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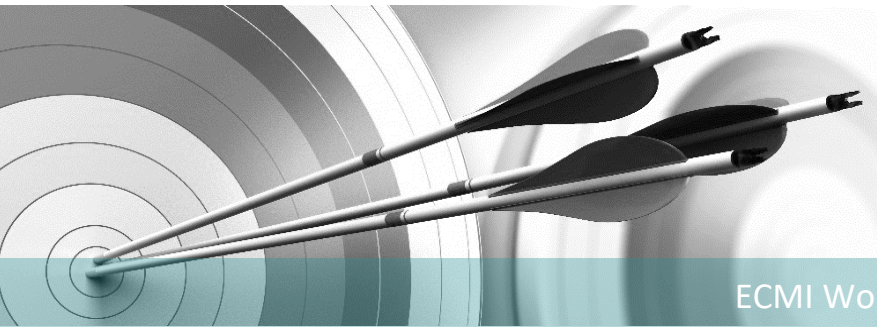

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Regulation, financial crises, and liberalization traps

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ECMI Working Paper

Regulation, financial crises, and liberalization traps

Francesco Marchionne, Beniamino Pisicoli, Michele Fratianni*

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Abstract

This paper first develops a theoretical model showing a concave impact of regulation on the probability of a crisis, and then tests this relationship by applying a non-linear Probit model to annual data from 138 countries over the period 1996-2017. Our key inference is that the probability of a financial crisis fits an inverted U-shaped curve: it rises as regulation stringency moves from low to medium levels and falls from medium to high levels. Countries located in the intermediate level of regulatory stringency face more financial instability than either loosely or severely regulated countries. The latter two groups of countries are respectively caught in a "liberalization trap" and a "regulation trap." Institutional quality interacts significantly with the regulatory environment, implying trade-offs between regulatory stringency and institutional quality.

JEL classification: G01, G21, G28.

Keywords: crisis; banks; institutions; liberalization; regulation

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I. INTRODUCTION

Financial regulation is prone to big swings. Over almost a century, there have been two big peaks of financial regulation, the first in the wake of Great Depression of the 1930s and the second after the Great Financial Crisis of 2008-2009. Between these two regulatory peaks, we have gone through a long wave of deregulation that started in the 1980s in the industrial countries and moved to the developing world in the 1990s. This deregulation preceded financial crises. Bordo et al. (2001) show that crisis frequency doubled after the collapse of Bretton Woods in 1973. Many developing countries that deregulated in the 1990s had to soon contend with banks' insolvency, currency crises and difficulties in financing government deficits (Daniel and Jones, 2007; Abiad et al., 2010). A more liberal financial environment, including freer capital mobility, preceded most banking crises. Kaminsky and Reinhart (1999; 2008, Fig. 10.1) find that in their sample liberalization occurred before the eruption of crises in approximately 70 percent of banking crises.

The temporal relationship between regulation and crises is not uniform over relatively short timeframes: the timing sequence can be either first regulation and then crisis or first crisis and then regulation. But the conclusion of the empirical literature is that, in the vast majority of cases, regulation determines the environment in which banks operate (see Kaminsky and Reinhart, 1999; Hellmann et al., 2000; Barth et al., 2001; Reinhart and Rogoff, 2008; Arinaminpathy et al. 2011; Haldane and May 2011; Levine, 2012).[1] The Financial Crisis Inquiry Commission (2011) concluded that the 2008-2009 financial crisis was also the consequence of financial deregulation. This is the starting assumption of our paper: that is, the probability of a crisis is a left-hand side variable and regulation is a right-hand side of a testable equation. Nonetheless, the paper explicitly deals with the endogeneity problem.

[1] A regulatory environment should not be confused with the ability of the authorities to effectively regulate financial firms, as it is claimed by adherents of the efficient market paradigm (Shaw, 1973; McKinnon, 1973).

As to the impact of regulation on the probability of a crisis, three broad findings emerge in the literature. The first is that the early papers suggest a negative effect of regulation on financial stability. Banking crises more often occur in countries with a sharper divide between investment and commercial banks and greater asset restrictions placed on commercial banks (Barth et al., 2001). The impact of regulation, furthermore, varies according to the regulatory structure. Barth et al. (2004) report that only higher bank asset restrictions, greater foreign-banks entry barriers, and deposit insurance schemes increase financial instability. In general, tighter restrictions and government interventions are associated with more vulnerable financial systems (Lee et al., 2016; Lambert et al., 2017; Goetz, 2018). But the literature struggles to find a consensus. For example, Lee and Lu (2015) conclude that stricter capital regulation and greater entry requirements lower the ratio of non-performing loans (NPLs) to gross loans and promote a more stable financial sector. In contrast, Papi et al. (2015), using a sample of 113 developing countries, show that financial deregulation, included as part of the intervention package of the International Monetary Fund (IMF, henceforth), can prevent crises.

The second feature is that empirical findings are sensitive to the measure of banking regulation. According to Sundararajan et al. (2001), there is no direct relationship between financial stability and the application of the *Core Principles for Effective Bank Supervision* (*BCPs*) issued by the Basel Committee on Banking Supervision. In contrast, Podpiera (2006) concludes that a higher compliance to *BCPs* lowers the percentage of NPLs, a positive outcome that is corroborated by an improvement in Moody's ratings (Demirgüç-Kunt et al., 2008). After separating the various dimensions of the *Principles*, only compliance with *BCP* No. 21 is positively related to bank soundness, a result in line with findings on regulation channels. Extending their earlier study, Demirgüç-Kunt et al. (2010) fail to uncover that a higher compliance with *BCPs* affects bank soundness and risk. In sum, findings on bank stability are sensitive to *BCP* measures.

Lastly, results are ambiguous, not only for industrial countries, but also for developing countries. Berger at al. (2016) show that regulatory interventions in Germany reduced risky banking practices and impacted liquidity creation over the period 1999-2009. Barrell et al. (2010) confirm the lower procyclicality associated with higher capital ratios and liquidity regulation among Organization for Economic Co-operation and Development (OECD, henceforth) countries.[2] In contrast, Fratzscher et al. (2016), using a subsample of OECD countries, conclude that tighter post-crisis capital regulation curtailed domestic credit growth and impaired banking stability. Moving to developing countries, Tchana Tchana (2014) finds mixed effects on the Indonesian banking sector: while entry restrictions, deposit insurance and capital requirements reduce the probability and the duration of a banking crisis, larger reserve requirements instead raise them. Similarly, focusing on non-industrial economies, Klomp and de Haan (2014) show that stricter regulation reduces bank riskiness, but the impact of liquidity regulation and activity restrictions on bank risk critically depends on country-specific institutional quality.

To bypass the complex web of the regulatory structure and the influence that different measures may have on outcomes, a growing literature has employed the Heritage Foundation Financial Freedom Index (*FFI*) as an inverted proxy of banking regulation (e.g., González 2005, OECD 2006, Sufian and Habibullah, 2010; Lin et al., 2016, Data Appendix). The alternative to *FFI* would have been specific measures of banking regulations, such as capital requirements or the cost of the regulation. But international panel data of this kind is not available because specific regulatory measures suffer from incompleteness, lack of standardization or inconsistency across countries.

[2] Ambiguity persists even when regulation interacts with competition. For instance, Beck et al. (2013) reveal a significantly negative interaction among competition, stricter activity restrictions and more generous deposit insurance on banks' fragility, while Anginer et al. (2014) find that more stringent capital requirements and greater supervision increase stability, whereas competition is irrelevant.

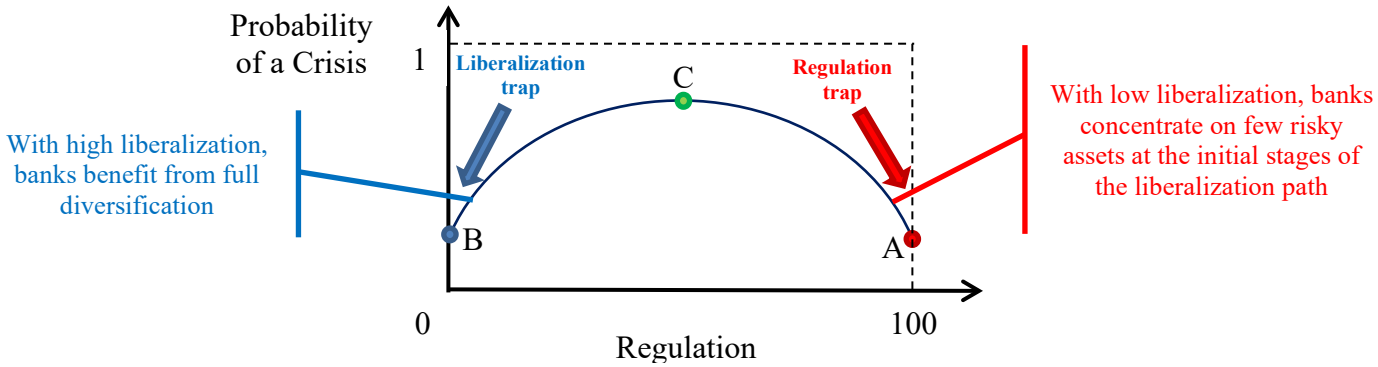
As to studies employing the Financial Freedom Index, González (2005) analyzes a sample of 251 banks from 36 countries and concludes that a lower value of *FFI* encourages banks to undertake riskier strategies. Chortareas et al. (2013), investigating a large sample of EU commercial banks, arrive at similar findings, namely that a higher *FFI* is accompanied by a higher bank efficiency, particularly in politically freer countries. Conversely, Cubillas and Gonzalez (2014), using a sample of 4,333 banks drawn from 83 countries, show that financial liberalization promotes bank competition in developed countries and expands risk-taking opportunities in developing countries, whereas capital requirements, supervision, and financial transparency mitigate in part this effect.[3]

In our paper, we define banking regulation, *REG*, as the negative of *FFI*; more precisely, $REG = 100 - FFI$. Figure 1, below, shows the frequency distribution of banking and financial crisis years measured against the *REG* index. The data come from our sample of 3,278 annual observations covering 138 countries over the period 1996-2017, for which both *REG* and the crisis dummy are available; see data section and Appendix B for details. Note the positive association between banking crisis years and regulation, as *REG* rises from the low level of 10 (corresponding to $FFI = 90$) to the higher level of 30. The peak of crisis years occurs with $REG = 50$. Beyond 50, the association between crisis years and regulation becomes negative, although a second, but minor, peak occurs at high regulation level of $REG = 70$. In sum, the above frequency distribution is consistent with studies that show that regulation has an adverse impact on the occurrence of banking crises, but this pattern is reversed as *REG* reaches a critical level.

[Insert Figure 1 here]

[3] Results are clearer when using the economic freedom index instead of the financial freedom index. With a sample of 175 countries over the period 1993-2010, Bjornskov (2016) concludes that regulatory components of the economic freedom index are associated with smaller peak-to-trough ratios and shorter recovery time.

With this background, we develop a two-period model. In the first period, banks minimize the risk of their portfolio, consisting of high risk (*H*) and low risk (*L*) assets. The minimization occurs after the regulator has placed a ceiling on the *H* share of banks' portfolio. In the second period, the regulator maximizes the expected present value of banks' net income. Our choice of modelling banks and regulator as a "dual problem", in preference of the alternative of banks maximizing their net income in the first stage and the regulator minimizing banks' risk in the second stage, is motivated by the easier and more intuitive way of managing the constraints on the *H* share of the banks' portfolio. The critical implication of the model is that the probability of a crisis is described by an inverted U curve of an investment in regulation. Starting with a regulated system, de-regulation (or a liberalization process) raises bank efficiency and portfolio diversification, but in the initial stage few options for diversification are available and a crisis is more likely because banks hold riskier assets than under a regulated system.



The above diagram illustrates two traps that are an implication of the model and a key result of the paper. Starting from point A, when a country deregulates, it moves to the left. If a crisis occurs, the banking system is up-regulated with adverse consequences on efficiency and profitability. When stability is restored, complacency sets in, bringing another increase in efficiency but also a higher probability of a crisis. This up-and-down pattern characterizes the regulatory pendulum along a de-regulation or liberalization path: it creates a regulation trap in

the sense that the country remains trapped in a situation of high regulation. The pendulum is more pronounced for countries with poorer institutions. If a crisis does not occur, the banking system continues to liberalize, and may go beyond the peak C and settle towards point B, where the probability of a crisis declines. In a super-liberalized state, an up-regulation is resisted because it raises the probability of a crisis so that the banking system prefers a lighter regulatory regime, albeit unstable, which is located on the left side of the inverted U curve. This second pendulum delineates the liberalization trap in the sense that the banking industry resists the reintroduction of regulation and, thus, remains trapped in a situation of high financial liberalization. Both traps —regulation trap and liberalization trap— imply a hump, a non-linearity, in the probability-of-a-crisis curve.

This theoretical non-linearity is confirmed when testing the relationship between regulatory stringency and the probability of a crisis by estimating a non-linear Probit model. Our key inference is that the probability of a financial crisis rises as regulation stringency moves from low to medium levels, due to the inefficiency of an incomplete diversification, and falls from medium to high levels, due to binding restrictions on risk taking; that is, it describes an inverted U-shaped curve. The implication of this finding is that countries located in the middle of regulatory stringency face more financial instability than countries that are either loosely regulated (i.e., countries falling into the liberalization trap) or severely regulated (i.e., countries falling into the regulation trap).

