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Jesus Crespo-Cuaresma, Gregor von Schweinitz, Katharina Wendt

Authors

Jesus Crespo-Cuaresma
Vienna University for Economics and Business, Department of Economics, Halle Institute for Economic Research (IWH) – Member of the Leibniz Association, Wittgenstein Centre for Demography and Global Human Capital, International Institute of Applied Systems Analysis (IIASA), and Austrian Institute of Economic Research (WIFO)
E-mail: jcrespo@wu.ac.at

Gregor von Schweinitz
Halle Institute for Economic Research (IWH) – Member of the Leibniz Association, Department of Macroeconomics, and Leipzig University, Institute for Theoretical Economics
E-mail: gregorvon.schweinitz@iwh-halle.de
Tel +49 345 7753 744

Katharina Wendt
Leipzig University
E-mail: katharina_wendt@web.de

Editor

Halle Institute for Economic Research (IWH) – Member of the Leibniz Association

Address: Kleine Maerkerstrasse 8
D-06108 Halle (Saale), Germany
Postal Address: P.O. Box 11 03 61
D-06017 Halle (Saale), Germany

Tel +49 345 7753 60
Fax +49 345 7753 820

www.iwh-halle.de

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On the Empirics of Reserve Requirements and Economic Growth*

Abstract

Reserve requirements, as a tool of macroprudential policy, have been increasingly employed since the outbreak of the great financial crisis. We conduct an analysis of the effect of reserve requirements in tranquil and crisis times on credit and GDP growth making use of Bayesian model averaging methods. In terms of credit growth, we can show that initial negative effects of higher reserve requirements (which are often reported in the literature) tend to be short-lived and turn positive in the longer run. In terms of GDP per capita growth, we find on average a negative but not robust effect of regulation in tranquil times, which is only partly offset by a positive but also not robust effect in crisis times.

Keywords: reserve requirements, macroprudential policy, credit growth, economic growth, Bayesian model averaging

JEL classification: C11, E44, F43, G28

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1 Introduction

Especially since the outbreak of the global financial crisis, central banks have employed a large variety of macroprudential instruments to strongly differing degrees (Cerutti et al., 2017). These instruments were often introduced without much prior empirical evidence on their potential effects. The main aim of this study is to provide robust inference on the medium to long-run effects of reserve requirements, one of the most widespread macroprudential measures, on credit growth and economic growth. In order to ensure robustness to model specification, we use Bayesian model averaging techniques in order to quantify the role played by reserve requirements. Our main interest lies in quantifying the real growth effects of reserve requirements as a regulatory (macroprudential policy) tool during normal and stress times.

The main objective of macroprudential policy is to promote the resilience of the financial system (Schoenmaker, 2014). This is important because financial risk taking may not always be beneficial for economic growth. On the one hand, financial risk taking has been found to have – on average – a positive effect on growth by mitigating financial bottlenecks (Rancière et al., 2008). On the other, this may not be true to the same extent for countries with strong and sound institutions or for extremely high levels of risk. Financial crises as an undesired outcome of systemic risk taking can have severe adverse consequences for the financial system and the real economy (Laeven and Valencia, 2013). In order to maximize welfare, a balance therefore needs to be struck between financial stability on the one hand, and some (systemic) risk taking on the other hand (Borio and Shim, 2007).

A variety of theoretical papers have evaluated costs and benefits of regulation. Statements on the most efficient approach usually depend on the setup of the economy and modelled frictions (Jeanne and Korinek, 2013; Benigno et al., 2013). The assessment of the effects of macroprudential instruments in empirical studies has – in comparison – not kept pace. The first generation of empirical studies on macroprudential instruments and their effects uses aggregate measures in international panel studies, for example by creating simple indices identifying the legal existence of these instruments (Borio and Shim, 2007; Cerutti et al., 2017). The focus of these studies – influenced by the recent financial crisis – has mostly been on measuring the effect on credit growth and house prices. Due to the use of variables based on legal existence, the intensity of an instrument is never a factor in these studies. This problem is addressed in a second group of studies, which employ either microeconomic or time-series analysis to identify the effects of the strengthening of one instrument in a single country (Tovar et al., 2012; Arregui et al., 2013; Camors and Peydro, 2014). In general, single-country studies confirm the evidence on credit and house price growth found in the first group of studies mentioned above.

We aim to reassess and extend the previous findings of the empirical literature. To do so, we address the general research question on the effects of macroprudential policy from a slightly different angle: We aim to identify the medium to long-run effect of one particular macroprudential instrument, reserve requirements, on credit and GDP per capita growth in the context of economic growth regressions under the presence of model uncertainty, using Bayesian methods.[1] Both the focus on a longer horizon and a switch to GDP growth are aimed at bringing our study more in-line with the welfare-maximizing objective of forward-looking policymakers. The Bayesian analysis has the additional advantage that it does not presuppose a particular

[1]Reserve requirements can also be seen as a form of capital controls. There is an extensive literature looking at costs and benefits of capital controls (see for example Chinn and Ito, 2006; Forbes, 2007), however not with a focus on the potential benefits during a banking crisis. We control for the strength of total capital controls in our estimations.

econometric specification to address the effect of reserve requirements on income growth for the sample. In particular, the method creates weighted averages of the effects found across different specifications making use of posterior model probabilities as weights. It thereby integrates away the uncertainty embodied in the choice of a particular model, thus providing inference which already accounts for the fact that the true specification is unknown to the researcher. The advantages of such a method depend on the set of models entertained, so we put an effort on collecting a dataset including the most relevant variables employed in the literature to assess differences in long-run economic growth and also assess potential nonlinearities by allowing for quadratic and interaction effects in the models used.

The paper is organized as follows. Section 2 provides a review of our the relation of crises, regulation and growth, and describes the data employed in the empirical exercise. Section 3 gives an overview over Bayesian model averaging techniques, section 4 presents the results of the analysis and section 5 concludes.

2 Variables, data and sources

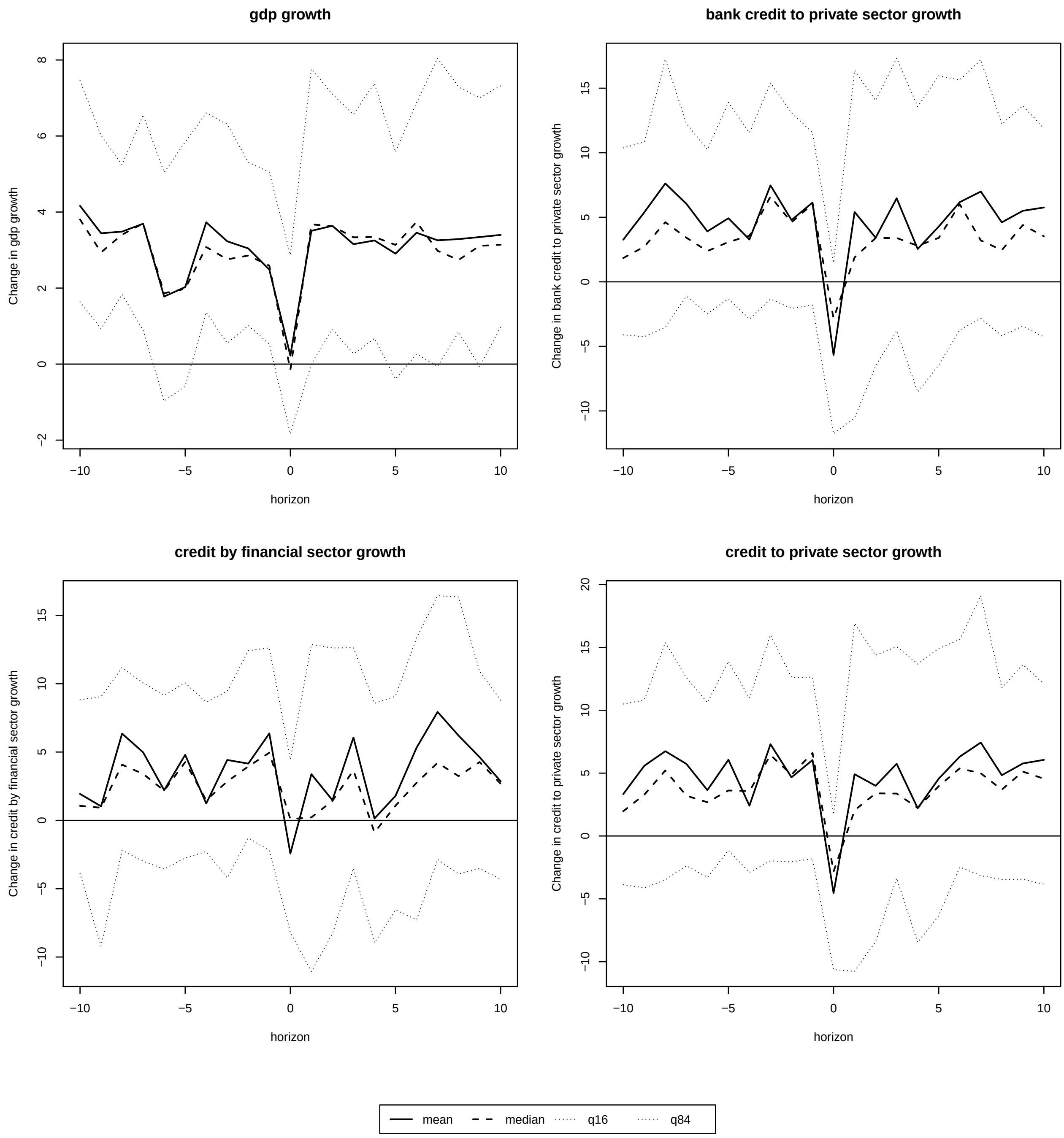
This section reviews the extensive literature on (a) the link between crises and economic growth; (b) the scope of macroprudential regulation in general and reserve requirements in particular; (c) empirical findings on the effect of reserve requirements. It also describes the additional control variables we employ in our Bayesian model averaging exercise for economic growth regressions.[2]

2.1 The relationship of crises, regulation and growth

In the literature, there is considerable disagreement on the effects of crises and corresponding welfare losses. To illustrate different results regarding the link between growth and crises, in Figure 1 we show yearly GDP and credit growth rates from ten years before to ten years after a systemic banking crises identified by Laeven and Valencia (2013). Growth rates of GDP and credit are substantially lower in the year of a crisis than in other years. Importantly, neither credit nor GDP growth rates seem to be much higher after a crisis than before. Thus, if a trend is calculated based on pre-crisis growth rates, this would give rise to a very slow return to trend (as found by Laeven and Valencia, 2013) or even large and persistent output losses (as argued by Cerra and Saxena, 2008). However, we can also see that nearly 50% of the countries have positive GDP growth during a crisis. This is the key finding of Devereux and Dwyer (2016), who argue that output losses should be calculated relative to pre-crisis output rather than to a trend, because the latter is hard to establish for volatile (and crisis-prone) middle-income countries. Beyond direct effects, crises often trigger long and protracted adjustment processes. Thus, they can in principle have effects on GDP growth more than five years in the future. However, there is not much agreement on these effects. On the one hand, persistence would point to a continuing negative effect on growth, even after five years (Bordo et al., 2010). On the other hand, standard macroeconomic models would predict stronger growth after a crisis, as the economy moves slowly back to its long-run growth path.

