015)	(4.848)
Non-performing loans	−0.004**	−0.005
	(−2.083)	(−1.578)
Bank size	−0.065***	−0.049***
	(−6.350)	(−4.219)
Bank importance	0.021	−0.186*
	(0.676)	(−1.769)
GDP growth annual	0.020***	0.031***
	(5.536)	(3.969)
Interest rate		0.004
		(0.957)
Gross fixed capital formation		−0.030***
		(−4.375)
Financial development		0.289***
		(3.019)
Trade openness		0.000
		(0.638)
Government spending		−0.007***
		(−3.943)
Rule of law		0.093***
		(7.111)
Inflation		0.010***
		(3.574)
Constant	1.022***	0.965***
	(6.522)	(3.666)
Observations	34,973	32,212
Number of bname	6313	5712
AR2	0.159	0.122
Hansen	0.251	0.207

References

Admati, A.R., DeMarzo, P.M., Hellwig, M., Pfleiderer, P., 2010. Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is Not Expensive, 42. Max Planck Institute for Research on Collective Goods Preprints of No. 2010.

Athanasoglou, P.P., Daniilidis, I.A., Delis, M.D., 2014. Bank procyclicality and output: issues and policies. J. Econ. Bus. 72, 58–83.

Barth, J.R., Caprio, G., Levine, R., 2000. Banking systems around the gobe: Do regulation abd owenership affect performance and stability? Policy Brief 15. Milken Institute.
Barth, J.R., Caprio, G., Levine, R., 2003. Bank regulation and supervision: lessons from a new database. Macroeconomic Stability, Financial Markets, and Economic Development. Banco de Mexico.
Barth, J.R., Caprio, G., Levine, R., 2008. Bank regulations are changing: For better or for worse? Comparative Economic Studies 50, 537–563.
Barth, J.R., Caprio, G., Levine, R., 2013a. Bank regulation and supervision in 180 countries from 1999 to 2011. J. Financ. Econ. Policy 5, 111–219.
Barth, J.R., Caprio, G., Levine, R., 2013b. World Bank Surveys on Bank Regulation. World Bank.
Beck, T., Demirgüç-Kunt, A., Levine, R., 2000. A new database on financial development and structure. World Bank Econ. Rev. 14, 597–605.
Beck, T., Demirgüç-Kunt, A., Levine, R., 2006. Bank concentration, competition and crises: first results. J. Bank. Financ. 30, 1581–1603.
Beck, T., Demirgüç-Kunt, A., Levine, R., 2009. Financial Institutions and Markets Across Countries and Over Time – Data and Analysis. World Bank Policy Research Working Paper Series 4943.
Beck, T., De Jonghe, O., Schepens, G., 2013. Bank competition and stability: cross–country heterogeneity. J. Financ. Intermed. 22, 218–244.
Bekaert, G., Harvey, C.R., Lundblad, C., Siegel, S., 2007. Global growth opportunities and market integration. J. Financ. 62 (3), 1081–1137.
Berrospide, J.M., Edge, R.M., 2010. The effects of bank capital on lending: what do we know, and what does it mean? Int. J. Cent. Bank. 6 (4), 5–54.
Blum, J., Hellwig, M., 1995. The macroeconomic implications of capital adequacy requirements for banks. Eur. Econ. Rev. 39, 739–749.
Blundell, R., Bond, R., 1998. Initial conditions and moment restrictions in dynamic panel data models. J. Econom. 87, 115–143.
Bridges, J., Gregory, D., Nielsen, M., Pezzini, S., Radia, A., Spaltro, M., 2015. The Impact of Capital Requirements on Bank Lending. Bank of England working paper 486.
Cihak, M., Demirgüç-Kunt, A., Martinez Peria, M.S., Mohseni-Cheraghlou, A., 2012. Bank Regulation and Supervision Around the World – A Crisis Update. World Bank Policy Research Working Paper Series 6286.
Claessens, S., Laeven, L., 2004. What Drives Bank Competition? Some International Evidence. Proceedings. Federal Reserve Bank of Cleveland, pp. 563–592.
Cohen, B., 2013. How Have Banks Adjusted to Higher Capital Requirements?. Bank for International Settlements BIS Quarterly Review.
De Nicolo, G., 2015. Revisiting the Impact of Bank Capital Requirements on Lending and Real Activity. IMF and CESifo.
Delis, M.D., 2012. Bank competition, financial reform, and institutions: the importance of being developed. J. Dev. Econ. 97 (2), 450–465.
Elyasiani, E., Mester, L. and Pagano, M. 2014. Large capital infusions, investor reactions, and the return and risk-performance of financial institutions over the business cycle. J. Financ. Stab., 11, 62–81.
Jimenez, G., Ongena, S., Peydro, J-L., Saurina, J., 2012. Credit supply and monetary policy: identifying the bank balance-sheet channel with loan applications. Am. Econ. Rev. 102 (5), 2301–2326.
Jokivuolle, E., Pesola, J., Viren, M., 2015. Why is credit-to-GDP a good measure for setting countercyclical capital buffers. J. Financ. Stab. 18, 117–126.
Kashyap, A.K., Stein, J.C., 2000. What do a million observations on banks say about the transmission of monetary policy? Am. Econ. Rev. 90 (3), 407–428.
Labonne, C., Lamé, G., 2014. Credit Growth and Bank Capital Requirements: Binding or Not?. Banque de France working paper 481.
Roodman, D., 2009. How to do xtabond2: an introduction to difference and system GMM in stata. Stata J. 9 (1), 86–136.
VanHoose, D., 2008. Bank capital regulation, economic stability, and monetary policy: what does the academic literature tell us? Atl. Econ. J. 36, 1–14.
Van den Heuvel, S.J., 2008. The welfare cost of bank capital requirements. J. Monet. Econ. 55, 298–320.
Windmeijer, F., 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. J. Econom. 126 (1), 25–51.