Another finding of note is that institutional quality interacts significantly with the regulatory environment; for a given level of regulatory investment, an improvement in institutional quality reduces the probability of a crisis.[4] All of the results are robust to a battery of different econometric exercises.

[4] The quality of institutions plays an important role in affecting the frequency and depth of crises. As Demirguc-Kunt and Detragiache (1998) note, post-liberalization banking crises are less frequent where the institutional environment is strong. Furthermore, banking competition, after deregulation, increases more in developed countries with robust institutions than in countries with weaker institutions (Delis, 2012).

The paper is organized as follows. Section II develops the theoretical model. The empirical equation and description of the data appear in Section III. Findings and robustness checks are discussed in Section IV. Conclusions are drawn in Section V. Appendices include details of the theoretical model (A), the full list of variables with their sources (B), and correlations between *REG* and alternative measures of regulation (C).

II. THEORETICAL MODEL

The model has two periods, two bank assets, a representative bank, and a regulator. The representative bank minimizes, over a one-period horizon, the risk of a portfolio consisting of a high-risk *H* asset and a low-risk *L* asset.[5] Risk minimization is subject to a constraint requiring that the portfolio return cannot fall below the required rate of return available in the rest of the economy, otherwise the bank fails to attract capital. A second constraint sets an upper limit on the high-risk asset weight imposed by the regulator to reduce bank risk-taking and mitigate bank losses. The latter cannot be completely eliminated because it is affected by exogenous factors such as the quality of institutions.[6] The bank does not plan for a possible future crisis. This myopic behavior can be justified either as a gamble that a crisis may affect other banks but not herself or that the regulator (backed by the government) will come to the rescue of the bank should a crisis materialize.

The regulator's objective is to stabilize the banking system and shares similar preferences of the representative bank with two important differences. The first is that it has a long planning horizon and maximizes the present value of the bank's expected income. The

[5] Risk in the model refers technically to market risk, but we assume that credit risk is positively correlated to market risk.

[6] Another factor affecting the loss given default is the bank's priors regarding future crises. Banks are risk neutral and update their priors in a Bayesian manner: if a crisis does not take place, banks expect a lower probability of firms' default and reduce non-performing loan provisions, whereas if a crisis takes place, surviving banks expect a higher probability of firms' default and increase non-performing loan provisions; see Aizenman (2009).

second is that the regulator, in thinking about the future, imbeds the expected loss due to a bank default into the income stream of the representative bank.

Regulation is costly and banks pay for it up front. Given that portfolio allocation is not observable, the regulator imposes minimum capital requirements, as in the Basel agreements. These capital requirements are equivalent to placing a ceiling on the share of the high-risk asset in the portfolio. In a similar way, liquidity constraints can also be transformed into ceiling on the share of high-risk assets. This ceiling makes banking less attractive to investors because it lowers the bank's profits and limits asset diversification. The regulator, on the other hand, is prepared to mitigate the bank's loss given default (LGD).

Given that current regulation affects the probability of bank default, the model solves, backward, a two-period optimization problem. In the first stage, banks minimize the risk of their *H* and *L* asset portfolio. The minimization occurs after the regulator has placed a ceiling on the *H* share of the portfolio. Risk minimization is achieved with portfolio diversification but given the relatively short planning horizon of banks and limited range of options, portfolio concentration cannot be ruled out. Portfolio concentration could be driven either by targeting a return on capital high enough to attract funds from the rest of the economy or to simply raise income (albeit accompanied by higher risk) or by the limited number of available financial instruments. This is the reason for the regulator to place a cap on the *H* share of the portfolio. In the second stage, the regulator maximizes the expected present value of banks' net income. The critical implication of the model is that the probability of a crisis is described by a concave curve, an inverted U curve, with respect to an investment in regulation. Starting with a regulated system, de-regulation (or a liberalization process) raises bank efficiency but also the probability of a crisis. Three joint effects determine an inverted U-shaped relationship between regulatory stringency and the probability of bank default: the limited diversification stemming from the reduction in the share of high-risk assets in the bank's portfolio, the favorable impact of the

larger share of low-risk assets on LGD, and the overall negative impact of regulatory stringency on bank income.

The critical implications of this paper emerge by comparing the case when regulation does not constrain the risky share of the portfolio and when it does: the slope of the probability curve of bank default with respect to regulatory investment is positive in the first case and negative in the second. With regulation being lower in the first scenario than in the second, the probability curve is concave with respect to the level of regulation, the concavity stemming from the stringency of regulation.

The timeline of the model is as follows. Banks are homogenous and myopic, and minimize the one-period portfolio risk given the rate of return required by the capital markets. The regulator is benevolent, in the sense that it shares the banks' preferences, and forward-looking, in the sense that its planning horizon is longer than the banks'. Current levels of regulation affect the future probability of bank default. We solve the model by first obtaining the one-period optimal share of high-risk assets in the portfolio of a myopic representative bank under asset allocation and market return constraints, and then determine the optimum level of regulation from a two-period utility function of the regulator.

The bank problem

A representative bank invests its income, net of the regulation cost, in a high-return high-risk *H* asset and a low-return low-risk *L* asset with a portfolio return r_p and variance δ_P^2:

$$r_p = (1-q)[1 + r_L + \alpha(r_H - r_L)] - 1 \quad (1)$$

$$\delta_P^2 = (1-q)^2[\alpha^2(\delta_H^2 + \delta_L^2 - 2\rho_{HL}\delta_H\delta_L) + 2\alpha(\rho_{HL}\delta_H\delta_L - \delta_L^2) + \delta_L^2], \quad (2)$$

where α is the *H* share in the bank's portfolio, $r_H > r_L$, and $\delta_H > \delta_L$. Furthermore, the correlation between the two assets, ρ_{HL}, must satisfy the condition $\rho_{HL} \leq \frac{\delta_L}{\delta_H}$ to ensure that δ_P^2

is a positive function of α.[7] From the bank's perspective, q is equivalent to a tax on total returns; if $q = 0$, the bank is completely free to decide on asset allocation and if $q = 1$, the bank ceases to operate. Note that $q < 1$ is not a sufficient condition for a bank to survive in the sense that the "tax" can be set so high to violate the required minimum rate of return. In the model, the regulator caps α indirectly through a regulation function, *G(q)*, where the *H* asset share is also constrained on the down side by its lowest politically acceptable value, denoted by θ. Since several factors can affect political acceptability, we model θ as a shape parameter of function *G*, so that the actual function *G* is larger than the politically acceptable G_θ:

$$\alpha \leq G, \qquad with\ G > G_\theta, \tag{3}$$

where $0 < G \leq 1$, with $G'_q < 0$ and $G''_q < 0$. An increasingly negative sloped *G* captures the notion that regulatory complexity increases more than proportionally when constraints interact with the model.[8] This condition guarantees that results of our two assets model can be generalized. The other constraint banks face is to attract capital, which translates in offering an "after-tax" r_p that is at least equal to the required rate of return:

$$(1-q)[\alpha r_H + (1-\alpha) r_L] \geq \bar{r}, \tag{4}$$

where $\bar{r}$ denotes the exogenous required rate of return.

Banks minimize their portfolio variance under the regulator-imposed asset share restriction and the market-imposed constraint of a required rate of return:

$$\min_{\alpha} \delta_P^2 \quad s.t.\ a \leq G\ \ and\ \ (1-q)[\alpha r_H + (1-\alpha) r_L] \geq \bar{r}, \tag{5}$$

where γ and λ are the Lagrangian multipliers of the required market return and regulatory stringency constraint, respectively. This is the dual problem of a portfolio return maximization but given that strong duality holds under Slater's condition in convex problems, the duality gap

[7] That is, $\frac{\partial \delta_P^2}{\partial \alpha} = [2\alpha(\delta_H^2 + \delta_L^2 - 2\rho_{HL}\delta_H\delta_L) + 2(\rho_{HL}\delta_H\delta_L - \delta_L^2)](1-q)^2 \geq 0$ if $\rho_{HL} \leq \frac{\delta_L}{\delta_H}$.

[8] For example, despite Basel II basically refined the credit risk criteria of Basel I, the more complex regulatory framework disproportionally pushed banks to prefer government bonds.

is zero and the two problems are equivalent. The Lagrangian function to be optimized on the bank side is:

$$\mathcal{L}(\alpha,\gamma,\lambda) = (1-q)^2[-\alpha^2(\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L) - 2\alpha(\rho_{HL}\delta_H\delta_L-\delta_L^2)-\delta_L^2] \\ +\gamma\{(1-q)[r_L+\alpha(r_H-r_L)]-\bar{r}\}+\lambda[G-\alpha]. \quad (6)$$

The optimization under two inequality constraints creates eight possible Kuhn-Tucker solutions, but only three are strictly relevant for this paper. For further details, see Appendix A. The first refers to the case when neither of the two constraints are binding.[9] Banks are free to choose their share of *H* assets*:*

$$\hat{\alpha} = \frac{\delta_L^2-\rho_{HL}\delta_H\delta_L}{\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L}. \quad (7)$$

The second refers to the case where only the market-imposed required rate of return constraint is binding:

$$\hat{\alpha}_\gamma = \frac{\bar{r}-r_L(1-q)}{(r_H-r_L)(1-q)}. \quad (8)$$

The third refers to the case when only the regulator-imposed constraint on the *H* asset share is binding:

$$\hat{\alpha}_\lambda = G. \quad (9)$$

The regulator problem

The forward-looking regulator maximizes the representative bank's expected profits over a two-period horizon.[10] Current bank income is known, but future income is not. The regulator takes the expected value of future income, net of the impact of a probable crisis, *P*Q(G,τ)*. *P* denotes the probability made at time *t* that a crisis may occur at time *t+1* and *Q(G,τ)* is *LGD*, the loss given default that would occur should a crisis erupt; $Q'_G > 0$. *P* is endogenous for the regulator (but exogenous for the bank) and in its reduced form depends on *q*. By raising the

[9] This is possible with negative asset correlation.
[10] As it frequently happens, the regulator is not subject to a budget constraint.

"tax" q, the regulator lowers the ceiling on α that, in turn, mitigates *LGD*; that is, $0 < Q \leq 1$. The second argument of *Q(.)*, τ, captures an exogenous level of institutional quality affecting the country's resilience to a crisis: the higher the institutional quality, the lower *LGD*. Parameter τ is bound between zero and one, which prevents the possibility of $Q = 0$.[11]

The regulator faces the following two-period maximization problem:

$$\max_q V(q) = \max_q \{(1-q) + \beta(1-q)[1 + r_L + \alpha(r_H - r_L)](1 - PQ)\}, \quad (10)$$

where $(1-q)$ is the bank's net current income and the second expression in square brackets is the present value of net future income, β being the discount factor. The benevolent regulator imbeds the solution for α obtained from the bank problem (eqs. 7-9) in its maximization problem; see Appendix A for details of the model. In the text, we discuss the three relevant cases of equations (7)-(9).

In the first case of financial liberalization, $\alpha = \hat{\alpha}$ (eq. 7), the probability of a crisis is obtained from the first-order condition of (10), $\frac{\partial V(q)}{\partial q} = 0$:

$$P = \frac{1+k}{k} \cdot \frac{1}{[Q - (1-q)Q'_G G'_q]}, \quad (11)$$

where $k = \beta\left[1 + r_L + \frac{\delta_L^2 - \rho_{HL}\delta_H\delta_L}{\delta_H^2 + \alpha\delta_L^2 - 2\rho_{HL}\delta_H\delta_L}(r_H - r_L)\right] > 0$. Its derivative with respect to q is:

$$\frac{\delta P}{\delta q} = -\frac{1+k}{k} \cdot \frac{2Q'_G G'_q - (1-q)\left[Q''_G G'^2_q + Q'_G G''_q\right]}{\left[Q - (1-q)Q'_G G'_q\right]^2} \geq 0, \quad (12)$$

if $2Q'_G G'_q \geq (1-q)\left[Q''_G G'^2_q + Q'_G G''_q\right]$. In the absence of binding constraints from the regulator and market forces, the higher the regulatory "tax" q, the higher the probability of a crisis, P. Under these circumstances, countries would prefer to continue the process of financial liberalization.

[11] Analytically, τ in the *Q* function is modeled like θ in the *G* function; refer to footnote 11.

In the second case of a constrained market return, $\hat{\alpha}_\gamma$ (eq. 8), the probability of a crisis is:

$$P = -\frac{1}{\beta(1+\bar{r})Q'_G G'_q}. \tag{13}$$

P here is bounded between zero and one if $-\frac{1}{\beta(1+\bar{r})} < Q'_G G'_q < 0$. Furthermore, it is larger than (11), suggesting that the bank takes more risk to meet the stringent required rate of return and hence reaps larger benefits from the regulator's *LGD* protection. The derivative of P with respect to q is:

$$\frac{\delta P}{\delta q} = -\frac{\beta(\bar{r}-r_L)\left[Q''_G {G'_q}^2 + Q'_G G''_q\right]}{\left[\beta(\bar{r}-r_L)Q'_G G'_q\right]^2} > 0, \tag{14}$$

so long as $Q''_G < 0$. As in the financial liberalization scenario, a step-up in regulation raises the probability of a crisis. The only difference with respect to the first case is that here the *H* share is higher. The conclusion that countries would prefer to continue the process of financial liberalization holds here as well.