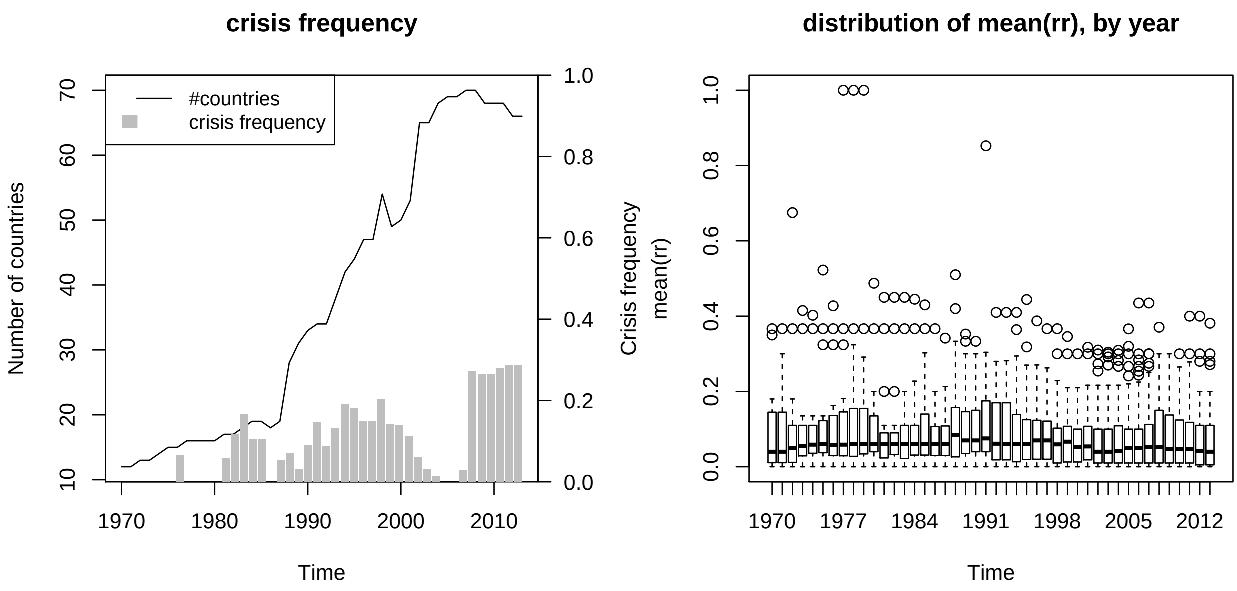
[2]An overview of transformations and sources for all variables as well as summary statistics on the full (unbalanced) dataset can be found in the Appendix, Tables A.1 and A.2. Table A.3 provides information on the coverage over countries and time for the two baseline estimations.

Figure 1: Development of GDP and credit growth around crises



Note: The analysis is based on 54 crises, drawn from Laeven and Valencia (2013). We report mean, median as well as the 16 and 84-percentile of the data.

Figure 2: Descriptive statistics of crises and reserve requirements



Note: The figure shows the frequency of crises and descriptive statistics for the average reserve requirement of a country in a given year (median as a thick line, interquartile range as a box, extended range as dashed line, and outliers as dots). Reserve requirement data are from the database of Federico et al. (2014).

In this study, we use the data on systemic banking crises as defined by Laeven and Valencia (2013). This is to our knowledge the most comprehensive database of systemic banking crises worldwide. Economic crises were not often employed as potential covariates in the literature on the robust determinants of long-run economic, which tends to abstract from short-run fluctuations. However and as argued above, this restriction may be flawed.

Figure 2 shows the development of our main two variables of interest, systemic banking crises and reserve requirements, over the period spanned by our sample. In the left plot, it can be observed that the share of crises per year in our sample is fairly high during the currency and banking crises of the late seventies and nineties, and during the great financial crisis. The smaller number of countries in our sample the early seventies, together with lower degrees of financial liberalization, may have contributed to the low frequency of crises in this period.

From a theoretical perspective, crises can be seen as consequences of frictions on financial markets. With an eye on middle-income countries, Rancière et al. (2008) construct a model of an open economy with two sectors – non-tradable and tradable – and two frictions – limited enforcement and systemic bailouts in case of an external debt crisis. Financial liberalization (a reduction in capital controls) allows firms in the non-tradable sector to borrow more, and the bailout guarantees induce them to borrow in foreign currency. However, firms still hold less debt than optimally. Rarely, this leads to crises. However, as average growth under financial liberalization is higher than under repression, Rancière et al. (2008) conclude that, if frictions cannot be tackled directly, a volatile high-growth path may be preferable to steady stagnation. The view of efficient crises is shared by proponents of the so-called *Greenspan doctrine*, which states that crises should only be counteracted after their occurrence as any ex-ante regulation will necessarily be too blunt a tool and create negative distortions (Benigno et al., 2013). Distortions on financial markets should affect investment, hampering growth (Ramey and Ramey, 1995) and potentially even increase real volatility (Aghion et al., 2010). This view is challenged by central banks and academics alike: if crises are the result of overborrowing, then ex-ante policy could improve welfare by reducing credit growth (Jeanne and Korinek, 2013; Mendoza and Bianchi, 2011). In practice, it is thus very likely that a mixture of many policy tools – ex-ante and ex-post – is the second best option in the face of a multitude of frictions.

The right plot of Figure 2 reports our second variable of interest, reserve requirements, for the same sample. Reserve requirements are one of the main tools of macroprudential policy and have been used in many countries in order to mitigate the severe negative short-run effects of systemic banking crises. Thus, they aim at reducing bubbles and systemic risk-taking in the financial sector (Arregui et al., 2013). They require banks to hold a certain percentage of their deposits as reserves at the central bank. Thus, reserve requirements act as a tax on the banking system (Glocker and Towbin, 2012). They increase intermediation costs and drive a wedge between deposit and lending rates.[3]

We obtain data on reserve requirements from the large international database of Federico et al. (2014). The database contains unbalanced quarterly data on reserve requirements in 60 countries (and, additionally, the euro area as an aggregate) from 1969 onwards. The advantage of our data is that we observe the exact value of reserve requirements. Advanced economies tend to set extremely low requirements, sometimes even zero. On the other end, Colombia had requirements of 100% from 1977 to 1979. Mexico and Brazil also set requirements at 50% or above during their respective economic crises in 1988 and 1994.[4] The right panel of Figure 2 shows that there seems to be a slight downward trend of requirements both in the median (thick black line) and the outliers (circles). This holds even though we are able to add many middle-income and low-income countries to our sample over the 1990's.

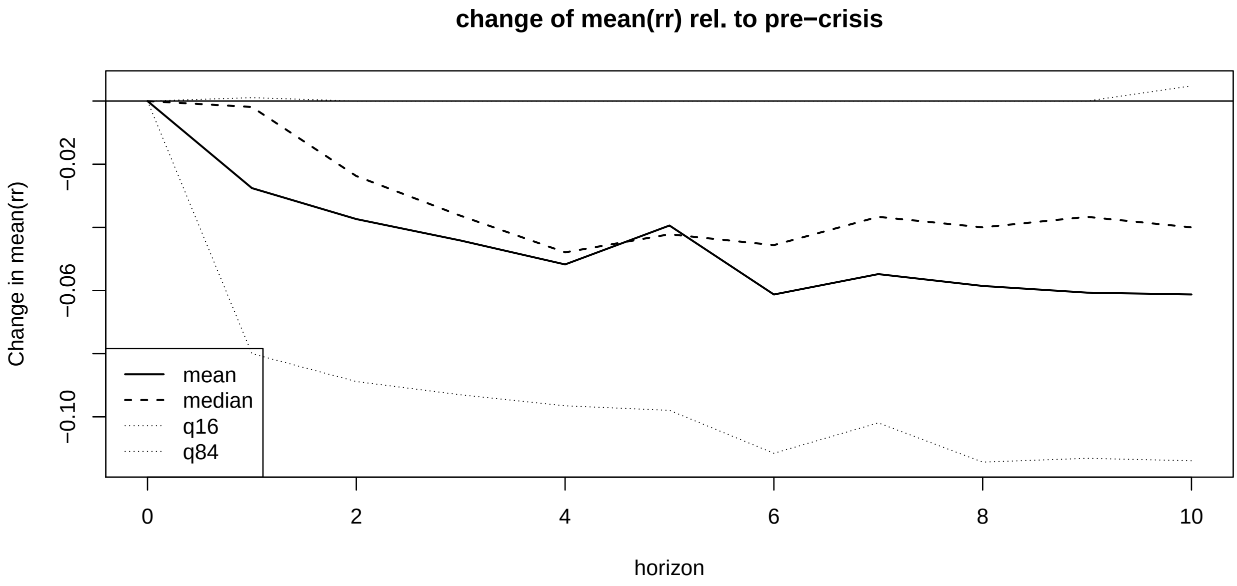
It should be noted, however, that we show the descriptive statistics on mean reserve requirements. This hides potentially large differentiation across different types of deposits. Reserve requirements are classified in four different categories: First, there may only be a single (flat) requirement. Second, requirements can be differentiated across maturities (demand, savings and term deposits). Japan, for example, requires banks to hold larger reserves for demand deposits than for savings and term deposits, because the former have shorter maturities and are therefore more prone to bank-runs. Third, requirements may be differentiated across local and foreign currencies. For example, Peru employs different requirements for deposits in local and foreign currencies. As a reaction to large capital inflows in the boom years from 2006 to 2008, requirements on foreign deposits were increased from 20% to 49%, while those on local deposits just went from 6% to 9%. A fourth classification differentiates both across maturities and currencies. In most of our analysis we use the simple average of these requirement, *mean(rr)*. In additional estimations, we also employ the squared average and two different measures for the degree of differentiation across requirements, namely the difference between the maximum and minimum requirement, *maxdiff(rr)*, and the standard deviation of requirements, *sd(rr)*.

Beyond these simple differentiation covered in our data, idiosyncratic rules are aplenty. They are set by the central bank, which can adjust a number of parameters. Possible options are, among others, that the central bank can choose (a) at which rate reserves are remunerated (if at all), (b) to allow reserve averaging

[3]As such, they are very similar to one of the ex-ante tools considered in Jeanne and Korinek (2013).

[4]Other databases such as Cerutti et al. (2017) provide information on the existence or legal opportunity to introduce reserve requirements, and other macroprudential policy tools. However, given the large cross-sectional variation already observed for reserve requirements we should not expect to find strong effects from the pure existence of requirements.

Figure 3: Development of reserve requirements after crises



Note: The analysis is based on 54 crises, drawn from Laeven and Valencia (2013) and reserve requirements from Federico et al. (2014). We report mean, median as well as the 16 and 84-percentile of the data.

(i.e., set a longer period over which reserves must be sufficient on average), (c) to differentiate requirements over certain types of deposits, or to exclude certain deposits altogether,[5] (d) to apply requirements to all existing deposits or only to newly created ones (Gray, 2011).

Three broad reasons have been suggested for the use of reserve requirements (Gray, 2011). First, mainly open developing countries have been using them as a complement to monetary policy. Capital flows to a country depend on its interest rate differential towards developed economies, and can thus render countercyclical monetary policy ineffective. Countercyclical reserve requirements can reduce the effect of interest rates on capital flows. Second, reserve requirements affect credit growth. Using them countercyclically can serve the purpose of liquidity management for the banking sector. Third and beyond addressing credit fluctuations, reserve requirements can be implemented with macroprudential policy in mind. Figure 3 provides some limited evidence of the countercyclical use of reserve requirements during crises. In the year of the crisis, requirements drop on average by 2.5% and continue to stay lower than in the year prior to the crisis thereafter.[6]

In line with the considerations above, increasing reserve requirements have been found to be a complement to monetary policy (Vargas et al., 2011; Glocker and Towbin, 2015; Tovar et al., 2012).[7] Glocker and Towbin (2015) identify interest rate and reserve requirement shocks via zero and sign restrictions

[5]Differentiation can go as far as exempting specific banks. In the case of Brazil, for instance, reserve requirements act as a de facto subsidy from large towards small banks (Robitaille et al., 2011).

[6]Some advanced economies like the Eurozone use a low level of requirements to stabilize money market rates and link them to central bank interest rates rather than as countercyclical tools. However, whenever this is the main goal of requirements, they are typically very close to zero. Fluctuations (if existent) are due to serious shortages on interbank markets, which are internationally linked across advanced economies. We control for this in our empirical setting by using country and time fixed effects.

[7]It should be noted, however, that reserve requirements only affect banks, and thus have a much less ubiquitous focus than interest rate policy.

in an structural vector autoregressive model (VAR model) employing Brazilian data. They show that a discretionary tightening of reserve requirements leads to a decline in domestic credit, an increase in unemployment, a depreciation of the exchange rate, an improvement of the current account, and an increase in the price level. Overall, they conclude that reserve requirements provide a potential way of reining in credit growth without attracting net capital inflows and appreciating the exchange rate. Tovar et al. (2012) and Arregui et al. (2013) confirm in panel VARs that macroprudential instruments including reserve requirements reduce (temporary) credit and house price growth. Montoro and Moreno (2011) find that higher requirements have two beneficial effects in crises times. First, higher buffers increase resilience per se. Second, the possibility to lower requirements helps to offset tighter financing conditions by providing liquidity. However, all these studies share a focus on short-run developments. We add to their analysis by describing the long-run growth effects of reserve requirements and crises.

The right panel of Figure 2 also shows that there is only little variation of average reserve requirements over the course of our sample. If anything, requirements slowly decrease. This coincides with an expansion of our geographical sample, mainly towards developing countries, which usually have higher requirements than advanced economies. That is, we find a downward trend for reserve requirements in nearly all countries in our sample. However, at all times there are some countries with very high reserve requirements (20% and more).

2.2 Data description

Our main variable of interest is the growth rate of *GDP per capita*. Thus, we extend the literature mentioned in the introduction, which mainly focuses on the effect of reserve requirements on credit aggregates or house price developments. However, our analysis allows us to also shed some light on the robustness of previous findings. To this end, we also provide results on the robust determinants of differences in the growth rate of three different credit measures and the role played by reserve requirements in this context. In particular, we look at growth rates of *bank credit to private sector*, *credit by financial sector* and *credit to private sector*. While conceptually close, there may be some accounting differences. For example, *bank credit to the private* sector may be much closer to *credit to private sector* in a bank-based than in a market-based financial system. Also, the size of the government sector plays affects the different credit aggregates differently.

Our additional control variables are mostly standard covariates employed in the growth literature (Moral-Benito, 2012, see for example). Our variables focus mostly on determinants of long-run growth and include covariates that correspond to theoretical frameworks that are often used in the empirical literature to study economic growth differences across economies. We include variables that correspond to the human capital-augmented Solow model (gross capital formation, population growth, initial income per capita and educational attainment variables), as well as covariates measuring age structure, which have been highlighted as economic growth predictors by Lindh and Malmberg (1999) or Bloom et al. (2007), variables related to international trade and foreign direct investment (see, for example, Frankel and Romer, 1999) or to credit access (King and Levine, 1993). Importantly, we include capital account openness and other variables of financial liberalization to make sure that our results are driven by macroprudential motives for reserve requirements (Rancière et al., 2008). The set of potential models encompassed by combinations of covariates of the pool used in our analysis corresponds therefore to many of the specifications which are routinely used to address long-run economic growth in modern empirical studies. However, our variables of interest most likely have the strongest effect on growth at business cycle frequencies. In order to avoid attributing wrong effects to crises and reserve requirements, we need to control for additional macroeconomic variables operating at the same frequency. Therefore, we include real interest rates, inflation measures and unemployment, as well as the current account measures and external debt to our list of potential regressors. This captures the most important macroeconomic and financial leading indicators. Our dataset also contains information on exchange rate regimes, which is used in a robustness check aimed at assessing subsample heterogeneity in the effect of reserve requirements on economic growth (see section 5).

As usual in the literature on long-run economic growth, we abstract away from effects within business cycle frequencies by forming non-overlapping five-year averages for all variables. All right hand side variables are lagged one period (i.e., averages of the prior five-year block). In order to control for unobserved country specificity and global shocks, we add country and period fixed effects in all regressions.

We have 314 observations in our baseline model and our estimation covers 5-year periods in 66 countries. In a robustness check without reserve requirements and crises, we are able to extend our dataset to 485 observations, covering 97 countries. If we deviate from our baseline estimation by replacing GDP growth with credit growth or by including exchange rate arrangements as an additional explanatory variable, the number of observations varies only slightly.

3 Methodological framework: Reserve requirements and economic growth under model uncertainty

In order to assess quantitatively the role played by reserve requirements as a determinant of both credit and income per capita growth in the presence of specification uncertainty, we consider the following class of linear panel data models applied to N observations,

$$g_{i,t} = \alpha_i + \sum_{j=1}^{k} \beta_j x_{i,j,t-1} + \lambda_t + \varepsilon_{i,t}, \tag{1}$$

where $g_{i,t}$ is the dependent variable of interest (alternatively the growth rate of credit or income per capita in country i and five-year period t). A model is defined by the choice of k variables as explanatory covariates. These variables are assumed to belong to a pool of K potential covariates that may explain within-country differences in the dependent variable of interest. All models include country fixed effects (α_i) and time fixed effects (λ_t) to control for observable and unobservable differences across economies that remain constant over time, as well as for shocks to $g_{i,t}$ that are common across countries.[8] In addition, we assume that $\varepsilon_{i,t}$ is a homoskedastic, normally distributed shock with variance σ^2.

Our main interest is to quantify the effect of the variable measuring reserve requirements, which is in the pool of available covariates. Since the effect of reserve requirements on both credit growth and income per capita growth is potentially affected by whether the economy is experiencing a crisis, we add the interaction between the reserve requirements covariate and a crisis dummy as an additional variable in the set of potential determinants of $g_{i,t}$. The full set of covariates used to construct panel data models of the

[8]In practice, we account for fixed effects by conducting the analysis on deviations from country-time specific means.

type given by equation (1) corresponds to that presented in Table A.2, augmented with the interaction term mentioned above.

We integrate model uncertainty by carrying out inference on the effect of the explanatory variables based on the full set of models that can be created using the pool of potential covariates. In such a setting, the posterior distribution for the parameter corresponding to variable x_j, β_j, is given by

$$P(\beta_j|y) = \sum_{l=1}^{2^K} P(\beta_l|M_l, y)P(M_l|y), \tag{2}$$

where posterior distributions are denoted by $P(\cdot|y)$, and where $P(\cdot|M_l, y)$ stands for the posterior distribution conditional on the specification given by model M_l and data y. Inference is performed based on the posterior distributions obtained from individual specifications, weighted by posterior model probabilities, $P(M_l|y)$. These are proportional to the product of the marginal likelihood of the corresponding model ($P(y|M_l)$) and the prior model probability ($P(M_l)$). The integrated likelihood of a model can be computed as

$$P(y|M_l) = \int_{\beta_l}\int_{\sigma} f(y|\beta_l, \sigma)P(\beta_l, \sigma)d\beta_l d\sigma, \tag{3}$$

where $f(y|\beta_l, \sigma)$ is the likelihood function under model M_l and $P(\beta_l, \sigma)$ is the prior density over the parameters of M_k. It is standard in the literature on Bayesian Model Averaging (BMA, see for example Fernández et al., 2001b,a; Ley and Steel, 2007, 2012) to assume a flat prior over $\log(\sigma)$, so that $P(\sigma) \propto \sigma^{-1}$, and an independent g-prior over β_l, which implies that

$$\beta_l|\sigma, M_l \sim N(0, g\sigma^2(X_l'X_l)^{-1}), \tag{4}$$

where the columns of matrix X_l contain the observations of the explanatory variables included in M_l. The g-prior given by equation (4) assumes the same covariance structure as for the OLS estimator of β_l, scaled by g. Recent contributions propose the use of a hierarchical prior structure where a prior distribution over g is imposed. Liang et al. (2008), Feldkircher and Zeugner (2009) or Cui and George (2008), for instance, put forward alternative Beta priors over the shrinkage factor (given by $g/(1+g)$) which increase robustness of inference in the presence of model uncertainty further (see also Ley and Steel, 2012, for a comparison of hyper-g-priors in simulated settings). This is the setting employed in the empirical application of this study.[9]

With respect to the prior over models, $P(M_l)$, the BMA literature has moved from assigning a uniform prior over the model space (see for example Fernández et al., 2001b) or fixed prior inclusion probabilities by covariate (see for example Sala-i-Martin et al., 2004) to hierarchical priors where a (Beta) prior is imposed on the inclusion probability of each variable. Such a Beta-Binomial prior on model specifications has the advantage of providing more robust inference than priors based on fixing the inclusion probability of explanatory variables. Additionally, it makes the prior on model size less dependent on the choice of

[9] Early contributions to the application of BMA to econometric specifications (Fernández et al., 2001b; Sala-i-Martin et al., 2004) tend to use fixed values of g corresponding to settings that result on integrated likelihoods that result on well understood penalties on the inclusion of new variables in the model. The uniform information prior (UIP) results on an integrated likelihood that can be approximated using the Bayesian information criterion (BIC, see Schwarz, 1978) and corresponds to setting $g = N$. Alternatively, setting $g = K^2$, for instance, leads to the so-called risk inflation criterion (RIC, Foster and George, 1994). Fernández et al. (2001a), making use of a comparison based on simulated settings, propose the so-called BRIC criterion, which corresponds to $g = \max(N, K^2)$.

the g-prior (Ley and Steel, 2009). Since our particular application includes an interaction term among the potential covariates, treating all specifications in the model space equally *a priori* may lead to inference which is difficult to interpret. This is because specifications with interaction term but without the parent variables would be entertained in the averaging exercise. In order to avoid basing our inference on such potentially misleading models, we apply a strong heredity prior on covariate inclusion (Chipman, 1996; Crespo Cuaresma, 2011). Under this prior, specifications which include an interactive variable without also including the linear terms corresponding to both of the interacted variables are assigned a zero prior probability, thus ensuring that inference on the interaction term is properly interpretable.