The third case is a scenario of stringent regulation, $\alpha = \hat{\alpha}_\lambda = G$ (eq. 9). The probability of a crisis is:

$$P = \frac{1+A+B\left(G-(1-q)G'_q\right)}{A\left(Q-(1-q)Q'_G G'_q\right)+B\left[QG-(1-q)\left(Q'_G G'_q G+QG'_q\right)\right]} = \frac{N(q)}{D(q)} > 0, \tag{15}$$

where $A = \beta(1 + r_L)$ and $B = \beta(r_H - r_L)$. Its derivative with respect to q is:

$$\frac{\partial P}{\partial q} = \frac{N'(q)D(q)-N(q)D'(q)}{D(q)^2} \leq 0, \tag{16}$$

provided $N'(q)D(q) \leq N(q)D'(q)$. The implication is that an increase in the regulatory "tax", when regulation bites, reduces the probability of a crisis.

In sum, a higher q raises P under a regime of financial liberalization and under a minimum market return constraint but reduces P under a stringent regulatory constraint. As q increases, regulation function *G(q)* determines the switch from one of the first two scenarios to

the third one in which the cap on α constrains the bank's *H* share. Without this constraint, *G=1* and *q=0,* but *LGD* is high for the regulator (i.e. *Q=1*). Under the assumptions of the model and the conditions imposed to solve it, *LGD* decreases more quickly than the increase in the cap on the *H* asset. The mere presence of an upper limit on risky assets, although high, deters banks from taking excessive risks. However, larger restrictions on the *H* asset achieve smaller reductions in *LGD*. The stricter the constraint on the *H* asset, the smaller the impact of the next restriction. This outcome works through portfolio risk: when this risk is low, the regulator is inclined to deregulate and allows the *H* share to rise, whereas when bank portfolio risk rises, the regulator places a cap on the *H* share. It is worth noting that in arriving at a portfolio risk, banks are influenced by the quality of local institutions and, hence, regulation can produce different outcomes under different conditions, as we have seen in the literature review.

To enhance an understanding of these critical relationships, we simulate the model by parametrizing *G* and *Q.* Rather than a numerical solution of the model, this exercise is meant to show that the required conditions for the sign of $\frac{\partial P}{\partial q}$ do exist and hold for a wide range of values of the underlying variables. To this end, we rely on Beta functions because they are restricted between 0 and 1, and yet flexible enough to parameterize *G* and *Q* to obtain equations (12), (14), and (16). More specifically, we use the complement to one of an incomplete Beta function to obtain non-negative functions with non-positive monotonic first derivatives for the regulation function *G* and the *LGD* function *Q*. This pattern is in line with that observed in the real world.

We denote with θ an inefficiency factor to adjust for politically acceptable outcomes, such as a minimum acceptable level of *G*, and with τ an inefficiency factor to adjust for the quality of institutions, such as the operational level of *Q*.[12] While theoretically $0 < \theta \leq 1$,

[12] The two incomplete Beta function are multiplied by inefficiency factors θ and τ respectively, as follows:

$$G = 1 - \theta I_q(a_G, b_G)$$
$$Q = 1 - \tau I_q(a_Q, b_Q),$$

realistically one would expect it to be very close to unity, given the power of the regulator to impose very stringent regulations. In fact, in our simulations we set $\theta = 1$ because we find virtually no variation in outcomes for values of θ 10 to 15 percent below one. As to the inefficiency factor of institutions, we set τ=*0.5*, which is the average value of institutional quality in our data.[13]

In sympathy with the optimization problem, we set $a_G = 3$ and $b_G = 1$ for G and $a_Q = 1$ and $b_Q = 3$ for Q. The symmetry of the parameter values is employed for convenience, whereas $b_G = 1$ and $a_Q = 1$ to avoid sign reversals in the second derivatives. a_G and b_Q values larger than 2 guarantee non-linear first derivatives and non-zero second derivatives.[14] In particular, $a_G = 3$ produces a concave *G* function suggesting that the regulator is increasingly aggressive in restricting the *H* share, and $b_Q = 3$ produces a convex *Q* function indicating that a stricter regulation reduces the *LGD* less than proportionally. Also, we use $\frac{\partial Q}{\partial q}$ as a short cut of $\frac{\partial Q}{\partial G} \cdot \frac{\partial G}{\partial q}$. In brief, G and Q are defined as follows:

$$G = 1 - \frac{\theta}{B(y,z)} \int_0^q x^{a_G - 1}(1-x)^{b_G - 1} dx \qquad \textit{with } \theta = 1,\ a_G = 3, \textit{ and } b_G = 1 \qquad (17)$$

$$Q = 1 - \frac{\tau}{B(y,z)} \int_0^q x^{a_Q - 1}(1-x)^{b_Q - 1} dx \qquad \textit{with } \tau = 0.5,\ a_Q = 1, \textit{ and } b_Q = 3. \qquad (18)$$

Figure 2 shows the profile of $\frac{\partial P}{\partial q}$ under the three scenarios. In the first two scenarios (black solid and blue dashed curves), $\frac{\partial P}{\partial q}$ is positive; in the third scenario with a binding regulatory constraint (red solid curve), it is negative provided certain general conditions are met. Therefore, simulations are particularly informative about the third scenario. To ensure a certain degree of

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where $I_q(a,b)$ denotes the incomplete Beta function of q defined as:

$$I_q(a,b) = \frac{B_q(a,b)}{B(y,z)} = \frac{1}{B(y,z)} \int_0^q x^{a-1}(1-x)^{b-1} dx,$$

with a>0, b>0 and $B(y,z) = \int_y^z x^{a-1}(1-x)^{b-1} dx$.

[13] Assuming a normalized symmetric distribution is consistent with a relative concept of institutional quality.

[14] We get similar results with $a_G = b_Q = 6$ and $a_G = b_Q = 9$.

robustness, we checked the sensitivity of our results with respect to a broad range of parameter values.[15] In all cases, a higher q, when regulation is binding, lowers the risk of a crisis. Furthermore, by combining either scenario one or scenario two with scenario three, we obtain our fundamental concavity relationship between investment in regulation and crisis probability. That is, conditional on the level of bank portfolio risk, the stricter the cap on the *H* asset, the more likely the cap is binding, and the final outcome shifts from scenario one or two to scenario three. Lastly, simulations, which are not reported here for brevity, show a more intense reaction to regulation at lower values of τ; this result underscores the importance of good institutions. In the next section, we show that this concavity is confirmed by the data.

[Insert Figure 2 here]

III. EMPIRICAL MODEL AND DATA

The main implication of our theoretical model is that regulation has a non-linear impact on the probability of a crisis, a finding that reconciles the mixed results found in the empirical literature. To test our hypothesis, we develop in this section an empirical framework that draws on Hutchison and McDill (1999) and Barth et al. (2001): it assumes a causal nexus from regulation to banking crises. We employ a Probit regression to infer how regulation and the quality of institutions affect the probability of a banking crisis, given a set of macroeconomic and cultural control variables.

The empirical framework and hypotheses testing

We propose three different hypotheses: a traditional linear hypothesis, *HYP1,* which tests that the probability of a banking crisis increases as regulation increases; a non-linear hypothesis, *HYP2,* which tests an inverted U-shaped relationship between regulation and banking crisis;

[15] Given $a_Q, b_G = 1$, the simulations were run for values ranging $3 \leq a_G, b_Q \leq 9$, $0.2 \leq \theta \leq 1$, $0.2 \leq \tau \leq 0.8$, and $0.6 \leq \beta \leq 0.8$.

and an interacting-effects hypothesis, *HYP3,* which tests that the regulation-crisis non-linear relationship is also influenced by the quality of institutions. Both *HYP2* and *HYP3* are implications of our theoretical model.

The specification of *HYP1,* the linear hypothesis, is:

$$CRISIS_i = f(\alpha + \beta REG_i + \gamma INST_i + \partial CTRL_i + \varepsilon_i), \quad (19)$$

where *f(.)* is a Probit transformation function, ε is a well-behaved idiosyncratic error term, and time subscript is omitted in all variables for brevity. The dependent variable is a dummy variable that is equal to one during a banking crisis and zero otherwise; *REG* is the regulatory index defined as 100 - *FFI*; *INST* is a measure of country-specific institutional quality; and *CTRL* is a set of one-year lagged control variables. Macroeconomic controls include per capita GDP in current US 10,000 dollars (*GDPpc*), the consumer price index inflation rate (*INFL*), the current account balance as a percentage of GDP (*CAB*), and the income inequality index (*GINI*). Microeconomic controls refer to sector-specific variables such as bank concentration (*TOP5*) and the size of the banking sector (*BAS*). The base specification is parsimonious: it only includes *GDPpc* at the macroeconomic level, *TOP5* at the microeconomic level, and few dummies. In the extended specification, we add the other controls. To control for potential endogeneity issues, we use the time required to build a warehouse (*TBW*), the percentage of public over total employment (*PE*), and two indexes of liberal and deliberative democracy (*LD* and *DD* respectively) as instruments of *REG*; see the section on robustness checks.

From a macroeconomic viewpoint, *GDPpc* adversely affects financial stability for two reasons. The first is that the level of *GDPpc* is positively associated with financial development, which in turn is positively associated with the frequency of financial crises. The evidence from the 2008-2009 financial crisis is consistent with this reasoning: the US and the EU were affected directly, Asian and Latin American countries indirectly, and the less financially developed regions of the world, such as Africa, only marginally (Fratianni and

Marchionne, 2013). The second reason is statistical. As per-capita income falls during a crisis and increases afterwards, the one-year lagged *GDPpc* captures this negative correlation.

The expected impact of *INFL* and *CAB* on *CRISIS* is positive. A high inflation rate indicates a mismanagement of macroeconomic policy (Demirgüç-Kunt and Detragiache 1998). A large current account deficit is symptomatic of a deteriorating competitiveness, which in turn raises the probability of a sovereign debt crisis with spillovers into a systemic banking crisis; see Beker and Moro (2016) in relation to the EU and Section IV below.

The literature disagrees on the impact of income inequality on economic performance. Rhee and Kim (2018) find that higher inequality encourages domestic credit booms and hence increases the probability of a banking crisis in developing countries. In contrast, Forbes (2000) shows a robust and statistically significant positive relationship between income inequality and economic growth in the short and medium term. Madsen et al. (2018) document a strong interaction effect between inequality and financial development on growth determinants such as savings and investment. In particular, inequality is beneficial in periods (or countries) with a high degree of financial development. In light of the fact that our data and empirical approach are close to Forbes' (2000) and the considerable financial advancements achieved during our period of interest (1996-2017), we expect that the impact of financial development on *CRISIS* more than offsets the impact of inequality; hence a negative *GINI* coefficient in eq. (19).

As to microeconomic factors, *TOP5* measures national bank concentration with the share of asset value held by the five largest commercial banks. According to the traditional charter value paradigm, banking concentration improves financial stability by guaranteeing rents to incumbent banks so that their charter values rise and risk-taking incentives are reduced (Keeley, 1990; OECD, 2011). We expect *TOP5* to have a negative impact on $CRISIS$. The second sectoral variable, *BAS*, measures banking sector size by total assets held by deposit money banks as a share of GDP. We expect *BAS* to have a negative impact on $CRISIS$ because

of the implicit subsidy and guarantees that oversized banking sectors receive from government (Fratianni and Marchionne, 2017). *BAS* is introduced in the extended specification of eq. (20).

Institutional quality has a positive impact on financial stability because a more transparent governance improves the monitoring of the financial sector and ensures a cheaper crisis resolution. This implies $\gamma<0$. As to the regulatory index *REG*, we have argued above that a stringent regulation limits diversification opportunities and leads to excessive risk, that is $\beta>0$.

The conflicting empirical results found in the literature could stem from a failure to capture the non-linear impact of regulation on financial stability. The theoretical model of Section II addresses specifically this issue. The specification of *HYP2,* the non-linear hypothesis, is:

$$CRISIS_i = f\left(\alpha + \beta_1 REG_i + \beta_2 REG_i^2 + \gamma INST_i + \partial CTRL_i + \varepsilon_i\right), \quad (20)$$

where $\beta_1>0$ and $\beta_2<0$ define an inverse U-shaped relation and create the mentioned regulatory pendulum.

Ambiguous findings arise also from differences in institutional quality. Liberalization policies are beneficial when they are implemented in economies with seasoned and transparent institutions; in countries plagued by corruption and bad governance, instead, liberalization may generate no payoff or be outright destabilizing. These factors enter in the specification of *HYP3,* the interacting-factor effect hypothesis:

$$CRISIS_i = f(\alpha + \beta_1 REG_i + \beta_2 REG^2{}_i + \gamma INST_i + \partial CTRL_i + \Psi_1 REG_i * INST_i + \Psi_2 REG_i^2 * INST_i + \varepsilon_i), \quad (21)$$

where *INST* and *REG* interact quadratically. The hypothesis is that, with weak institutions, the inverted U-shaped regulation curve becomes steeper due to institutional inefficiency and achieves a higher maximum at the same or higher level of *REG:* that is, $\psi_1 < \beta_1$ and $\beta_2 < \psi_2$ (given $\beta_1>0$ and $\beta_2<0$).