Given the large number of models that need to be estimated to compute posterior distributions (in our benchmark estimation we have $K = 36$, so the model space contains around 69 billion specifications), we employ a Markov Chain Monte Carlo (MCMC) method to analyze the space of specifications (Kass and Wasserman, 1995). Our inference is based on 1,000,000 MCMC draws (visiting around 550,000 different models), after discarding 100,000 steps as a burn-in sample. The usual statistics used to ensure convergence of the Markov chain indicate systematically that statistics based on the visited models can be safely used to perform inference.[10]

4 Empirical results: The effect of reserve requirements on economic growth

4.1 Reserve requirements and credit growth

The previous literature has documented in a number of studies that tightening reserve requirements tends to be followed by lower credit growth. However, most of these studies focus on short-term to medium-run effects. Camors and Peydro (2014), for example, exploit a single change in regulation in Uruguay to identify reactions by banks. Glocker and Towbin (2015) and Tovar et al. (2012) employ VAR methods with monthly data and are therefore in principle able to identify longer-run effects of reserve requirement shocks. However, they restrict their impulse-response functions to four and one year horizons. Our analysis has a natural focus on longer horizons, and therefore provides a reference to compare the conclusions of these studies and assess whether short-run reactions persist at longer horizons. Moreover, our Bayesian approach to dealing with inference allows to integrate away the uncertainty attached to the choice of controls in the specification, thus providing robust alternative empirical evidence as compared to the findings from (admittedly rather large-scale) VARs. The comparative disadvantage of our analysis, on the other hand, is that we are not able to provide results on adjustment dynamics beyond conditional convergence speeds, nor can we strictly identify exogenous shocks. In order to rule out reverse causality, we need to make the assumption that reserve requirements and other control variables do not react to medium-run expectations (covering the following five years) of credit and GDP growth. The lag structure imposed in our model space, where explanatory variables are lagged by five years, provides a chronology that makes endogeneity concerns arguably unimportant in our setting.

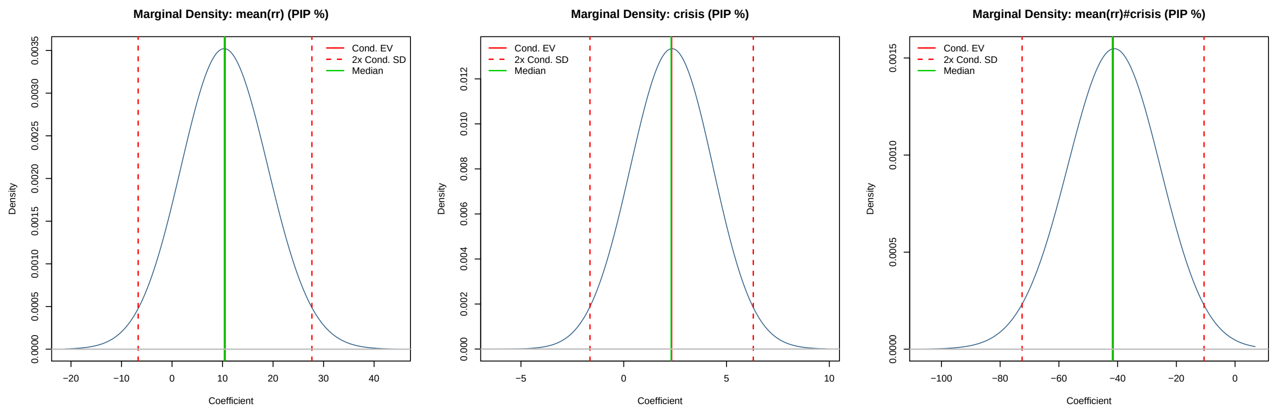
[10] The correlation between the analytical and MCMC-based posterior model probabilities is above 0.99 in the baseline model on GDP growth. Further convergence checks can be obtained from the authors upon request.

Table 1: Bayesian model averaging results for credit growth

	bank credit to private sector			credit by financial sector			credit to private sector		
variable	pip	mean	t-stat	pip	mean	t-stat	pip	mean	t-stat
mean(rr)	0.472	4.572	1.048	0.766	9.408	1.379	0.450	4.061	1.053
crisis	0.427	0.344	0.401	0.758	1.967	1.270	0.551	-0.545	-0.479
mean(rr)#crisis	0.241	-5.887	-1.534	0.704	-33.076	-2.899	0.304	-9.133	-1.984
bank credit to private sector	1.000	-0.206	-4.272	0.422	-0.018	-0.998	0.434	-0.030	-1.459
credit by financial sector	0.837	0.078	2.352	0.988	-0.126	-3.882	0.690	0.063	2.286
credit to private sector	0.402	-0.024	-0.917	0.353	0.004	0.177	0.970	-0.182	-3.041
EU dummy	0.954	-7.037	-2.975	0.697	-3.010	-1.747	0.931	-6.018	-2.803
labor force part.	0.844	-0.202	-2.494	0.546	-0.078	-1.528	0.700	-0.139	-2.198
pop. above 65	0.840	-1.423	-2.730	0.351	0.114	0.572	0.617	-0.775	-2.161
pop. growth	0.798	2.434	2.341	0.871	2.704	2.518	0.933	3.362	3.024
log gdp/capita	0.772	4.731	2.251	0.960	7.964	3.187	0.702	3.979	2.207
low-income country dummy	0.723	6.388	1.961	0.625	5.114	1.647	0.529	3.694	1.714
pop. under 14	0.600	-0.345	-1.868	0.344	-0.021	-0.205	0.367	-0.135	-1.222
capital account openness	0.562	2.070	1.669	0.413	0.876	0.971	0.344	0.773	1.061
upper-middle income dummy	0.534	-1.336	-1.061	0.432	0.008	0.007	0.373	-0.606	-0.749
tertiary education	0.472	0.152	1.344	0.391	-0.077	-0.817	0.249	0.007	0.127
lower-middle income dummy	0.467	0.781	0.452	0.546	2.115	1.181	0.337	0.470	0.443
urban pop.	0.414	-0.084	-1.126	0.337	0.008	0.143	0.256	-0.018	-0.410
inflation, cpi	0.407	0.022	0.990	0.536	0.015	0.755	0.428	0.033	1.298
inflation, gdp deflator	0.373	-0.013	-0.795	0.538	0.013	0.841	0.395	-0.020	-1.122
current account	0.360	0.030	0.491	0.456	0.086	1.068	0.318	0.029	0.562
fdi outflows	0.348	0.054	0.733	0.351	0.025	0.348	0.253	0.005	0.111
imports/GDP	0.348	-0.009	-0.023	0.370	-0.102	-0.169	0.288	0.024	0.068
life expectancy	0.346	0.071	0.750	0.327	-0.003	-0.038	0.288	0.057	0.761
secondary education	0.335	0.012	0.441	0.339	0.006	0.229	0.265	0.000	-0.018
household consumption	0.329	-0.045	-0.114	0.433	0.161	0.243	0.278	-0.065	-0.184
exports/GDP	0.319	-0.026	-0.066	0.373	0.078	0.129	0.272	-0.050	-0.146
govt. consumption	0.316	0.026	0.066	0.716	0.533	0.620	0.301	0.023	0.062
investment/gdp	0.315	-0.041	-0.105	0.519	0.009	0.012	0.315	-0.084	-0.224
govt. debt	0.313	-0.004	-0.397	0.534	-0.022	-1.504	0.270	-0.004	-0.566
trade openness	0.312	0.008	0.456	0.341	0.008	0.424	0.310	0.015	0.921
reserves (months of imports)	0.310	-0.029	-0.393	0.341	-0.030	-0.373	0.270	-0.028	-0.444
pop. density	0.310	0.000	-0.145	0.337	0.000	0.270	0.267	0.000	0.552
fdi inflows	0.308	-0.012	-0.160	0.340	0.016	0.218	0.254	0.014	0.275
primary education	0.306	-0.005	-0.181	0.434	-0.037	-0.993	0.379	-0.036	-1.186
total pop.	0.301	0.000	0.262	0.359	0.000	0.478	0.266	0.000	0.383
political rights	0.292	-0.005	-0.101	0.348	-0.031	-0.498	0.241	0.006	0.143
Fixed effects		YES			YES			YES	
Observations		305			305			305	

Note: Columns report the posterior inclusion probability (*pip*), unconditional mean (*mean*) and t-statistic conditional on inclusion (*t-stat*) of the coefficients. The corresponding BMA results without average reserve requirements and crisis dummies can be found in the appendix in Table A.4.

Figure 4: Credit by financial sector, posterior marginal densities of selected coefficients



Note: Densities are conditional on inclusion of the variable in the model. The full posterior density would be given by a scaled version of the reported densities, combined with a point-mass at zero.

Table 1 reports results from our BMA exercise with three different measures of credit growth as dependent variable. Specifically, we consider growth rates of (i) domestic credit provided by the financial sector, (ii) total credit to the private sector, and (iii) credit to the private sector provided by the banking sector. For every credit growth measure, we report results for BMA applied to the model space spanned by combinations of control variables in Table A.2 including *mean(rr)*, the crisis dummy and the interaction of the two.[11] In all cases, we report the posterior inclusion probability, the unconditional mean and the ratio of posterior mean to posterior standard deviation (thus resembling the frequentist t-statistic) conditional on inclusion for all variables entertained in the exercise. The posterior inclusion probability of a variable is given by the sum of posterior model probabilities of the specifications which include that variable as a covariate and is routinely interpreted as the importance of the variable when explaining variability in our dependent variable. As a different representation, Figure 4 depicts the *conditional* posterior distribution of our three main variables of interest in the regression on the growth rate of credit by the financial sector. The reported conditional mean effect (denoted by *Cond. EV* in the figure) is determined by the unconditional mean in the Table 1 divided by the corresponding inclusion probability.

Several results among those presented in Table 1 stand out. First, posterior inclusion probabilities are in general much more extreme and mostly closer to zero in the model estimates based on datasets without reserve requirements and crises (that have more observations), as can be seen by comparing these results to those in Table A.4, presented in the Appendix. That implies that the posterior model size distribution favours much smaller models (four to six regressors) among the latter models as compared to the specifications that lead to the results reported in Table 1, which indicate average model sizes of 15 to 18 regressors. It also implies that posterior means for coefficients of variables with low inclusion probabilities are much closer to zero than in the estimations from models including the variables of interest. However, the posterior means of the corresponding parameters conditional on inclusion are quite comparable over different settings. Second, we find fairly high posterior inclusion probabilities for *mean(rr)*, *crisis* and their

[11]In Table A.4 of the Appendix, we report results from a similar model averaging exercise without the variables of interest.Due to missing observations, the dataset including our variables of interest is markedly smaller. 28 (mostly developing) economies had to be removed from the dataset due to lack of information in the covariates of interest

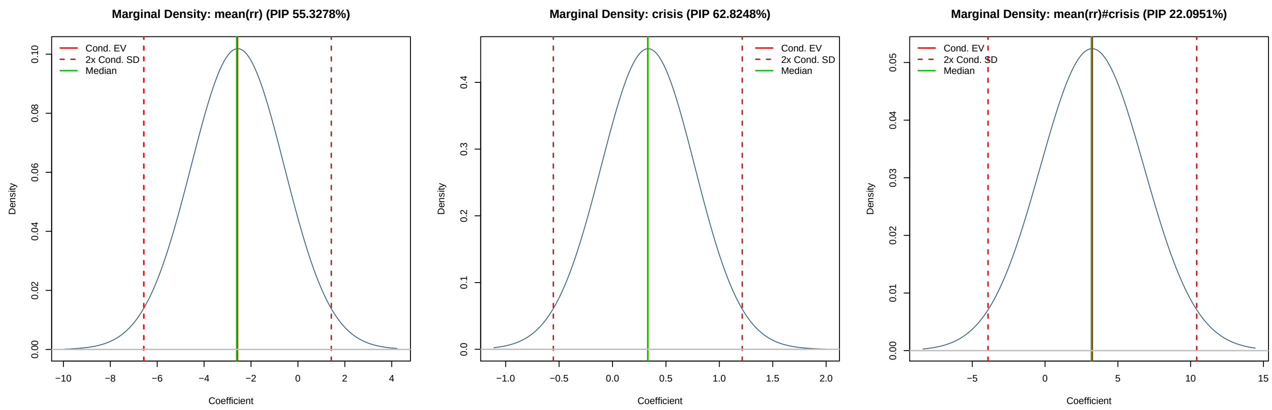
interaction, in particular for credit by the financial sector, indicating that the data tend to support the robustness of these variables as determinants of credit growth. Third, we find that past crises and past levels of reserve requirements have a positive effect on credit growth. Since crises rarely extend over more than one period and are contemporaneously associated with a sharp slowdown of credit growth (see Figure 1), the positive coefficient on lagged crises implies a credit expansion back to normal levels. We also find a positive coefficient on mean reserve requirements. VAR-studies Tovar et al. (2012); Arregui et al. (2013); Glocker and Towbin (2015) suggest a short-run negative effect of increasing requirements on credit growth. However, as requirements are very persistent, increases have an effect in the medium to long run (our measure of analysis), which seems to be positive for credit growth according to our findings. Taken together, faster credit growth after a short-run credit tightening may be a sign that either reserve requirements do not create permanent impairments to credit levels, or that there is an initial overreaction of financial markets in a reduction of credit. Last but not least, high reserve requirements during systemic banking crises have a strongly negative effect on credit growth even in the long run. This is consistent with the idea that reserve requirements should be lowered during a crisis to remove constraints from the stressed banking sector and enable its quick stabilization. Indeed, our data suggest that requirements are lowered in the first year of a crisis (see Figure 3). Once model uncertainty is taken into account, the standard deviation of our coefficient estimates are quite large (see Figure 4). Only the mean of the posterior distribution of the interaction coefficient is more than two standard deviations away from zero, further strengthening the recommendation of reducing requirements during a crisis.

In addition to our results for reserve requirements and crises, we also find evidence of conditional convergence dynamics in all credit measures, which materializes in a robust negative partial correlations between the initial level of credit and subsequent credit growth. Systematic robust effects with relatively precise estimates for all credit measures are also found for the following control variables: An economy with faster *population growth* tends to exhibit also faster credit growth, while *older populations* tend to reduce their reliance on credit. Moreover, richer economies (as measured by *log GDP/capita*) show faster credit growth. Furthermore, *EU economies* tend to present lower growth rates of credit independently of the measure used, while the opposite is true for *low income countries* (as defined by the World Bank classification). Finally, a higher *labor force participation* is associated with lower credit growth, a result which is likely to be caused by the fact that the highest increases in labor force participation (due mostly to the incorporation of women into the labor force, as well as improvements in educational attainment levels) tended to occur in the low and middle-income countries of our sample.

4.2 Reserve requirements and income growth

We now turn to the main analysis, where we investigate the effects of reserve requirements and systemic banking crises on economic growth. In a first step, we perform a similar analysis as above with the growth rate of GDP per capita as a dependent variable. The results of the BMA analysis applied to this setting are reported in Table 2. Differences in results between the settings with and without the three additional variables are much smaller than in the case of credit growth. As expected, initial GDP per capita levels have a strong negative effect on growth after controlling for other covariates, indicating conditional convergence to country-specific long-run balanced growth paths. Moreover, variables describing economic openness and international competitiveness appear as important robust determinants of economic growth. Concerning

Figure 5: GDP growth, posterior marginal densities of selected coefficients



Note: Densities are conditional on inclusion of the variable in the model. The full posterior density would be given by a scaled version of the reported densities, combined with a point-mass at zero.

demographics, population growth has the expected negative effect on income growth, while the size of the population affects growth positively.

We again report the distribution of our three main coefficients of interest, the ones on *mean(rr), crisis* and their interaction, in Figure 5. Average reserve requirements have (on average) a negative long-run effect on growth, as would be expected from stronger regulation.[12] A 10 percentage point higher level of requirements reduces economic growth by about 0.13 percentage points. However, reserve requirements have a positive effect on growth during crises. A possible reason for such a result is that crises are less severe if regulation is stronger, and that reserve requirements are employed countercyclically and loosened to free liquidity during a crisis. It should be noted, however, that the low inclusion probability of the interaction term of mean(rr) and crisis implies that there is little evidence for the robustness of such asymmetric effects of reserve requirements in this particular setting. Moreover, while reserve requirements may smooth volatility of GDP through a crisis, the overall effect appears negative for the data at hand. As in the results for credit growth, we find that past crises have a positive effect on income growth. Recessions and recoveries after crises take longer than usual business cycles, and cyclical amplitudes are higher (Reinhart and Rogoff, 2009, 2014; Bordo and Haubrich, 2017), which can explain why crises have a positive effect on long-run growth on average in our results. A second reason may be related to the fact that crises provide a trigger to improve institutions (for example through IMF programs), having an additional and permanent positive effect on economic growth (Acemoglu et al., 2005). However, it should be noted that all coefficients are small and very imprecisely estimated. That is, we can not refute the possibility that there is no catching up after a crisis (see Cerra and Saxena, 2008).

The database of Federico et al. (2014) does not only report average reserve requirements, but also differentiates requirements across maturities and/or currencies of regulated deposits. Thus, it allows to construct and investigate additional measures of reserve requirements that may shed light on the degree of differentiation embodied in different policy strategies with respect to reserves. During crises, more differentiation should allow policymakers a more targeted response to the crisis, having a positive effect on economic

[12] These effects remain nearly identical if we drop capital account openness from the set of explanatory variables.

Table 2: Bayesian model averaging results with and without reserve requirements and crisis

	GDP growth			GDP growth, with RR and crisis		
variable	pip	mean	t-stat	pip	mean	t-stat
mean(rr)				0.553	-1.290	-1.188
crisis				0.628	0.303	1.186
mean(rr)#crisis				0.221	0.621	0.779
log gdp/capita	1.000	-3.735	-6.672	0.986	-2.061	-2.930
pop. growth	0.983	-0.785	-3.109	0.605	-0.289	-1.555
total pop.	0.954	0.000	3.183	0.890	0.000	2.404
fdi outflows	0.849	-0.115	-2.300	0.998	-0.272	-3.988
urban pop.	0.583	0.034	2.122	0.543	0.027	1.280
credit to private sector	0.568	-0.011	-1.571	0.629	-0.012	-1.440
fdi inflows	0.530	0.049	1.889	0.997	0.251	3.629
life expectancy	0.504	0.044	1.898	0.332	0.003	0.126
investment/gdp	0.455	-0.018	-0.317	0.424	-0.003	-0.028
current account	0.434	0.021	1.626	0.947	0.102	2.710
credit by financial sector	0.372	0.004	1.285	0.546	0.008	1.239
reserves (months of imports)	0.343	-0.020	-1.481	0.813	-0.105	-2.328
lower-middle income dummy	0.341	0.287	1.173	0.453	0.307	0.890
trade openness	0.333	0.004	1.325	0.417	-0.004	-0.883
inflation, gdp deflator	0.313	0.001	0.776	0.331	0.000	-0.060
inflation, cpi	0.302	0.001	0.514	0.335	-0.001	-0.232
upper-middle income dummy	0.297	0.218	1.169	0.524	0.387	1.266
exports/GDP	0.247	0.008	0.199	0.378	0.013	0.126
bank credit to private sector	0.239	0.000	0.120	0.377	-0.001	-0.307
low-income country dummy	0.233	0.038	0.134	0.434	-0.284	-0.575
pop. above 65	0.219	-0.021	-0.849	0.501	-0.093	-1.320
imports/GDP	0.210	-0.007	-0.178	0.366	-0.016	-0.151
pop. under 14	0.207	-0.008	-0.676	0.366	-0.012	-0.506
secondary education	0.202	0.002	0.745	0.333	-0.001	-0.093
household consumption	0.195	0.007	0.184	0.396	0.021	0.192
govt. debt	0.189	0.000	0.070	0.770	0.010	2.017
labor force part.	0.186	-0.002	-0.617	0.330	-0.002	-0.268
political rights	0.185	0.004	0.613	0.607	-0.041	-1.635
pop. density	0.185	0.000	0.496	0.334	0.000	0.187
govt. consumption	0.179	0.003	0.072	0.339	0.007	0.066
capital account openness	0.177	0.042	0.521	0.567	0.460	1.603
primary education	0.171	0.000	-0.021	0.363	0.004	0.546
tertiary education	0.170	0.002	0.227	0.457	-0.029	-1.170
EU dummy	0.170	-0.013	-0.147	0.336	0.040	0.211
Fixed effects		YES			YES	
Observations		475			306	

Note: Columns report the posterior inclusion probability (*pip*), unconditional mean (*mean*) and t-statistic conditional on inclusion (*t-stat*) of the coefficients.