Data and descriptive statistics

Our final sample consists of an unbalanced panel of 138 countries covering the period 1996 to 2017 and summing to 3,278 annual observations. We have collected information from different sources. Data on banking crises come from Laeven and Valencia (2018), regarded as the most accurate dataset on the subject (Chaudron and de Haan, 2014).[16] We use this data set to create two crisis variables: *CRISIS* is a dummy equal to one during a banking crisis, and zero otherwise; *ALL_CRISIS* is a dummy that takes value of one during a banking crisis or a sovereign debt crisis or twin crises, and zero otherwise. We use primarily *CRISIS*, while *ALL_CRISIS* is employed in robustness exercises to take into account for the possibility of a sovereign debt crisis spilling over into a banking crisis (Beker and Moro, 2016).[17] In our sample, we identify 219 banking crisis years, of which 113 occurred before 2008, and 46 sovereign debt crisis years, of which 28 occurred before 2008.

We recall that our banking regulation index *REG* is defined as 100 minus *FFI*, the index measuring the degree of the country's independence from government control and interference. *FFI* covers five broad areas: (i) the extent of government regulation of financial services, (ii) the degree of state intervention in banks and other financial firms through direct and indirect ownership, (iii) the extent of financial and capital market development, (iv) government influence on the allocation of credit, and (v) openness to foreign competition. See Appendix B for further details. *FFI* ranges from 0 to 100: the higher the score, the freer the financial sector. Correspondently, *REG* ranges also from 0 to 100: but the higher the score, the more regulated the financial sector.[18] *REG* is positively correlated with the main alternative indexes of

[16] Previous versions of Laeven and Valencia's dataset were released in 2008 and 2013. Other sources of banking crises data are Caprio et al. (2005) and Reinhart and Rogoff (2008).

[17] During the European sovereign debt crisis, there was a perverse sovereign-banking feedback loop from the interconnection between the sovereign and the banking sector: domestic banks held a considerable part of the national sovereign debt and the fiscal cost of government rescuing banks was huge. Consequently, financial turmoil that puts in doubt sovereign solvency also spills over onto the balance sheets of creditor banks (Fratianni and Marchionne, 2017).

[18] The countries with the lowest average *REG* value are Australia and Hong Kong (*REG*=10), and the United Kingdom (*REG*=13.6). The United States is ranked in the 11th position, moving from *REG*=30 in the 1990s to *REG*=10 in 2000s and gradually back to *REG*=30 in the 2010s. At the bottom of the ranking, we find Afghanistan (average REG=100), North Korea (average *REG*=95), Cuba, Iran, Iraq, Uzbekistan, and Turkmenistan (*REG*=90).

regulation used in the literature but has the advantage of covering a larger sample of countries and a longer time period. Appendix C provides details on the definition of the alternative measures (Tables C.1) and the correlation between *REG* and each of the alternative measures (Table C.2). Here, we note that Cerrutti et al.'s (2017) measure deals with macroprudential policy instead of regulation, and Prados De La Escosura's (2016) Hiel index and Federico et al.'s (2014) reserve requirements index are narrower than broad indices such as Abiad et al.'s (2010) comprehensive index of liberalization and Barth et al.'s (2013) financial regulation index. The main point is that *REG* is also a broad index and is sufficiently comprehensive not to suffer from idiosyncratic effects or influences that are not imputable to regulation. Furthermore, as we have already mentioned, *FFI* has a wide country coverage and stretches temporally to recent years.

We draw the annual percentage change of the consumer price index (*INF*), the current account balance as a percentage of GDP (*CAB*), and GDP per capita in current US dollars (*GDPpc*), the ratio of assets held by the five largest banks to total commercial banking assets (*TOP5*), and total assets held by deposit money banks as a share of GDP (*BAS*) from the Global Financial Development database (2018) and the World Development Indicators database (2019) of the World Bank. Six measures of institutional quality come from the Worldwide Governance Indicators database of the World Bank (2018): government effectiveness, regulatory quality, rule of law, voice and accountability, corruption control, and political stability. The source of the income inequality index (*GINI*) is the Global Consumption and Income Project by Lahoti et al. (2016). We control for the specificity of Europe and the Great Financial Crisis (*GFC*) with four dummies: *EU* and *EURO* take the value of one if the country is part of the European Union or the eurozone, respectively; *GFC* and *POST-GFC* are equal to

Belarus shows the largest increase in *REG* moving from 30 in the 1990s, to 70 in the 2000s and 90 in the 2010s. Lithuania reported the largest reduction in *REG* moving from 70 in the 1990s to 10 in the 2000s, and then slightly back to 20 after the great financial crisis of the 2010s.

one from 2008 to 2012 (the crisis period) and from 2013 to 2017 (the recovery period), respectively.[19] Finally, country-specific cultural variables are drawn from La Porta et al.'s (1999): the country's legal origin dummy (*ENGLISH*) takes the value of one if the country adopts a common law system. We group legal frameworks other than the common law system to reduce the number of dummy variables, increase the probability of convergence in our regressions, and improve the efficiency of the estimates. *MUSLIM* is is the percentage of Muslims in the total population in 1980 and captures cultural distance, including Islamic banking. Religious composition, like legal origin, are widely used in the literature as determinants of financial development and as proxies of cultural affinity (La Porta et al., 1999; Beck et al., 2003; Lee and Lu, 2015).[20] Finally, four variables are used as instruments of *REG* for robustness purposes. The time required to build a warehouse (*TBW*) is a proxy for the intensity of the bureaucracy: it is measured in days, with data drawn from the Doing Business Project by the World Bank (2020); the percentage of public over total employment (*PE*) is collected from the International Labour Organization Statistics (2020) and proxies the importance of the public sector in the economy; the indexes of liberal and deliberative democracy are published by the Varieties of Democracy Project (2019) in the V-Dem Dataset and capture the level of individual and minority protection in the political setting and the degree of respectful dialogue in the decision-making process, respectively. A complete description of the variables and their sources can be found in Appendix B.

[19] The Lehman Brothers' collapse on September 15 2008 triggered the great financial crisis in the US, but the effects of the crisis started in 2009. In other regions, the reaction was slower but more intense. For example, in Europe, the crisis began one year later and evolved into a debt crisis in 2011-2012. Our 2008-2012 time window selection for *GFC* is not only conservative but works against confirming our hypotheses; it also allows to have enough observations in both the crisis and post-crisis period.

[20] Islamic culture is strongly based on tradition and is relatively resilient to the process of globalization and thus is candidate to capture *Within* country heterogeneity; cultural distance between Islam and other religions is higher than the differences among other religions; and the percentage of citizens is a more precise measure of the cultural distance within a country than a dummy variable.

Descriptive statistics are reported in Table 1.[21] Banking crisis episodes represent 6.1% of the observations and are only 0.9% less than all crises, confirming a strict correlation between banking and sovereign debt crises. *REG* ranges from 10 to 100 with an average of around 50 and a standard deviation of 20. The relatively low coefficient of variation (0.401) reflects the fact that the index changes slowly over time. The variables measuring institutional quality range from -2.5 to 2.5, with higher values corresponding to better governance. We normalize them between 0 and 1 to remove any cross-variable discrepancy. The six variables are highly correlated: all pairwise correlations are highly positive and significant at the 1% level. Given that the lowest pair correlation is 0.65, we average the six institutional measures in one synthetic Institutional Quality Index (*IQI*).

[Insert here Table 1]

Table 2 compares different subsamples. Panel A tests the difference of the means (Panel A.1) and medians (Panel A.2) of each variable between regions in each sub-period, i.e. the difference between EU and non-EU countries in the pre-crisis period (column 1 vs 2), crisis period (column 3 vs 4), and post-crisis period (column 5 vs 6). Panel B rearranges the columns of Panel A to test the difference of means (Panel B.1) and medians (Panel B.2) across sub-periods in each region, i.e. the difference between pre-crisis, crisis and post-crisis period in non-EU (column 1 vs 2, and 2 vs 3) and EU countries (column 4 vs 5, and 5 vs 6).[22]

EU countries have better institutions and a lower *REG* than non-EU countries (Panel A). Furthermore, the great financial crisis produced less of a structural break in the EU than elsewhere in the world (compare column 2 and 5 in Panel B). In fact, *REG* is not statistically different across periods for the EU countries, but it is for non-EU countries that experience a significant increase in regulation during the *GFC* period. Average regulation increases in non-

[21] The reported descriptive statistics refer to the entire dataset available for the period 1996-2017. The reduction to 138 countries occurs because of attrition.
[22] In particular, columns 1, 2, 3, 4, 5, and 6 in Panel A correspond to columns 1, 4, 2, 5, 3, and 6 in Panel B.

EU countries during the recovery period, but its difference relative to the pre-crisis level is statistically insignificant (compare column 1 and 3 in Panel B). *BAS* rose after 2008 in both sub-samples and diverged in the recovery period (Panel B) for two reasons. The decline of GDP relative to the size of the banking sector explains the increase in the crisis period. The divergence in the recovery period is consistent with an implicit mutual protection pact between banks and government, whereby banks are willing to raise their stock of government securities against the no-default protection accorded to them by the government (Fratianni and Marchionne, 2017). We note that, despite the severity of the crisis, the level of bureaucracy, public sector, and democracy —our instruments– remained higher in EU countries than non-EU countries in all the three sub-periods. Finally, *REG* is different between EU and non-EU countries in each sub-period (Panel A), whereas it is statistically and/or economically not different through the sub-periods in each region (Panel B).[23]

[Insert here Table 2]

IV. EMPIRICAL RESULTS

Two econometric issues arise with the use of a binary dependent variable in panel data. The first is the incidental parameter problem, which biases the fixed effects estimator under a limited time dimension.[24] Furthermore, as fixed effects omit countries unaffected by a crisis, the number of observations in the estimates falls. A random effects model does not suffer from these shortcomings, but the assumption that country effects are uncorrelated with the independent variables is incompatible with our dataset. An alternative strategy is to use the

[23] As the Wilcoxon test is a rank sum test (not a median test), different within-groups distribution can produce different rank sums (statistically significant difference) despite equal or nearly equal medians (economically irrelevant impact).

[24] While generally parameter estimates tend to converge to their true values as the ratio of observations to parameter number rises, it does not happen with fixed effects because the number of parameters grows with the number of observations. Monte Carlo exercises show that the resulting estimator remains biased even with 20 periods (Greene, 2004).

Correlated Random Effects Model (CREM) (Wooldridge, 2010). The second issue is that the probability of a crisis is persistent and hence requires a lagged dependent variable as a regressor. It suggests potential endogeneity issues due to the correlation of explanatory variables with time-varying idiosyncratic errors. A *Dynamic Random Effects (DREM) Model* controls for serial correlation and the initial values problem (Wooldridge, 2005). By combining *CREM* and *DREM* into a double correction model (*DCOR*) is possible to (partially) address the endogeneity problem. Another approach to manage this issue is the instrumental variables (*IV*) estimator. In conclusion, our estimation strategy is to use a pooled Probit as a benchmark model and *CREM, DREM, DCOR,* and *IV* as robustness tests. Potential simultaneity and reverse causality biases are corrected with one-year lagged independent variables (denoted with prefix *L*), except for slow-changing institutional variables; see descriptive statistics.[25] Moreover, the resulting potential endogeneity is addressed with *DCOR* and *IV*.

Main findings

Different specifications of the benchmark model are presented in Table 3. The base specification includes *L.GDPpc, L.TOP5, IQI, GFC* and *POST-GFC*, and *EU* (column 1). The linear *HYP1* is rejected because *L.REG* is statistically insignificant (column 2). When we add the squared term, a significant inverted U-shaped relationship between regulatory stringency and the probability of a banking crisis emerges (column 3); it corroborates *HYP2*. We control for potential omitted macroeconomic variables with *L.INF* and *L.CAB* (columns 4 and 5). Given the simultaneous increase in the McFadden pseudo R^2 and a decrease in both AIC and BIC, we respectively elect columns 4 and 5 as the benchmark specifications of *HYP1* and *HYP2*. The negative *IQI* coefficient suggests that better institutions reduce the probability of a banking crisis. In all specifications, this probability increases with *L.INF* and *L.GDPpc* that

[25] Banking regulation does not change substantially year by year because it is difficult to obtain a large political consensus, in particular during or shortly after a crisis. For example, see the tormented *iter* in the approval and implementation of the Basel III agreement.

capture, respectively, the risk of investment at the country level and the negative serial correlation between a banking crisis and the previous year's income. The beneficial effect of banking concentration, *L.TOP5*, confirms the implications of the charter value paradigm. The coefficients of *GFC* and *POST-GFC* are highly significant and with the expected sign, the first positive and the second negative. The *GFC* time window does not drive the results; these improve (in terms of statistical significance and/or larger coefficients, in particular for *L.REG* and $L.REG^2$) with a 2009-2011 crisis window and are similar with a 2009-2013 crisis window. EU members face a greater probability of being influenced by crises.

[Insert here Table 3 and Figure 3]

We select the column 5 estimate of *HYP2* in Table 3 to plot the impact of *L.REG* on the probability of a crisis before, during, and after the great financial crisis. The top diagrams in Figure 3 set *GFC* and *POST-GFC* equal to zero, the middle diagrams set *GFC*=1, and the bottom diagrams set *POST-GFC*=1. The adjusted predictions are calculated by keeping all independent variables at their mean values, except for *IQI* and the three dummies (*GFC*, *POST-GFC*, and *EU*), against the value of regulation index *L.REG*. *L.REG* ranges from 0 to 100. *IQI* is set at 0, 0.25, 0.50. 0.75 and 1. Each combination of dummies identifies a different diagram.