Table 3: Nonlinear effects of reserve requirements

	Baseline			SD(RR)			Difference(RR)			RR squared		
variable	pip	mean	t-stat	pip	mean	t-stat	pip	mean	t-stat	pip	mean	t-stat
mean(rr)	0.543	-1.266	-1.189	0.478	-1.092	-1.144	0.473	-1.080	-1.146	0.618	1.846	0.549
crisis	0.613	0.297	1.194	0.596	0.286	1.184	0.575	0.277	1.193	0.763	0.467	1.257
mean(rr)#crisis	0.209	0.583	0.773	0.160	0.404	0.570	0.151	0.385	0.582	0.397	-5.675	-1.226
sd(rr)				0.138	0.526	0.484						
sd(rr)#crisis				0.370	-0.624	-0.386						
maxdiff(rr)							0.129	0.214	0.463			
maxdiff(rr)#crisis							0.359	-0.245	-0.366			
$mean(rr)^2$										0.494	23.526	1.431
$mean(rr)^2$#crisis										0.740	-9.342	-1.282
Controls		YES			YES			YES			YES	
Fixed effects		YES			YES			YES			YES	
Observations		306			306			306			306	

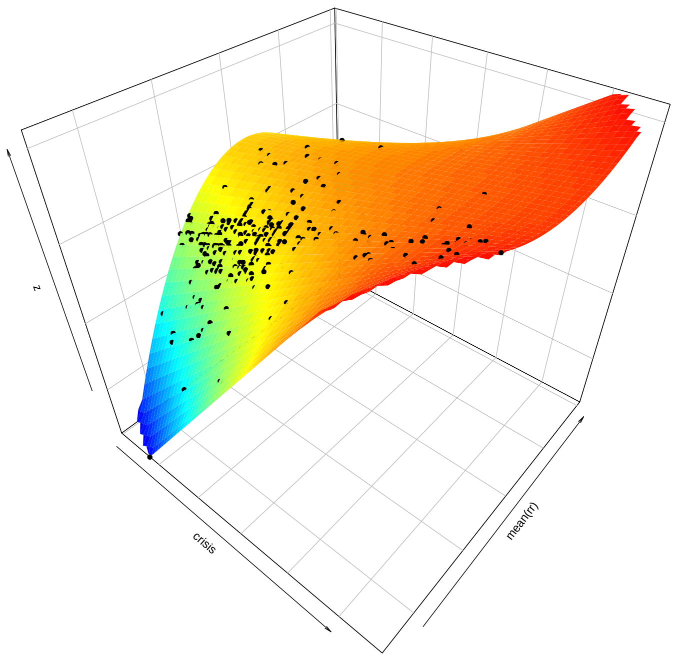
Note: Columns report the posterior inclusion probability (*pip*), unconditional mean (*mean*) and t-statistic conditional on inclusion (*t-stat*) of the coefficients.

growth. During normal times, increased differentiation could either be positive (due to the same targeting argument), or regulatory complexity could weigh negatively on growth. In particular, we look at the standard deviation of requirements across categories, and the difference between maximum and minimum requirements.[13] We use these variables individually and – as for *mean(rr)* – interact them with the crisis dummy. The findings on control variables are nearly unaffected, thus we report only variables of interest in Table 3. The differentiation measures have only a minor effect on the results obtained for the parameters of our baseline variables of interest. In addition, we find that inclusion probabilities are very similar to those of *mean(rr)* and its interaction with the crisis dummy. Regarding the effects of differentiation (*sd(rr), maxdiff(rr)* and their interactions with the crisis variable), we do not find any evidence of robust effects.

The fourth set of columns in Table 3 presents the model averaging results for models where the quadratic term of the reserve requirements covariate and its interaction with the crisis dummy are included as part of the pool of explanatory variables, capturing a potential nonlinear effect of average reserve requirements on economic growth. A quadratic relation could imply an "optimal level" of requirements, balancing growth against volatility. Indeed, we find that the posterior inclusion probabilities of these two variables are high, indicating a more complex nature of the link between economic growth and reserve requirements than that implied by linear models, and its modulation by crisis occurrence. The estimated partial relationship between crisis and reserve requirements (jointly) and economic growth is presented in Figure 6. It reports the joint effect of individual and interaction terms, and displays the actual observations on which our estimates are based. The dominating feature is a strong positive effect on growth for larger values of the crisis variable, consistent with the large positive coefficient in our estimations. On a more subtle note, we can see some differences when we vary the amount of reserve requirements. For low levels of the crisis occurrence variable (that is, for tranquil periods), the function is strongly hump-shaped. Moreover, the majority of observations have lower reserve requirements than the function maximum. That is, higher reserve requirements could have had a positive effect on growth. This finding is reassuring for the use of reserve requirements, which should provide a safeguard against crises and large economic fluctuations without affecting growth too

[13] These are, admittedly, blunt measures for the degree of regulatory differentiability, as they measure the de facto differentiation, rather than regulatory options.

Figure 6: Joint effect of crisis and reserve requirements: quadratic specifications



Note: The surface plot reports the quadratic function implied by the coefficients on *crisis, mean(rr), mean(rr)*^{2} and their interactions. Black dots report actual observations.

negatively. Apparently, this strategy works for medium levels of reserve requirements. For larger values of the crisis variable, we do not find the same hump-shaped relationship. Instead, the relationship flattens, indicating that reserve requirement levels do not affect the growth path after a long and severe financial crisis. However, we need to be careful about interpreting too much into results at high crisis values, as we have only very few observations at such levels of the variable.

Last, we account for the fact that many developing economies employed reserve requirements for monetary policy or as capital controls, rather than as macroprudential policy. As argued by Walsh (2012) in his discussion of the contribution by Glocker and Towbin (2012), reserve requirements may weigh more negatively on growth under fixed exchange rates. Higher reserve requirements increase the gap between lending and deposit rates necessary to maintain bank profitability. Thus, they should lead to higher capital outflows and currency devaluation. Under a fixed exchange rate regime (where devaluation is not an option), the central bank needs to increase its interest rate or continuously sell reserves in order to counteract the capital outflows. This interest rate tightening, in turn, has an additional negative effect on growth. We test if we can confirm this hypothesis even in a setup with a focus on longer horizons and allowing for crises. In order to do so, we make use of the exchange rate arrangement classification of Ilzetzki et al. (2017). We construct two measures in addition to their coarse and a fine classification schemes (where increasing index values are associated with lower degrees of exchange rate control). First, we remove all periods in which Ilzetzki et al. (2017) classify the currency as either free-falling or as a "dual market in which parallel market data is missing" (their two last categories). Second, we construct a simple dummy which is one if the fine index is equal or above the median (eight). In addition to exchange rate arrangements, we also test the interaction with the capital openness index of Chinn and Ito (2008).

Independently of the way we measure exchange rate arrangements, we cannot confirm the theoretical hypothesis.[14] In all cases, increasingly fixed exchange rates (i.e., lower index values) together with higher reserve requirements tend to be followed by higher growth, as indicated by the negative coefficients on the interaction terms. Somewhat pointing in the opposite direction, larger capital account openness in interaction with higher reserve requirements are also good for growth. We draw from this set of results that both our results and the theoretical prediction should be taken with a grain of salt. First, the time horizon at which predictions of the theoretical model hold is most likely shorter than in our empirical analysis. Furthermore, the theoretical model does not explicitly account for crises, which may heavily influence our estimation results. There remains a considerable number of systemic banking crises even if we exclude periods where exchange rates were freely falling.

5 Conclusion

This paper investigates the effect of reserve requirements on medium to long-run credit and GDP growth. Adding to the previous literature on reserve requirements, we employ a large international panel study. Our Bayesian estimation framework, aimed at assessing explicitly model uncertainty and incorporating it to our estimates, provides robust evidence on the importance of reserve requirements for growth, and its effect. In terms of credit growth, previously indicated *negative* effects of reserve requirements seem to be short-lived. After five years, we instead find a robust *positive* effect of past requirements on current credit growth. In terms of GDP growth, reserve requirements have on average the expected negative effect of regulation, and although they seem to be somewhat helpful on average in mitigating the effects of a crisis, their effect is not robust to specification uncertainty in the economic growth regressions entertained. A nonlinear estimation suggests that medium levels of reserve requirements may in fact be optimal for medium to long-run growth.

[14] Table A.5 in the Appendix presents the results.

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Appendix

Table A.1: Variable sources and description

Variable Name	Source	Description
crisis	Laeven and Valencia (2013)	Dummy for systemic banking crisis
reserve requirements	Federico et al. (2014)	Level of reserve requirements, potentially differentiated across currencies and maturities of deposits
gdp growth/capita	World Bank WDI	GDP/capita growth (annual %)
credit by financial sector	World Bank WDI	Domestic Credit Provided By Financial Sector (%GDP)
bank credit to private sector	World Bank WDI	Domestic Credit To Private Sector By Banks (%GDP)
credit to private sector	World Bank WDI	Domestic Credit To Private Sector (%GDP)
gdp/capita	IMF World Economic Outlook	Gross Domestic Product Per Capita, Current Prices
investment/gdp	World Bank WDI	Gross Capital Formation (%GDP)
household consumption	World Bank WDI	Household Final Consumption Expenditure (%GDP)
govt. consumption	World Bank WDI	General government final consumption expenditure (%GDP)
govt. debt	(Abbas et al., 2011)	Govt. Debt (%GDP) from the Historical Public Debt Database, updated yearly
inflation, cpi	World Bank WDI	Inflation, CPI (annual %)
inflation, gdp deflator	World Bank WDI	Inflation, GDP deflator (annual %)
trade openness	World Bank WDI	Merchandise Trade (%GDP)
capital account openness	Chinn and Ito (2008)	Capital account openness, based on IMF AREAER, updated to 2015
era	Ilzetzki et al. (2017)	Classification of de facto exchange rate arrangements
fdi inflows	World Bank WDI	Foreign Direct Investment, Net Inflows (%GDP)
fdi outflows	World Bank WDI	Foreign Direct Investment, Net Outflows (%GDP)
exports/GDP	World Bank WDI	Exports Of Goods & Services (%GDP)
imports/GDP	World Bank WDI	Imports Of Goods & Services (%GDP)
reserves (months of imports)	IMF IFS	Total reserves in months of imports
current account	World Bank WDI	Current Account Balance (%GDP)
political rights	Marshall et al. (2016)	Strength of political rights, ranges from +10 (strongly democratic) to -10 (strongly autocratic).
labor force part.	World Bank WDI	Labor Force Participation Rate, (% Of Total, Ages 15+)
primary education	Barro and Lee (2013)	Primary Educational Attainment for Total Population, 1950-2010
secondary education	Barro and Lee (2013)	Secondary Educational Attainment for Total Population, 1950-2010
tertiary education	Barro and Lee (2013)	Tertiary Educational Attainment for Total Population, 1950-2010
pop. growth	World Bank WDI	Population Growth (annual %)
total pop.	World Bank WDI	Population, Total
urban pop.	Oxford Economics	Population - Urban (% of total)
life expectancy	World Bank WDI	Life Expectancy At Birth, Total (Years)
pop. density	World Bank WDI	Population Density (People Per Sq. Km Of Land Area)
pop. under 14	World Bank WDI	Population Ages 0-14 (% of total)
pop. above 65	World Bank WDI	Population Ages 65 & Above (% of total)
low-income country dummy	World Bank	Country dummy, GNI per capita (WB Atlas method) of $1,005 or less in 2016
lower-middle income dummy	World Bank	Country dummy, GNI per capita (WB Atlas method) between $1,006 and $3,955
upper-middle income dummy	World Bank	Country dummy, GNI per capita (WB Atlas method) between $3,956 and $12,235
EU dummy		Dummy for EU countries