Figure 3 confirms the concavity in the crisis-regulation space emerging from our theoretical model. Also, EU countries have been more prone to crises than non-EU countries (respectively right vs left graphs); the failure of Lehman Brothers marked a dramatic increase in the probability of a crisis in both regions (top vs middle graphs) that rapidly reduced during the recovery period (middle vs bottom graphs). The probability of a crisis peaks at *REG* values between 30 and 40. For these middle countries, regulatory moderation does not seem to pay off because the probability of a crisis falls on either side of the peak: moving towards the

extremes appears a superior strategy than staying in the middle.[26] This is particularly relevant for EU countries that score approximately 31 in the *REG* index and are very close to achieving the highest probability of a banking crisis (25% on average); see Table 2.

The inference we draw from our results is that both a liberalization trap and a regulation trap may be operating. To see them, start from *REG=100* in Figure 3. A liberalization process raises efficiency but initially it also raises the probability of a crisis. If a crisis occurs, the banking system is up-regulated with negative consequences on efficiency and profitability. Tranquil periods restore a mood for complacency; restrictions are again loosened, bringing about another increase in efficiency but with an increasing probability of a crisis. In short, as it climbs the crisis hill, the banking system, as in a Sisyphean struggle, rolls back down the valley. This up-and-down pattern on the right side of the crisis-regulation curve characterizes the regulatory pendulum along a liberalization path from East to West and generates a regulation trap; the pendulum being more pronounced for countries with poorer institutions, such as those in Latin America in the 1970s and the 1990s. If a crisis does not occur, the banking system continues to liberalize, may go over the peak point, and will settle on the West side of the hill, where the probability of a crisis declines due to the benefits of full diversification, while remaining positive (e.g., *REG*=0). If a crisis occurs, up-regulation takes place, the turmoil being blamed on excessive liberalization. But, up-regulation is resisted because it raises the probability of a crisis: the banking system prefers the return to a lower regulatory regime, albeit unstable, to a safer position on the East side of the hill. This is the pattern of the liberalization trap, a pendulum in regulation along the path of a fuller liberalization on the left side of the crisis-regulation curve. The pattern described above is consistent with the findings of Kaminsky and Schmukler (2008) who show that financial deregulation in emerging economies

[26] The probability of a crisis is the same at *REG*=0 and *REG*=80, even if financial markets are more efficient at lower *REG* values.

fuels short-term instability, while stabilizing markets in the longer term. It suggests that policymakers should be patient in implementing a liberalization process. The United States, from 2017 to 2020, is an example of regulatory impatience by doing a quick de-regulation after having introduced the strict regime of the Dodd-Frank Act: for example, the Volcker rule, part of the Act, went into effect in 2015 and was rolled back starting in 2019. A sharp swing from the West side to the East side of the peak in the inverted U curve would occur in the case of a severe crisis, like that of the 1930s, when a massive up-regulation was required to stop financial turmoil, albeit with adverse consequences on efficiency and profitability.

Moving to *HYP3*, note that the inclusion of an interaction terms in the Probit estimates, although feasible, creates a number of problems because the marginal effect of a change of the interacting variables is not equal to the marginal effect of just changing the interaction term (Ai and Norton, 2003:154). To avoid biases and also to keep our specification parsimonious, we follow Greene (2010:295) in applying adjusted predictions to approximate the interaction of *IQI* with *REG*; see Figure 3. Adjusted predictions keep all independent variables at their mean values, except for *REG* and *IQI,* which instead increase gradually from low to high values, and the dummy variables *EU, GFC,* and *POST-GFC* that define the subsamples. Another message of Figure 3 is that institutional quality alters the position of the crisis probability curve: the lower the quality of institutions, the thicker and darker the curves. Countries with poorer institutions face a greater risk of a banking crisis, particularly in the EU. For example, before 2008 an EU country with *IQI*=1 faces a tiny probability of financial distress, but a sizable one if *IQI*=0 (the maximum probability rising to 38% at *REG*≈40). A similar pattern holds for non-EU countries. Given the relationship between the liberalization trap and *IQI*, finance-developing countries should be prudent in liberalizing the financial

sector.[27] Once again, the location of the medium-level countries in the *REG* index suggests that these countries may not rejoice about their prospects in a future crisis.

EU members suffer from a regulatory coordination problem. Stricter regulation reduces the probability of a crisis when a country has reached *REG>40,* as in the case of Greece and Romania. Countries with *REG*<40, such as Denmark and Finland, instead, minimize the probability of a crisis at *REG*=0; that is, they can afford to further liberalize their financial sector. Furthermore, there is a trade-off between institutional quality and liberalization. Countries with poor institutions must accept a more regulated financial sector to contain financial instability, whereas countries with good institutions can afford a more liberal financial environment. Brexit is a case in point of contrasting views on banking regulation between the UK and the EU. Due to good institutions, the UK minimizes the probability of a crisis with an extremely liberal financial environment, as one can infer from an average score of about *REG*=13; conversely, EU continental countries with lower institutional quality minimize crisis probability with tighter rules, as one can infer from an average score of REG>40. Under heterogeneous preferences for policy reforms, a common regulation is inefficient because it pushes some countries away from their optimal combination of institutional quality and regulatory stringency. As a result, a common regulatory setting will be difficult to achieve and/or is unstable. The internal contrasts in creating the European Banking Authority (EBA, henceforth) in 2011 and the protracted process in completing the European Banking Union are examples of a precarious bargain (De Rynck, 2015).

Additional findings

We now expand our analysis by introducing additional variables. The findings are shown in Table 4. Column 1 reports the estimate of our benchmark model (column 5 of Table 3). In

[27] The pattern is also consistent with the experience of Latin American countries: the two waves of financial liberalization in the 1970s and 1990s were rapidly followed by deep financial disturbances (Mishkin, 1999).

column 2, we add *L.BAS* to test whether the size of the domestic banking sector matters on crisis probability, *L.GINI* to test the effect of income inequality, and *ENGLISH* and *MUSLIM* to control for potential omitted cultural variables.

[Insert here Table 4]

Column 3 reports the estimate of the extended model using *EURO* in place of *EU*. In column 4, we control for potential cross-country contagion effects by adding *CONTAGION*, a dummy that is equal to 1 when another country in the same region is affected by a crisis. The definition of the regions is provided by the World Bank.[28] To capture the impact of crisis persistence on next year's crisis probability, we also add *TREND,* a variable indicating the year number in the current crisis episode; see column 5. In column 6, we control for both cross-country contagion and crisis persistence. In columns 7, 8 and 9, we use regional and year dummies; the former account for cross-county effects and are a substitute of *CONTAGION,* and the latter are a simpler alternative to *TREND*.[29] Finally, in column 10 we replace *CRISIS* with *ALL_CRISIS* to verify the stability of results with respect to the definition of crisis. All new variables are highly statistically significant.

The positive sign of *L.BAS* suggests that, *ceteris paribus*, banking crises are more likely to occur in countries with larger banking sectors. An oversized sector may trigger an implicit government subsidy or protection that encourages risk appetite on the part of banks. The *GINI* coefficient is statistically significant and negative in line with Forbes' findings (2000). A common law system rises the probability of a banking crisis, but the effect is statistically not significant. Countries with a substantial Muslim population are financially more stable than

[28] Every geo-economic country classification is questionable, but the World Bank definition of regions has the advantage of being consistent over time. Seven regions are identified in the world: East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia, and Sub-Saharan Africa.

[29] Regional dummies are less efficient than country dummies in controlling for omitted variables, but do not generate an incidental parameter problem because they do not increase with the number of countries. Year dummies tend to be collinear with *GDPpc*: to maintain comparability with previous specifications, we add only year dummies not collinear with *GDPpc*.

others. The impact of *EURO* is similar to that of *EU* but shows more intensity (compare columns 2 and 3). Specifications with *CONTAGION* and *TREND* (columns 4-6), with regional and year dummies (columns 7-9), and *ALL_CRISIS* (column 10) are consistent with the main findings of the benchmark model. In particular, the coefficients of *L.REG*, *L.REG2*, and *IQI* remain stable and statistically significant, confirming that regulatory stringency exerts an inverted U-shaped impact on the probability of a crisis, while institutional quality improves overall financial stability.

[Insert here Figure 4]

Figure 4 reports the same graphs of Figure 3 using *EURO* in place of *EU*. There are few differences. Moving from EU to eurozone countries, the pre-2008 probability of a crisis is 25% lower for low-*IQI* countries and 50% higher for good institutional quality members. Graphically, the distance between the solid and the dotted line in the top right graph of Figure 4 is smaller than in the corresponding graph of Figure 3. This is due to the selection effect created by the eurozone. During the crisis, the euro worked as a stabilizer at the expense of countries with good institutions. From 2009 to 2013, the probability of a crisis in the eurozone (middle-right graph of Figure 4) increased proportionally more than in non-euro countries (middle-left graph of Figure 4) and EU countries (middle-right graph of Figure 3). Within the eurozone (top and middle-right graphs of Figure 4), the probability of a crisis doubled for high-*IQI* countries (dotted line) against a 50% increase for low-*IQI* ones (solid line). A more pronounced inverted U-shaped *REG* pattern, especially for countries with good institutions, does not guarantee a stable financial system in the eurozone. In the recovery period (bottom graphs in Figure 4), the probability of a crisis converges to less than 1% for non-eurozone countries and to an approximate average level of 8% for eurozone countries.

The *REG* mean for eurozone members is around 32, a value very close to the maximum for each *IQI*-level crisis probability curve. In this situation, not only a single response cannot

fit all eurozone countries, but also improvements in institutional quality will be ineffective because high-*IQI* countries face a considerable crisis probability (around 28% in the crisis period and 6% in the recovery period). Hence, structural shortcomings of the eurozone appear more severe than those of the EU, regardless of the level of banking regulation and institutional quality: despite a lower variability (shown by smaller difference between solid and dotted line), the average crisis probability is higher. Although there is more coordination in the eurozone than in the EU, remedies to stabilize the area must go beyond the creation of a new financial regulatory framework.

Robustness tests

We carry out six robustness exercises. The first checks the sensitivity of our findings to the measure of regulatory stringency. In Table 5, we replace *REG* alternatively with Abiad et al.'s (2010) financial liberalization index (column 1), Barth et al.'s (2013) comprehensive measure of financial regulation (column 2), the Hiel (2007) credit market regulation index (column 3), Federico et al.'s (2014) average reserve requirement index (column 4), Cerutti et al.'s (2017) macroprudential index (column 5), Fernandez et al.'s (2016a) average commercial credits restrictions index (column 6), and Fernandez et al.'s (2016b) average financial credits restrictions (column 7). To make it consistent with our *REG*, all indexes were rescaled and/or inverted between 0 and 100, where higher values indicate higher regulation. Our sample is smaller when we rerun *HYP2* using the alternative measures of *REG* because of their different time coverage and data availability. Results using comprehensive or general indexes of regulation (column 1 and 2, and column 6 and 7 respectively) are similar to our benchmark (column 5 in Table 3). Regulatory stringency is statistically insignificant using smaller samples (column 3), indexes on specific regulation instruments (column 4) and/or indexes that capture broad concepts such as macroprudential policy (column 5).

[Insert here Table 5]

The second applies a correlated random effects model (*CREM*) to permit a correlation between unobserved heterogeneity and observed covariates in a random effects framework (Wooldridge, 2010). The implementation makes a within-country Mundlak correction by adding cross-sectional means of all covariates (Table 6, columns 1 and 2). The third applies a dynamic random effects model (*DREM*) (Wooldridge, 2005) to a specification that adds the lagged dependent variable to capture crisis persistence. The implementation makes a time-average Mundlak correction on temporal means of all covariates and with an initial year value of the dependent variable, *CRISIS_t0* (Table 6, columns 3 and 4). The fourth is to combine both methods in a double correction model (*DCOR*) to control for unobserved simultaneity and also include the lagged dependent variables; see Table 6, columns 5 and 6.[30] In all these random effects models, the joint F-tests F^{REG_M}, F^{REG_T}, and F^{REG_MT} show that the correction terms are individually and jointly statistically very significant. While there is corroboration for the linear model, the F statistic of both the linear and squared terms is higher under the quadratic model, thus confirming the inverted U-shaped *REG* pattern. The *IQI* impact is negative. The statistically significant positive coefficient of *L.CRISIS* does not alter the results. Overall, we corroborate the previous findings.[31]

[Insert here Table 6]

The fifth exercise is an IV estimation to further address the endogeneity problem: we perform an IV Probit with the lagged *CRISIS* as a regressor. This is a 2SLS estimator similar to the standard IV estimator for non-bounded dependent variables but applies a conditional

[30] Joshi and Wooldridge (2019) demonstrate that adding individual averages of time-varying exogenous instruments into a random effect (*RE*) framework controls for endogeneity problems and is algebraically equivalent to a *RE IV* model. In *DREM* and *DCOR*, we omit the average of the exogenous instruments, but include the averages of the explanatory variables. To the extent that these averages are good proxies of the lagged endogenous variable, they work as instruments as in a GMM estimation; that is, *DREM* and *DCOR* partially address the endogeneity problem.