Table A.2: Summary statistics of full dataset

variable	min	mean	median	max	sd	Observations
gdp growth/capita	-4.485	2.390	2.182	13.880	2.460	475
mean(rr)	0.000	0.087	0.054	0.486	0.096	306
crisis	0.000	0.138	0.000	1.000	0.277	475
mean(rr)#crisis	0.000	0.010	0.000	0.306	0.032	306
log gdp/capita	5.419	8.748	8.666	11.405	1.383	475
govt. consumption	4.080	15.781	15.912	38.678	5.458	475
household consumption	26.184	62.834	61.886	104.064	12.471	475
investment/gdp	5.884	24.191	23.230	48.920	6.101	475
inflation, gdp deflator	-6.214	15.152	5.972	582.726	43.258	475
inflation, cpi	-0.516	14.378	5.996	411.608	34.476	475
labor force part.	22.494	59.856	59.680	88.187	9.372	475
trade openness	10.950	63.470	53.006	321.084	41.934	475
current account	-32.366	-1.477	-1.814	38.704	6.637	475
reserves (months of imports)	0.049	4.359	3.475	33.379	3.619	475
fdi outflows	-4.798	1.501	0.366	45.562	3.723	475
fdi inflows	-3.206	3.346	2.236	40.410	4.206	475
exports/GDP	5.882	38.066	31.568	218.892	26.085	475
imports/GDP	6.158	40.866	35.050	191.972	25.286	475
bank credit to private sector	3.292	50.784	42.130	183.040	36.627	475
credit by financial sector	-57.156	70.313	56.686	338.886	52.747	475
credit to private sector	3.314	55.121	44.422	208.736	41.237	475
primary education	0.200	17.366	16.400	50.560	10.073	475
secondary education	0.540	26.004	23.720	69.600	15.185	475
tertiary education	0.140	7.367	5.740	30.000	5.954	475
political rights	-9.800	5.806	8.000	10.000	5.248	475
life expectancy	43.655	70.957	72.316	83.090	7.386	475
pop. growth	-1.514	1.199	1.156	5.880	1.139	475
pop. density	1.670	207.943	80.202	7494.225	686.086	475
total pop.	6.680E+05	6.365E+07	1.448E+07	1.351E+09	1.853E+08	475
pop. under 14	13.122	27.982	27.662	49.720	9.776	475
pop. above 65	1.888	8.765	6.704	24.308	5.211	475
urban pop.	5.628	60.379	63.846	100.000	21.840	475
EU dummy	0.000	0.183	0.000	1.000	0.380	475
low-income country dummy	0.000	0.141	0.000	1.000	0.336	475
lower-middle income dummy	0.000	0.316	0.000	1.000	0.438	475
upper-middle income dummy	0.000	0.235	0.000	1.000	0.394	475
capital account openness	0.000	0.568	0.523	1.000	0.357	475
govt. debt	4.220	54.491	47.880	302.660	34.090	475
mean(rr)^2	0.000	0.017	0.003	0.270	0.034	306
mean(rr)^2#crisis	0.000	0.002	0.000	0.118	0.010	306
sd(rr)	0.000	0.020	0.000	0.283	0.041	306
sd(rr)#crisis	0.000	0.004	0.000	0.226	0.018	306
maxdiff(rr)#crisis	0.000	0.008	0.000	0.492	0.041	306
maxdiff(rr)	0.000	0.044	0.001	0.642	0.092	306
era fine	1.000	8.008	8.000	15.000	3.639	468
era coarse	1.000	2.368	2.000	6.000	1.042	467
era dummy	0.000	0.576	1.000	1.000	0.469	456
era fine rest.	1.000	7.647	8.000	13.000	3.469	456
mean(rr)#era fine	0.000	0.720	0.402	5.197	0.931	304
mean(rr)#era coarse	0.000	0.214	0.105	1.876	0.291	305
mean(rr)#era dummy	0.000	0.051	0.012	0.486	0.083	298
mean(rr)#era fine rest.	0.000	0.660	0.388	4.858	0.840	298
mean(rr)#ka_open	0.000	0.041	0.018	0.355	0.060	306
era fine#crisis	0.000	1.046	0.000	13.900	2.423	468
era coarse#crisis	0.000	0.326	0.000	4.950	0.722	467
era dummy#crisis	0.000	0.073	0.000	1.000	0.200	456
era fine rest.#crisis	0.000	0.966	0.000	13.000	2.254	456
ka_open#crisis	0.000	0.086	0.000	1.000	0.218	475
mean(rr)#era fine#crisis	0.000	0.085	0.000	3.601	0.313	304
mean(rr)#era coarse#crisis	0.000	0.026	0.000	1.282	0.103	305
mean(rr)#era dummy#crisis	0.000	0.006	0.000	0.273	0.023	298
mean(rr)#era fine rest.#crisis	0.000	0.076	0.000	2.728	0.271	298
mean(rr)#ka_open#crisis	0.000	0.003	0.000	0.098	0.011	306

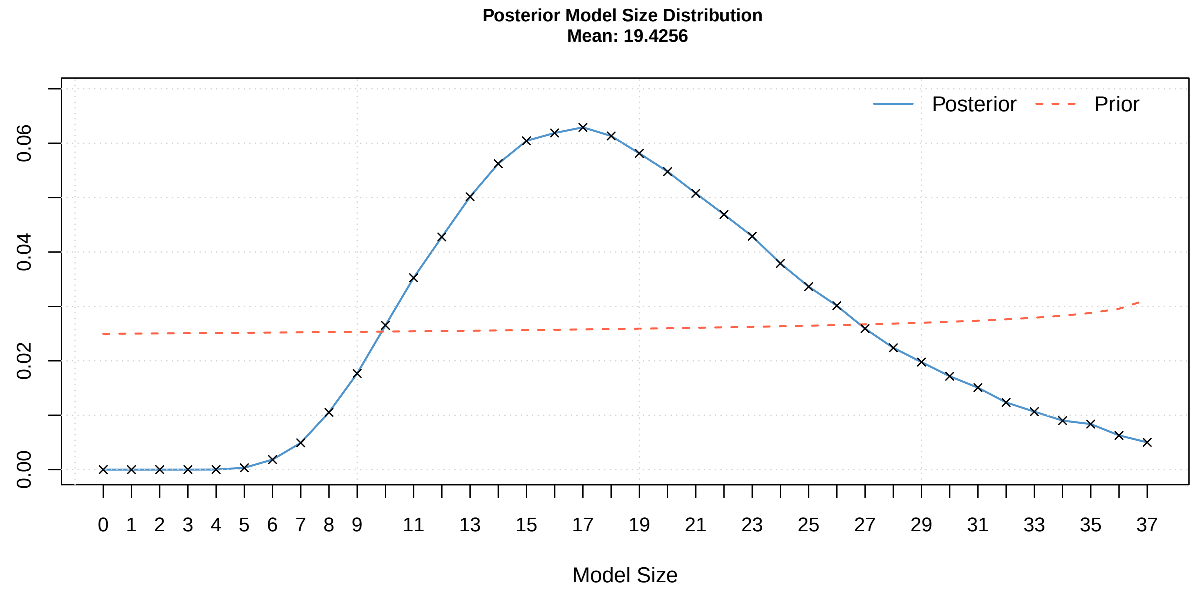
Note: The different reserve requirements variables (*mean(rr), sd(rr), maxdiff(rr) and mean^2(rr)*), as well as the different exchange rate arrangement indizes (*era fine/coarse/dummy/fine rest.*) are described in the text. *ka_open* refers to capital account openness.

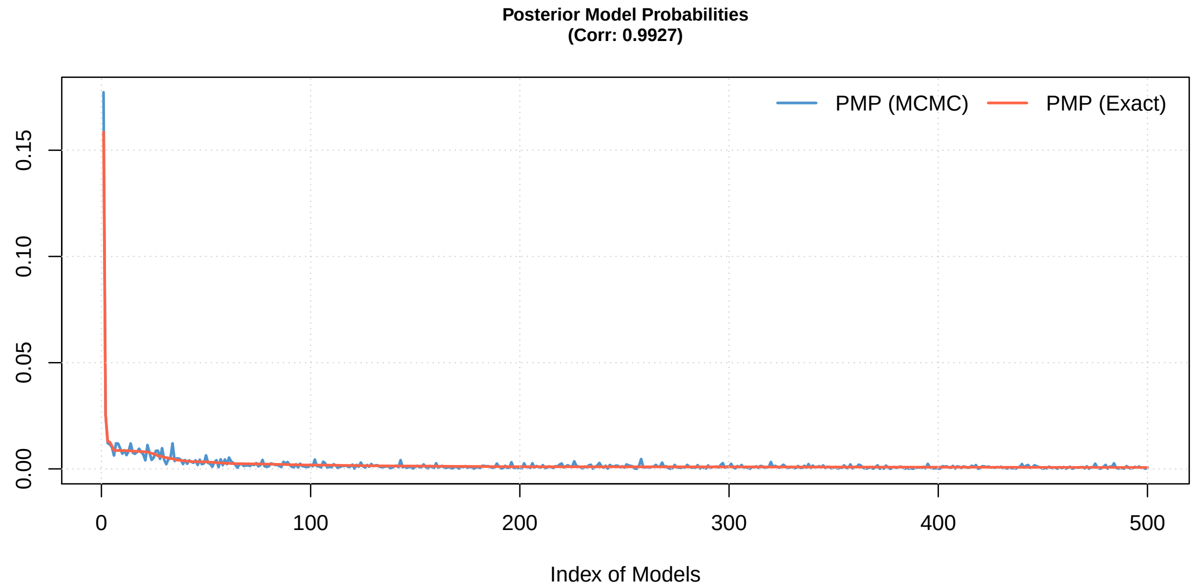
Table A.3: Coverage across countries and time