[31] We replicate the models presented in the first two columns of Table 5 by replacing *IQI* with six indices of institutional quality. The squared pattern of *REG* is once more confirmed; results are not reported for brevity. The implementation of *DREM* and double correction using the six institutional indices instead of *IQI* turned out statistically inconclusive. Furthermore, individual institutional indices produced mixed results.

maximum-likelihood method because the dependent variable is binary. Given the quadratic relationship between regulatory stringency and financial instability, we need two first-stage estimates to remove the endogeneity from both *REG* and REG^2. In a stepwise fashion, we add the instruments: first the time building warehouse *TBW*, then the share of public employment in total employment *PE,* followed by the two indices of democracy *LD* and *DD*.[32] For each instrument, we also include its squared value to remain consistent with the quadratic form of the endogenous variable.

Table 7 reports the results from the IV Probit estimates: the second stage estimates are shown at the top and selected first-stage results are at the bottom. The Wald test of the exogeneity of *REG* rejects the null hypothesis of no endogeneity and suggests that the regular Probit regression could be inappropriate. As a proxy for bureaucracy, *TBW* ought to be correlated with regulatory stringency but not with financial instability. In the two first-stage estimates, the highly significant coefficients of *TBW* and TBW^2 suggest that the variables work well as instruments, but the F^{INST} test reveals that *TBW* is a relatively weak instrument due to the insignificant F-statistic in the first stage.[33]

Next, we move from perfect identification to overidentification and thus include more instruments. We add, stepwise, *PE* and *LD* in columns 2 and 3 respectively; and replace *LD* with an index of deliberative democracy *DD* in column 4. The inverted U-shaped impact of regulatory stringency on the probability of a crisis is broadly corroborated. However, the Hansen's overidentification test casts doubt on the validity of the democracy indexes as instruments because it rejects the null hypothesis that all instruments are uncorrelated with the idiosyncratic error. A possible explanation, confirmed by the switch in sign of the *IQI*

[32] We use all five indexes of democracy provided by the Varieties of Democracy Project (2019) as instruments separately. For brevity, we report only results using the best and the worst instrument according to the Hansen test, that is *LD* and *DD* respectively.
[33] The F-statistic is smaller than 10 and our judgement of insignificance relies on the Stock and Yogo (2005) rule of thumb.

coefficient, is that *IQI* partially captures the information imbedded in *LD* and *DD*. We also apply the IV estimator to the main specifications of Table 4, using *TBW* and *PE* (in both linear and quadratic form) as instruments. Then, we estimate in column 5 the extended specification with *CONTAGION* (column 6), *TREND* (column 7), and both (column 8). Finally, we use *ALL_CRISIS* (column 9). In conclusion, all IV estimates strongly corroborate our previous results.

[Insert here Tables 7]

The sixth and final exercise verifies whether persistence in variables may drive our findings. For this purpose, we transform the data in ten averages of two-year periods and regress the dependent variable on the previous two-year averages of the covariates: i.e., the probability of a crisis in 1999 is regressed on the 1997-1998 covariate averages, the probability of a crisis in 2001 on the 1999-2000 covariate averages, and so on. The regression estimates, shown in Tables 8 and 9, are in line with the estimates in Tables 3 and 4, thus confirming the validity of our earlier findings.

[Insert here Tables 8 and 9]

We repeat the exercise using three-year averages for the period 1997-2017 and four-year averages for the period 1996-2016. Table 10 compares the quadratic model of the base specification (column 3 in Table 3), the benchmark specification (column 5 in Table 3), and the extended specification (column 2 in Table 4) for ten two-year averages, seven three-year averages and five four-year averages. *IQI*, being quite persistent, becomes less significant at lower frequencies, but the inverted U-shaped impact of *L.REG* on *CRISIS* remains strong and significant under every specification. It suggests that our results are robust to a slow reaction of the banking system to the introduction of regulation; e.g., a long implementation period or a slow adjustment in bank risk-taking.

[Insert here Table 10]

V. CONCLUSIONS

Regulation can either reduce the probability of a banking crisis or increase it, depending on factors such as the stringency of regulation, the type of regulation, and the quality of institutions present in a country. Empirical findings in the literature, in fact, tend to be ambiguous on the link between regulation and the probability of a banking crisis. Given that positive and negative effects can emerge, we develop a theoretical model that produces both outcomes and arrives at the implication that the probability of a crisis is best described by a concave curve with respect to an investment in regulation. Our simulation shows that we obtain a concave-shaped curve of crisis probability in relation to different levels of regulation under a broad set of conditions. The theoretical non-linearity is confirmed by the data. We test the relationship between regulatory stringency and the risk of a crisis by subjecting a non-linear specification to Probit estimation using annual data from 1996 to 2017 drawn from 138 countries. Our key inference is that the probability of a financial crisis fits an inverted U-shaped curve: it rises as one moves from low to medium levels of regulation and falls from medium to high levels of regulation. The peak point of the probability occurs where the Regulation Index, measured as the complement to 100 of the Financial Freedom Index, reaches approximately a value of 40 relative to a maximum of 100.

The peak point of an inverted U-shaped curve is surrounded by areas to the East and to the West with lower crisis probabilities. Countries in each of these areas find themselves respectively in a sort of regulation and liberalization trap. To the East of the peak, a country embarking on a liberalization process raises the probability of a crisis. When a crisis erupts, regulation tightens at the expense of efficiency and profitability. Complacency in good times restores more lenient regulations. A new cycle starts with the occurrence of another crisis. This up-and-down pattern characterizes a regulatory pendulum that we have described as a regulation trap because the country remains trapped into a situation of high regulation. If

instead a crisis does not occur, the banking system continues to liberalize and may settle to the West of the peak point. The occurrence of a crisis triggers regulatory stringency, but this is resisted because it raises the probability of a crisis, while increasing inefficiency and lowering profitability. Up-and-down swings can also occur to the West of the peak point creating a liberalization trap because the country is resilient to the reintroduction of regulation and remains trapped in a situation of high financial liberalization. If a crisis is massive, as in the Great Depression of the 1930s, the regulatory response can be so strong to suddenly propel a country from the West to the East side of the peak point.

Countries with a medium level of regulatory stringency that cluster around the peak, mostly European countries, have incentive to move either to the West or to the East of the peak to reduce the probability of a crisis. Those with good institutions have an incentive to move to the West because the quality of institutions attenuates the loss given default. Those with poor institutions have instead an incentive to tighten regulation. Either way, the position around the peak is unstable.

Liberalization and regulation traps exacerbate coordination problems when a trade-off can be made between regulation stringency and institutional quality. Common international regulatory standards resolve the coordination problem if participating countries have common preferences and similar quality of institutions; otherwise, the agreement is likely to be inferior to a domestic solution where trade-offs can be made between regulatory stringency and institutional quality. Brexit is a case in point of contrasting views on banking regulation between the UK and the EU. According to the Financial Freedom Index, the UK has a much higher score than EU continental countries and, hence, a much lower Regulation Index. It follows that the UK can minimize the probability of a crisis with a more liberal regulatory environment than many continental European countries. The common regulatory structure existing in the EU cannot resolve the conflict unless all EU Member States are willing to

undertake the same institutional reforms. Differences in national regulatory preferences may have played a role in the Brexit outcome; and paradoxically, without the UK, the adoption of stricter regulation in the EU could become not only easier but also more effective.

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Table 1: Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min	Median	Max	Coeff. Var.
CRISIS	3,608	0.061	0.239	0	0	1	3.934
ALL_CRISIS	3,608	0.070	0.254	0	0	1	3.658
GDPpc	4,388	1.275	2.072	0.010	0.39	18.515	1.625
INF	3,832	8.676	72.124	-18.109	3.67	4,145	8.313
CAB	3,621	-3.097	11.380	-147.997	-3.18	53.436	-3.675
GINI	3,165	0.470	0.110	0.228	0.48	1	0.234
TOP5	2,652	80.495	16.386	27.508	83.21	100	0.204
BAS	3,709	53.062	47.834	0.274	40.36	840	0.901
ENGLISH	4,422	0.348	0.476	0	0	1	1.368
MUSLIM	4,422	21.997	35.289	0	1.00	99.90	1.604
EU	4,818	0.103	0.304	0	0	1	2.949
EURO	4,818	0.058	0.234	0	0	1	4.026
GFC	4,818	0.227	0.419	0	0	1	1.844
POST-GFC	4,818	0.227	0.419	0	0	1	1.844
REG	3,617	50.149	20.107	10	50	100	0.401
TBW	2,269	181.02	97.18	27	161.50	714	0.54
PE	4,136	0.19	0.12	0.01	0.18	0.85	0.61
LD	3,820	0.41	0.27	0.01	0.37	0.91	0.66
DD	3,830	0.42	0.26	0.01	0.38	0.91	0.61
IQI	3,773	0.531	0.197	0.021	0.500	0.958	0.370

NOTES: Period: 1996-2017. *CRISIS* = 1 for systemic banking crises, 0 otherwise; *ALL_CRISES* = 1 for systemic banking crisis and/or a sovereign debt default/restructuring, 0 otherwise; *GDPpc* is the per-capita income; INF is the inflation rate; *CAB* is the current account balance; *GINI* is the income inequality index; *TOP5* is the share of five largest domestic banks on the domestic banking system; *BAS* is the share of banking total assets on the GDP; *ENGLISH* = 1 for common law systems, 0 otherwise; *MUSLIM* is the share of the Muslim population in total population in 1980; EU = 1 for EU member countries, 0 otherwise; EURO = 1 for eurozone member countries, 0 otherwise; GFC =1 for the period of the Great Financial Crisis (2008-2012), 0 otherwise; POST-GFC = 1 for the period after the Great Financial Crisis (2013-2017) , 0 otherwise; REG is a regulation index calculated as 100 – FFI, where FFI is the Financial Freedom Index; TBW is the number of days required to build a warehouse; PE is the share of public employment on total employment; LD is an index of liberal democracy; DD is an index of deliberative democracy; and IQI is an index of institutional quality. See Appendix B for the complete list of variable definitions and sources.

Table 2: Pre-crisis, crisis, EU countries, and non-EU countries sub-samples

Section A: comparison by areas.

Variables	Pre-GFC		GFC		Post-GFC	
	Non-EU	EU	Non-EU	EU	Non-EU	EU
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A.1	**Mean**	**Mean[a]**	**Mean**	**Mean[a]**	**Mean**	**Mean[a]**
IQI	0.500	0.814***	0.497	0.77***	0.491	0.759***
GDPpc	0.816	2.825***	1.320	3.419***	1.318	3.261***
INF	12.735	2.513***	6.754	2.916***	5.503	0.638***
CAB	-2.851	-1.284**	-4.183	-1.415***	-4.268	1.839***
GINI	0.495	0.314***	0.496	0.314***	0.488	0.321***
TOP5	81.688	81.354	80.176	80.412	76.945	82.051***
BAS	42.065	94.164***	51.151	107.879***	55.693	96.455***
TBW	202.51	196.41	184.28	199.58	162.05	179.74*
PE	0.190	0.251***	0.184	0.234***	0.185	0.234***
LD	0.354	0.805***	0.357	0.786***	0.353	0.754***
DD	0.369	0.791***	0.379	0.767***	0.367	0.738***
REG	51.779	30.270***	54.720	29.778***	55.020	32.071***
Panel A.2	**Median**	**Median[b]**	**Median**	**Median[b]**	**Median**	**Median[b]**
IQI	0.473	0.818***	0.471	0.765***	0.475	0.748***
GDPpc	0.211	2.646***	0.425	3.082***	0.440	2.521***
INF	4.611	2.219***	5.072	2.663***	2.773	0.523***
CAB	-3.202	-0.556***	-4.759	-1.225***	-3.955	1.338***
GINI	0.509	0.309***	0.497	0.321***	0.488	0.3256***
TOP5	85.691	85.597	82.341	81.269	79.485	83.188**
BAS	30.706	93.944***	37.438	104.267***	44.474	96.666***
TBW	187	196	166	192*	145.5	160**
PE	0.164	0.252***	0.152	0.228***	0.156	0.219***
LD	0.313	0.811***	0.325	0.814***	0.319	0.773***
DD	0.326	0.795***	0.359	0.797***	0.345	0.769***
REG	50	30***	50	30***	50	30***

Section B: comparison by periods.

Variables	Non-EU			EU		
	Pre-GFC	GFC	Post-GFC	Pre-GFC	GFC	Post-GFC
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B.1	**Mean**	**Mean[a]**	**Mean[a]**	**Mean**	**Mean[a]**	**Mean[a]**
IQI	0.500	0.497	0.491	0.814	0.77***	0.759
GDPpc	0.816	1.32***	1.318	2.825	3.419***	3.261
INF	12.735	6.754**	5.503*	2.513	2.916*	0.638***
CAB	-2.851	-4.183**	-4.268	-1.284	-1.415	1.839***
GINI	0.495	0.496	0.488	0.314	0.314	0.321
TOP5	81.688	80.176*	76.945***	81.354	80.412	82.051
BAS	42.065	51.151***	55.693*	94.164	107.879***	96.455**
TBW	202.51	184.28***	162.05***	196.41	199.58	179.74
PE	0.190	0.184	0.185	0.251	0.234**	0.234
LD	0.354	0.357	0.353	0.805	0.786**	0.754***
DD	0.369	0.379	0.367	0.791	0.767**	0.738**
REG	51.779	54.720***	55.020	30.270	29.778	32.071*
Panel B.2	**Median**	**Median[b]**	**Median[b]**	**Median**	**Median[b]**	**Median[b]**
IQI	0.473	0.471	0.475	0.818	0.765***	0.748
GDPpc	0.211	0.425***	0.44	2.646	3.082**	2.521
INF	4.611	5.072*	2.773***	2.219	2.663	0.523***
CAB	-3.202	-4.759***	-3.955	-0.556	-1.225	1.338***
GINI	0.509	0.497	0.488	0.309	0.321	0.326
TOP5	85.691	82.341**	79.485***	85.597	81.269	83.188
BAS	30.706	37.438***	44.474***	93.944	104.267**	96.666*
TBW	187	166***	145.5***	196	192	160**
PE	0.164	0.152	0.156	0.252	0.228**	0.219
LD	0.313	0.325	0.319	0.811	0.814	0.773***
DD	0.326	0.359	0.345	0.795	0.797	0.769**
REG	50	50***[c]	50	30	30	30

NOTES: Period = 1996-2017; Pre-GFC = 1996-2007; GFC = 2008-2012; Post-GFC = 2013-2017. See Appendix B for the complete list of variable definitions and sources. (a) Mean-comparison test against the previous sub-sample for mean; (b) Wilcoxon rank-sum test against the previous sub-sample for medians, (c) as Wilcoxon test compares distributions (not medians), statistically different distributions could have the same medians despite the fact that the null hypothesis is rejected.

*** p<0.01, ** p<0.05, * p<0.1.

Table 3: Different specifications of the benchmark model, pooled Probit regressions

VARIABLES	Base	*HYP1*	*HYP2*	*HYP1*	*HYP2*
	(1)	(2)	(3)	(4)	(5)
L.GDPpc	0.1126***	0.1169***	0.1463***	0.1508***	0.1772***
L.TOP5	-0.0136***	-0.0134***	-0.0135***	-0.0123***	-0.0123***
IQI	-0.5268	-0.8140#	-1.0337*	-0.8094#	-1.0188*
GFC	0.4115***	0.4112***	0.3717***	0.3971***	0.3615***
POST-GFC	-0.6641***	-0.6681***	-0.7248***	-0.6934***	-0.7432***
EU	0.7371***	0.7359***	0.7530***	0.7285***	0.7404***
L.INF				0.0023**	0.0023**
L.CAB				-0.0134*	-0.0137*
L.REG		**-0.0029**	**0.0302****	**-0.0004**	**0.0285****
L.REG²			**-0.0004*****		**-0.0003****
Constant	-0.5845**	-0.3104	-0.7909*	-0.5706	-0.9769**
Observations	2,081	2,028	2,028	1,890	1,890
Pseudo R^2	0.181	0.180	0.188	0.191	0.198
LL Model	-413.7	-411.4	-407.1	-389.1	-385.9
AIC	841.5	838.9	832.3	798.1	793.8
BIC	881	883.8	882.8	853.6	854.8
F^{ALL}	88.22	86.90	86.46	83.92	83.39
$Pr(F^{ALL})>F$	0	0	0	0	0
F^{REG}	-	0.619	7.973	0.00863	5.764
$Pr(F^{REG})>F$	-	0.431	0.019	0.926	0.056

NOTES: Pooled Probit regressions. Columns 1-5: 138 countries, 1996-2017. Column 6: 91 countries, 1996-2005. Column 7: 180 countries, 1999-2011. Dependent variable *CRISIS* = 1 if a banking crisis occurred, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017). *EU* = 1 for EU member countries, 0 otherwise. Prefix *L* indicates a one-year lagged variable. See Appendix B for the complete list of variable definitions and sources. Pseudo R^2 and LL Model report McFadden's R^2 and the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification F-test. F^{REG} is the statistics of a joint F-test on *REG* terms only. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Table 4: Different specifications of the benchmark model, pooled Probit regressions

VARIABLES	(1) CRISIS	(2) CRISIS	(3) CRISIS	(4) CRISIS	(5) CRISIS	(6) CRISIS	(7) CRISIS	(8) CRISIS	(9) CRISIS	(10) ALL_CRISIS
L.GDPpc	0.1772***	0.1864***	0.1362***	0.1661***	0.1736***	0.1664***	0.1730***	0.2255***	0.2107***	0.1794***
L.TOP5	-0.0123***	-0.0097***	-0.0106***	-0.0096***	-0.0077**	-0.0078**	-0.0090**	-0.0107***	-0.0098***	-0.0109***
IQI	-1.0188*	-3.0932***	-2.8979***	-2.6168***	-2.8753***	-2.7026***	-3.2925***	-3.8151***	-4.1380***	-1.3801***
GFC	0.3615***	0.2869**	0.3314***	0.0443	0.2891**	0.2156#	0.3233***	0.7151*	0.8004**	0.3477***
POST-GFC	-0.7432***	-0.8321***	-0.8136***	-0.8324***	-1.0550***	-1.0432***	-0.8794***	-0.0483	-0.0681	-0.7412***
EU	0.7404***	0.5268***		0.3962**	0.3290*	0.2884#	0.4548**	0.7830***	0.7323***	0.7339***
L.BAS		0.0058***	0.0058***	0.0049***	0.0036**	0.0033*	0.0063***	0.0061***	0.0072***	
L.GINI		-2.4056***	-2.8981***	-1.7105**	-2.3335**	-2.1071**	-1.3431	-2.5206***	-1.4904	
ENGLISH		0.1491	0.1485	0.2494*	0.0505	0.0884	0.4207**	0.2056	0.5139***	
MUSLIM		-0.0077***	-0.0077***	-0.0083***	-0.0061*	-0.0063*	-0.0065*	-0.0086***	-0.0069*	
L.INF	0.0023**	0.0020*	0.0020*	0.0018#	0.0009	0.0009	0.0017#	0.0007	0.0002	0.0024**
L.CAB	-0.0137*	-0.0173**	-0.0173**	-0.0135#	-0.0194**	-0.0183*	-0.0110	-0.0143#	-0.0060	-0.0101#
L.REG	**0.0285****	**0.0374*****	**0.0258***	**0.0355*****	**0.0274***	**0.0268***	**0.0390*****	**0.0337****	**0.0357****	**0.0293****
L.REG2	**-0.0003****	**-0.0005*****	**-0.0004****	**-0.0004*****	**-0.0004****	**-0.0004****	**-0.0004*****	**-0.0004****	**-0.0004****	**-0.0004*****
EURO			0.6594***							
L.CONTAGION				0.0468***		0.0153#				
L.TREND					0.5433***	0.5189***				
Constant	-0.9769**	0.7278	1.2737*	0.1407	0.6343	0.4445	-0.0095	0.3867	-0.5474	-0.7982*
Regional Dummies	No	No	No	No	No	No	Yes	No	Yes	No
Year Dummies	No	No	No	No	No	No	No	Yes	Yes	No
Observations	1,890	1,666	1,666	1,666	1,666	1,666	1,485	1,566	1,397	1,890
Pseudo R^2	0.198	0.225	0.233	0.255	0.386	0.388	0.228	0.305	0.312	0.180
LL Model	-385.9	-353.5	-349.9	-339.9	-280.4	-279.3	-340.3	-311.5	-297.5	-413.3
AIC	793.8	737.1	729.8	711.9	592.8	592.5	718.5	679	659	848.6
BIC	854.8	818.4	811.1	798.6	679.5	684.6	819.3	829	826.8	909.6
F^{ALL}	83.39	73.54	78.54	43.16	56.85	44	76.99	123.4	125.1	86.62
Prob(F^{ALL})>F	0	0	0	0	0	0	0	0	0	0
F^{REG}	5.764	9.123	6.968	7.327	5.768	5.118	8.376	6.793	5.860	7.186
Prob(F^{REG})>F	0.0560	0.0100	0.0310	0.0260	0.0560	0.0770	0.0150	0.0330	0.0530	0.0280

NOTES: Pooled Probit regressions: 138 countries, 1996-2017. *CRISIS* = 1 banking crisis, 0 otherwise. *ALL_CRISIS* = 1 banking, sovereign debt crisis or twin crises, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017). *.EU* = 1 EU member country, 0 otherwise. *EURO* = 1 eurozone member country, 0 otherwise. Prefix *L* indicates a one-year lagged variable. See Appendix B for the complete list of variables. Pseudo R^2 and LL Model report McFadden's R^2 and the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification F-test. F^{REG} is the statistics of a joint F-test on *REG* terms. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Table 5: Robustness analysis: Alternative measures of regulation.

VARIABLES	Abiad et al. (1)[a]	Barth et al. (2)[b]	Hiel (3)[c]	Federico et al. (4)[d]	Cerutti et al. (b) (5)[e]	Fernández et al. (a) (6)[f]	Fernández et al. (b) (7)[g]
L.GDPpc	-0.0154	0.1798***	1.1559***	0.1592**	0.2993***	0.2234***	0.2254***
L.TOP5	-0.0124**	-0.0180***	-0.0026	-0.0139***	-0.0203***	-0.0131***	-0.0138***
IQI	2.1034**	-0.0870	-7.8529**	0.1607	-0.8255	-1.0849*	-1.4954**
EU	-	0.8835***	0.7398	0.7958***	1.2593***	0.9368***	0.8542***
GFC	-	1.0959***	-	0.2663#	1.1475***	0.4407***	0.4080***
POST-GFC	-	-	-	-0.7676***	0.0361	-0.7273***	-0.7201***
L.INF	0.0009	0.0111***	-0.3127	0.0108***	0.0279***	0.0020*	0.0023**
L.CAB	0.0068	-0.0076	-0.1230**	-0.0126	-0.0190*	-0.0229**	-0.0243***
L.REG	**0.1203*** **	**0.0607*** **	**0.0750#**	**0.0248#**	**-0.0060**	**0.0167*** **	**0.0129** **
L.REG2	**-0.0013*** **	**-0.0005** **	**-0.0007#**	**-0.0003**	**0.0001**	**-0.0001** **	**-0.0001** **
Constant	-3.8068***	-3.0164***	-0.6104	-1.3833**	-1.3871**	-0.6859*	-0.2945
Observations	497	995	158	953	1,122	1,416	1,417
Period	1996-2005	1999-2011	1996-2007	1996-2017	2000-2013	1996-2013	1996-2013
N. of countries	83	115	21	59	98	87	88
Pseudo R^2	0.155	0.362	0.383	0.169	0.380	0.202	0.197
LL Model	-93.41	-198.6	-35.83	-199.3	-177.3	-331.6	-334
AIC	202.8	417.1	89.66	420.6	376.5	685.2	689.9
BIC	236.5	466.1	117.2	474.1	431.8	743	747.7
F^{ALL}	4.304	69.85	6.901	40.05	82.23	88.75	84.43
Prob(F^{ALL})>F	0.0380	0	0.0320	0	0	0	0
F^{REG}	14.84	9.884	2.542	2.579	0.374	11.58	7.423
Prob(F^{REG})>F	0.00100	0.00700	0.281	0.275	0.829	0.00300	0.0240

NOTES: Pooled Probit regressions. Dependent variable *CRISIS* = 1 if a banking crisis occurred, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017). *EU* = 1 for EU member countries, 0 otherwise. Prefix *L* indicates a one-year lagged variable. See Appendix B for the complete list of variable definitions and sources. *REG* is replaced with the *REG*-rescaled liberalization index based on: (a) Abiad et al. (2010), (b) Barth et al. (2013), (c) Hiel Credit Market Regulation index by Prados De La Escosura (2016), (d) Average reserve requirements index by Federico et al. (2014), (e) Macroprudential Index by Cerutti et al. (2017), (f) Average Commercial Credits Restrictions index by Fernández et al. (2016), (g) Average Financial Credits Restrictions index by Fernández et al. (2016). Pseudo R^2 and LL Model report McFadden's R^2 and the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification F-test. F^{REG} is the statistics of a joint F-test on *REG* terms only. The indexes are rescaled if their definitions are such that higher values imply a less stringent regulation, for purposes of comparability with *REG*. See Table C.2 for their complete definition and sources.
*** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Table 6: Correlated Random Effects Model (CREM), Dynamic Random Effects Model (DREM)