	Baseline without crises and mean(rr)		Baseline			Baseline without crises and mean(rr)		Baseline	
Country	Start	End	Start	End	Country	Start	End	Start	End
Albania	2005	2015	2005	2015	Lesotho	2010	2015	NA	
Algeria	1985	2015	NA		Lithuania	2000	2015	2000	2015
Argentina	1990	2015	1995	2015	Malawi	2000	2015	NA	
Armenia	2000	2015	NA		Malaysia	1985	2015	1990	2015
Australia	1990	2015	1990	2015	Mauritius	1990	2015	NA	
Austria	2010	2015	2010	2015	Mexico	1985	2015	1990	2015
Bangladesh	1995	2015	1995	2015	Moldova	2000	2015	2005	2015
Belgium	2005	2015	2005	2015	Mongolia	2010	2015	NA	
Botswana	1985	2015	NA		Morocco	1990	2015	NA	
Brazil	1985	2015	1985	2015	Mozambique	2010	2015	NA	
Bulgaria	1995	2015	NA		Nepal	2015	2015	NA	
Burundi	1990	2010	NA		Netherlands	1985	2015	2000	2015
Cambodia	2000	2015	NA		New Zealand	2005	2010	2005	2010
Canada	1985	2010	1995	2010	Nicaragua	2010	2015	2010	2015
Chile	1985	2015	1985	2015	Norway	1985	2015	1985	2015
China	1990	2015	1990	2015	Pakistan	1985	2015	1985	2015
Colombia	1985	2015	1985	2015	Panama	1985	2015	2000	2015
Costa Rica	1985	1995	1990	1995	Paraguay	1995	2015	NA	
Croatia	2000	2015	2005	2015	Peru	1985	2015	1995	2015
Czech Republic	2000	2015	2000	2015	Philippines	1985	2015	2005	2015
Dem. Rep. Congo	2010	2010	NA		Poland	1995	2015	1995	2015
Denmark	1985	2015	1985	2015	Portugal	1985	2015	1990	2015
Dominican Republic	1985	2015	1985	2015	Romania	2000	2015	2000	2015
Ecuador	1985	2015	1990	2015	Russian Federation	2000	2015	NA	
El Salvador	2000	2015	2005	2015	Singapore	1985	2015	1995	2015
Estonia	2000	2015	2000	2015	Slovakia	2000	2015	2000	2015
Fiji	1985	2015	NA		Slovenia	2000	2015	2000	2015
Finland	1985	2015	2000	2015	South Africa	1985	2015	1985	2015
France	1985	2015	1990	2015	South Korea	1985	2015	NA	
Germany	1995	2015	1995	2015	Spain	1985	2015	1995	2015
Ghana	1995	2015	2010	2015	Sri Lanka	1990	2015	2000	2015
Guyana	2000	2005	NA		Sudan	2010	2010	NA	
Haiti	2000	2015	NA		Sweden	1985	2015	1985	2015
Honduras	1985	2015	2005	2015	Switzerland	2000	2015	2000	2015
Hungary	1995	2015	1995	2015	Thailand	1985	2015	1985	2015
India	1985	2015	1985	2015	The Gambia	2015	2015	NA	
Indonesia	1985	2015	2010	2015	Trinidad And Tobago	1985	2015	1985	2015
Ireland	2010	2015	2010	2015	Tunisia	1985	2015	NA	
Israel	1985	2015	1990	2015	Turkey	1985	2015	1990	2015
Italy	1985	2015	2000	2015	Uganda	2000	2015	2000	2015
Jamaica	1995	2015	1995	2015	Ukraine	2000	2015	NA	
Japan	2000	2015	2000	2015	United Kingdom	1990	2015	1990	2015
Jordan	1985	2015	NA		United States	1985	2015	1985	2015
Kazakhstan	2000	2015	NA		Uruguay	1985	2015	1985	2015
Kenya	1990	2000	NA		Venezuela	1985	2010	1985	2010
Kuwait	2000	2015	NA		Vietnam	2010	2015	NA	
Kyrgyz Republic	2000	2015	NA		Zambia	2015	2015	NA	
Latvia	2000	2015	2000	2015					

Note: Data availability refers to the two estimations in Table 2.

Figure A.7: Posterior model size and probabilities, baseline estimation on GDP growth





Note: The upper plot shows the distribution of prior and posterior model sizes. The lower plot reports the posterior model probabilities calculated from numerical integration ("exact") and as implied by the MCMC draws for the 500 models with the highest posterior likelihood.

Table A.4: Bayesian model averaging results for credit growth, without reserve requirements and credit

	bank credit to private sector			credit by financial sector			credit to private sector		
variable	pip	mean	t-stat	pip	mean	t-stat	pip	mean	t-stat
bank credit to private sector	1.000	-0.178	-7.084	0.110	-0.006	-0.990	0.083	-0.009	-1.635
credit by financial sector	0.054	0.001	0.577	0.962	-0.127	-4.680	0.048	0.001	0.499
credit to private sector	0.079	0.003	0.794	0.110	-0.007	-0.848	0.963	-0.163	-7.055
EU dummy	0.419	-2.071	-2.493	0.097	-0.213	-0.817	0.242	-1.019	-2.267
labor force part.	0.085	-0.007	-1.194	0.443	0.101	2.307	0.041	-0.001	-0.507
pop. above 65	0.059	-0.001	-0.031	0.067	-0.010	-0.233	0.022	0.000	-0.012
pop. growth	0.090	0.111	1.369	0.297	0.637	1.824	0.093	0.134	1.742
log gdp/capita	0.057	0.021	0.164	0.087	0.156	0.559	0.026	0.001	0.014
low-income country dummy	0.202	1.327	1.645	0.144	0.890	1.205	0.039	0.140	1.217
pop. under 14	0.152	-0.055	-1.701	0.092	-0.033	-0.940	0.055	-0.010	-0.988
capital account openness	0.184	0.645	1.774	0.090	0.083	0.353	0.048	0.095	1.044
upper-middle income dummy	0.252	-0.714	-1.841	0.138	-0.211	-0.575	0.119	-0.257	-1.698
tertiary education	0.058	0.007	0.689	0.085	-0.019	-0.848	0.039	-0.002	-0.270
lower-middle income dummy	0.185	0.598	1.202	0.132	0.407	0.960	0.048	0.063	0.681
urban pop.	0.104	0.015	1.280	0.134	-0.025	-1.224	0.069	0.009	1.291
inflation, cpi	0.181	0.005	1.023	0.157	0.003	0.607	0.094	0.003	0.897
inflation, gdp deflator	0.126	0.001	0.182	0.120	0.001	0.322	0.043	0.000	-0.225
current account	0.967	0.326	3.873	0.135	-0.028	-1.206	0.901	0.288	3.884
fdi outflows	0.057	0.005	0.656	0.131	0.037	1.264	0.032	0.002	0.456
imports/GDP	0.098	-0.006	-0.203	0.089	-0.018	-0.174	0.096	-0.015	-1.289
life expectancy	0.070	0.006	0.490	0.995	1.004	4.079	0.044	0.007	0.910
secondary education	0.059	-0.001	-0.128	0.147	-0.020	-1.401	0.029	0.000	-0.233
household consumption	0.118	-0.016	-0.463	0.096	0.001	0.014	0.154	-0.029	-1.809
exports/GDP	0.059	-0.002	-0.066	0.081	0.017	0.170	0.054	0.009	1.126
govt. consumption	0.047	0.002	0.068	0.086	0.016	0.150	0.045	-0.001	-0.128
investment/gdp	0.072	-0.003	-0.113	0.095	0.009	0.085	0.052	-0.008	-1.055
govt. debt	0.053	0.000	-0.083	0.101	-0.003	-0.862	0.028	0.000	-0.148
trade openness	0.043	0.000	0.203	0.074	-0.001	-0.317	0.035	0.001	0.390
reserves (months of imports)	0.044	-0.001	-0.151	0.099	-0.008	-0.363	0.026	0.000	-0.079
pop. density	0.079	0.000	-0.879	0.076	0.000	-0.025	0.038	0.000	-0.610
fdi inflows	0.052	0.001	0.087	0.086	-0.008	-0.347	0.016	0.001	0.280
primary education	0.105	-0.011	-1.283	0.107	-0.017	-1.228	0.076	-0.010	-1.755
total pop.	0.066	0.000	0.581	0.076	0.000	-0.509	0.029	0.000	0.381
political rights	0.083	-0.012	-1.126	0.101	-0.011	-0.589	0.024	-0.002	-0.693
Fixed effects		YES			YES			YES	
Observations		473			473			473	

Note: Columns report the posterior inclusion probability (*pip*), unconditional mean (*mean*) and t-statistic conditional on inclusion (*t-stat*) of the coefficients.

Table A.5: Reserve requirements and exchange rate arrangements

	ERA fine			ERA coarse			ERA dummy, no free falling			ERA fine, no free falling			Capital account openness		
variable	pip	mean	t-stat	pip	mean	t-stat	pip	mean	t-stat	pip	mean	t-stat			
mean(rr)	0.729	0.393	0.100	0.735	1.509	0.437	0.924	1.465	0.584	0.945	8.133	1.737	0.533	-1.476	-1.238
crisis	0.582	0.274	1.031	0.737	-0.082	-0.135	0.582	0.215	0.827	0.611	0.272	0.926	0.585	0.199	0.395
mean(rr)#crisis	0.150	0.161	0.148	0.248	0.197	0.102	0.172	-0.070	-0.083	0.185	0.182	0.101	0.170	1.008	0.988
era fine	0.539	0.020	0.598												
mean(rr)#era fine	0.340	-0.298	-1.916												
era fine#crisis	0.113	0.001	0.077												
mean(rr)#era fine#crisis	0.107	0.014	0.159												
era coarse				0.714	0.125	0.974									
mean(rr)#era coarse				0.481	-1.129	-1.864									
era coarse#crisis				0.409	0.206	1.602									
mean(rr)#era coarse#crisis				0.228	0.039	0.063									
era dummy							0.913	0.389	0.965						
mean(rr)#era dummy							0.847	-7.269	-2.955						
era dummy#crisis							0.171	0.051	0.420						
mean(rr)#era dummy#crisis							0.161	0.221	0.204						
era fine rest.										0.928	0.083	1.496			
mean(rr)#era fine rest.										0.887	-1.337	-3.121			
era fine rest.#crisis										0.175	0.002	0.132			
mean(rr)#era fine rest.#crisis										0.172	-0.025	-0.126			
ka_open													0.590	0.385	1.115
mean(rr)#ka_open													0.175	0.779	1.028
ka_open#crisis													0.159	0.110	0.444
mean(rr)#ka_open#crisis													0.134	-1.333	-0.763
Controls		YES			YES			YES			YES			YES	
Fixed effects		YES			YES			YES			YES			YES	
Observations		304			305			298			298			306	

Note: Columns report the posterior inclusion probability (*pip*), unconditional mean (*mean*) and t-statistic conditional on inclusion (*t-stat*) of the coefficients. *ka_open* refers to capital account openness.

Halle Institute for Economic Research –
Member of the Leibniz Association

Kleine Maerkerstrasse 8
D-06108 Halle (Saale), Germany

Postal Adress: P.O. Box 11 03 61
D-06017 Halle (Saale), Germany

Tel +49 345 7753 60
Fax +49 345 7753 820

www.iwh-halle.de

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