VARIABLES	LINEAR CREM (1)	QUADRATIC CREM (2)	LINEAR DREM (3)	QUADRATIC DREM (4)	LINEAR DCOR (5)	QUADRATIC DCOR (6)
L.CRISIS			2.8008***	2.8823***	2.7632***	2.8610***
CRISIS_t0			-0.5498*	-0.5448*	-0.4721#	-0.4926#
L.GDPpc	0.3711***	0.3847***	0.0839	0.1252*	0.2776**	0.3072**
L.TOP5	-0.0056	-0.0067	-0.0117***	-0.0119***	-0.0139*	-0.0142*
IQI	-8.6812***	-9.4494***	-1.5023*	-1.8288**	-5.1549**	-5.8083**
GFC	0.3825***	0.3244**	2.7090***	0.6698	2.7720***	0.6012
POST-GFC	-1.0029***	-1.1005***	0.2391	-1.8936**	0.2078	-2.0348**
EU	0.5080**	0.5572**	0.7021***	0.7515***	0.6175***	0.6857***
L.REG	**-0.0184*** **	**0.0469** **	**-0.0100***	**0.0265**	**-0.0209*** **	**0.0281**
L.REG^2		**-0.0007*** **		**-0.0004***		**-0.0006***
Constant	-1.463#	-1.882*	197.630***	181.232***	201.379***	182.923***
Ln(Sigma_u)	-0.7259**	-0.7254**	-3.8749	-2.7992**	-3.4673	-2.9586*
Within-Country	Yes	Yes			Yes	Yes
Time-Average			Yes	Yes	Yes	Yes
Observations	2,028	2,028	2,028	2,028	2,028	2,028
Nr. of countries	138	138	138	138	138	138
Sigma_u	0.7	0.7	0.14	0.25	0.18	0.23
Rho	0.33	0.32	0.02	0.06	0.03	0.05
R^2	0.105	0.103	0.379	0.330	0.380	0.333
LL Model	-371.6	-366.8	-204.9	-197.6	-199.8	-192.2
AIC	769.3	763.6	439.9	429.2	437.7	428.4
BIC	842.3	847.8	524.1	524.6	544.3	551.9
F^{ALL}	77.40	79.11	58.79	30.33	60.20	33.09
Prob(F^{ALL})>F	0	0	0	0	0	0
F^{REG_M}	8.201	16.14				
Prob(F^{REG_M})>F	0.0170	0.00300				
F^{REG_T}			44.13	49.69		
Prob(F^{REG_T})>F			0	0		
F^{REG_MT}					46.94	53.83
Prob(F^{REG_MT})>F					0	0
F^{REG_A}	7.410	14.35	3.126	5.776	6.788	10.40
Prob(F^{REG_A})>F	0.006	0.001	0.077	0.056	0.009	0.006

NOTES: Panel Probit regressions: 138 countries, 1996-2017. *CREM* = Correlated Random Effects Model. *DREM* = Dynamic Random Effects Model. *DCOR* = double correction for both *CREM* and *DREM*. *CRISIS* = 1 for banking crisis years, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017). *EU* = 1 for EU member countries, 0 otherwise. Prefix *L* indicates a one-year lagged variable. See Appendix B for the complete list of variables. *Ln(Sigma_u)* is the (logged) variance of random effects and is equivalent to two times the log of the standard deviation *Sigma_u*. *Rho* is the ratio of the variance of random effects to the sum of variance of random effects and idiosyncratic error term. A *Rho* different from zero and a significant *Ln(Sigma_u)* indicates that the panel estimate is superior to the pool estimate. R^2 is calculated as the squared correlation between the observed response and the predicted response. LL Model reports the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification. F^{REG_M}, F^{REG_T}, and F^{REG_MT} are the statistics of a joint F-test for within-country Mundlak-correction *REG* means, time-average Mundlak-correction of *REG* means, within-country, and time-average Mundlak-correction of *REG* means. F^{REG_A} is the statistics of a joint F-test of *REG* terms and all Mundlak-correction *REG* means. LL Model indicates the log-likelihood function of the model.
*** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Table 7: IV Probit regressions (Conditional Maximum Likelihood).

SECOND STAGE	CRISIS	CRISIS	CRISIS	CRISIS	CRISIS	CRISIS	CRISIS	CRISIS	ALL_CRISIS
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
L.GDPpc	0.255***	0.2108***	0.2297***	0.2466***	0.189***	0.1998***	0.1772***	0.1863***	0.2014***
L.TOP5	-0.000215	0.0004	-0.0033	-0.0030	-0.000678	-0.0008	-0.0008	-0.0009	0.0014
IQI	-2.867*	-3.6576***	2.5331**	1.9320*	-3.093**	-3.0111**	-3.4803***	-3.6353***	-3.7729***
GFC	0.597*	0.4005**	0.8642***	0.8824***	0.539**	0.6035***	0.4604**	0.6025***	0.5502***
POST-GFC	0.223	0.2327*	0.1283	0.1595	0.0654	0.0674	-0.0329	0.0052	0.0159
EU	0.729***	0.5118***	1.0103***	1.0335***	0.507**	0.5749***	0.3100	0.3428#	0.5781**
L.INF	0.0472***	0.0424***	0.0339***	0.0359***	0.0551***	0.0555***	0.0530***	0.0541***	0.0583***
L.CAB	-0.0135*	-0.0091	-0.0226***	-0.0235***	-0.0102	-0.0117	-0.0114	-0.0127	-0.0057
L.GINI					-2.296***	-2.4186***	-2.4065**	-2.9469***	-2.0837**
L.BAS					0.00774***	0.0080***	0.0059**	0.0062***	0.0073***
ENGLISH					0.0800	0.0753	-0.0478	-0.0937	0.1441
MUSLIM					-0.00324	-0.0035	-0.0020	-0.0013	-0.0066
L.REG	0.146***	0.1145**	0.2162***	0.2166***	0.187***	0.1947***	0.1523**	0.1571**	0.1795***
L.REG²	-0.00192***	-0.0018***	-0.0019***	-0.0020***	-0.00235***	-0.0024***	-0.0021***	-0.0021***	-0.0023***
L.CONTAGION						-0.0128#		-0.0261***	
L.TREND							0.1571**	0.1974**	
Constant	-2.635	-0.6875	-9.0687***	-8.6703***	-2.760	-3.0283	-1.2866	-1.0270	-2.3809
Observations	1,362	1,362	1,362	1362	1,158	1,158	1,158	1,158	1,158
Wald exogeneity test	13.36	14.67	60.14	59.48	70.24	75.98	37.05	42.85	44.00
Wald p value	0.001	0.001	0.000	0.000	0	0	0	0	0
Hansen Overid.Test	-	2.22	7.84	10.11	3.01	2.32	2.789	2.442	2.885
Hansen p value	-	0.329	0.097	0.038	0.221	0.313	0.248	0.294	0.236

FIRST STAGE	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**	**REG**	**REG2**
INSTRUMENTS (significance)	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)	(7a)	(7b)	(8a)	(8b)	(9a)	(9b)
TBW \ TBW2	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
PE/PE2			******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
LD/LD2					******	******												
DD/DD2							******	******										
F^{INST}	9.8	4.7	10.45	14.16	28.77	47.07	26.97	40.19	12.75	20.45	12.92	20.61	12.87	20.81	13.20	21.20	12.75	20.45
Prob(F^{INST})>F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NOTES: Instrumental variables probit model. Cond.ML = Conditional Maximum Likelihood. *CRISIS* = 1 for banking crisis 0 otherwise. *ALL_CRISIS* = 1 for banking, sovereign debt or twin crises, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the GFC (2013-2017) .*EU* = 1 EU member country, 0 otherwise. *TBW* = Time Building Warehouse; *PE* = Public Employment; *LD* = Liberal Democracy; *DD* = Deliberative Democracy. See Appendix B for the complete list of the definitions of the variables of interest. Prefix L indicates a one-year lagged variable. See Appendix B for the complete list of variables. Wald test of exogeneity tests the null hypothesis of no endogeneity of the instrumented variables. Hansen Overid. is the Hansen J-test (chi-sq) for overidentification. F^{INST} is the F-test of joint significance of the instruments*** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Table 8: Two-year average regressions (compare to Table 3)

VARIABLES	Base	*HYP1*	*HYP2*	*HYP1*	*HYP2*
	(1)	(2)	(3)	(4)	(5)
GDPpc	0.1550**	0.1577**	0.1964***	0.1894***	0.2427***
TOP5	-0.0135***	-0.0131***	-0.0132***	-0.0122**	-0.0125**
IQI	-1.0814	-0.8511	-1.2451	-0.4342	-0.7776
GFC	0.0748	0.0625	0.0207	0.0508	0.0245
POST-GFC	-0.7800***	-0.8003***	-0.8644***	-0.7673***	-0.8172***
EU	1.2752***	1.2871***	1.3083***	1.2976***	1.3401***
INF				0.0432***	0.0580***
CAB				-0.0159	-0.0169
REG		**0.0046**	**0.0468****	**0.0044**	**0.0611*****
REG2			**-0.0005****		**-0.0007*****
Constant	-0.4421	-0.8059	-1.3557*	-1.4288*	-2.3423***
Observations	836	817	817	771	771
Pseudo R^2	0.264	0.263	0.276	0.285	0.306
LL Model	-151.2	-150.4	-147.8	-143.5	-139.3
AIC	316.3	316.8	313.6	307	300.6
BIC	349.4	354.5	356	353.4	351.7
F^{ALL}	87.35	85.82	87.15	86.60	86.54
Prob(F^{ALL})>F	0	0	0	0	0
F^{REG}	-	0.529	5.161	0.428	7.753
Prob(F^{REG})>F	-	0.467	0.0760	0.513	0.0210

NOTES: Pooled Probit regressions: 138 countries, 1996-2017. *CRISIS* = 1 for banking crisis years, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017). *EU* = 1 for EU member countries, 0 otherwise. See Appendix B for the complete list of variables. Pseudo R^2 and LL Model report McFadden's R^2 and the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification F-test. F^{REG} is the statistics of a joint F-test on *REG* terms.
*** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Table 9: Two-year average regressions (compare to Table 4)

VARIABLES	(1) CRISIS	(2) CRISIS	(3) CRISIS	(4) CRISIS	(5) CRISIS	(6) CRISIS	(7) CRISIS	(8) CRISIS	(9) CRISIS	(10) ALL_CRISIS
L.GDPpc	0.2427***	0.2512***	0.1694**	0.2508***	0.3033***	0.3043***	0.2252***	0.1896**	0.1411*	0.2547***
L.TOP5	-0.0125**	-0.0111*	-0.0135**	-0.0115**	-0.0047	-0.0051	-0.0081	-0.0132**	-0.0115#	-0.0101*
IQI	-0.7776	-2.9956**	-2.7073**	-2.7783**	-4.2060***	-4.0971***	-3.1921**	-2.0462	-1.9422	-1.5833#
GFC	0.0245	-0.0967	-0.0882	-0.5914*	-1.0926***	-1.3006***	-0.0420	-0.8494***	-0.8657***	0.0492
POST-GFC	-0.8172***	-0.8747***	-0.8708***	-0.8986***	-1.0877***	-1.0928***	-0.9705***	-1.5580***	-1.7960***	-0.8549***
EU	1.3401***	1.0534***		0.9541***	0.9042***	0.8785***	0.9940***	1.1607***	0.9965***	1.3270***
L.BAS		0.0074***	0.0082***	0.0070***	0.0063**	0.0060*	0.0078***	0.0067**	0.0071**	
L.GINI		-2.8364*	-4.7555***	-2.2231	-2.9903#	-2.8597#	0.2116	-2.5585#	0.8478	
ENGLISH		0.3019	0.3320	0.3974*	-0.0279	0.0180	0.5153*	0.2971	0.6378*	
MUSLIM		-0.0060	-0.0055	-0.0060	-0.0053	-0.0051	-0.0085	-0.0068	-0.0112#	
L.INF	0.0580***	0.0650***	0.0692***	0.0637***	0.0462**	0.0465**	0.0627***	0.0754***	0.0733***	0.0509***
L.CAB	-0.0169	-0.0233#	-0.0286**	-0.0225#	-0.0261#	-0.0264#	-0.0068	-0.0134	0.0086	-0.0128
L.REG	**0.0611*** **	**0.0802*** **	**0.0644** **	**0.0799*** **	**0.0644** **	**0.0647** **	**0.0821*** **	**0.0772*** **	**0.0808*** **	**0.0626*** **
L.REG2	**-0.0007*** **	**-0.0010*** **	**-0.0009*** **	**-0.0009*** **	**-0.0007** **	**-0.0007** **	**-0.0009*** **	**-0.0009*** **	**-0.0009** **	**-0.0007*** **
EURO			0.9483***							
L.CONTAGION				0.0456**		0.0177				
L.TREND					0.8034***	0.7899***				
Constant	-2.3423***	-0.6462	0.8366	-0.9996	0.0574	-0.0354	-2.6960#	-0.4466	-2.9810#	-1.9037**
Regional Dummies	No	No	No	No	No	No	Yes	No	Yes	No
Year Dummies	No	No	No	No	No	No	No	Yes	Yes	No
Observations	771	708	708	708	708	708	631	608	543	771
Pseudo R^2	0.306	0.324	0.327	0.338	0.488	0.489	0.338	0.381	0.406	0.280
LL Model	-139.3	-130.7	-130	-128	-99.08	-98.87	-123.6	-114.2	-105.7	-149.9
AIC	300.6	291.5	290.1	288.1	230.2	231.7	285.2	264.5	255.4	321.9
BIC	351.7	359.9	358.5	361.1	303.2	309.3	369.7	343.9	349.9	373
F^{ALL}	86.54	82.96	81.29	86.33	105.4	105.2	77.69	87.63	83.75	84.08
Prob(F^{ALL})>F	0	0	0	0	0	0	0	0	0	0
F^{REG}	7.753	10.45	7.930	10.11	5.676	5.687	10.25	7.703	7.762	8.628
Prob(F^{REG})>F	0.0210	0.00500	0.0190	0.00600	0.0590	0.0580	0.00600	0.0210	0.0210	0.0130

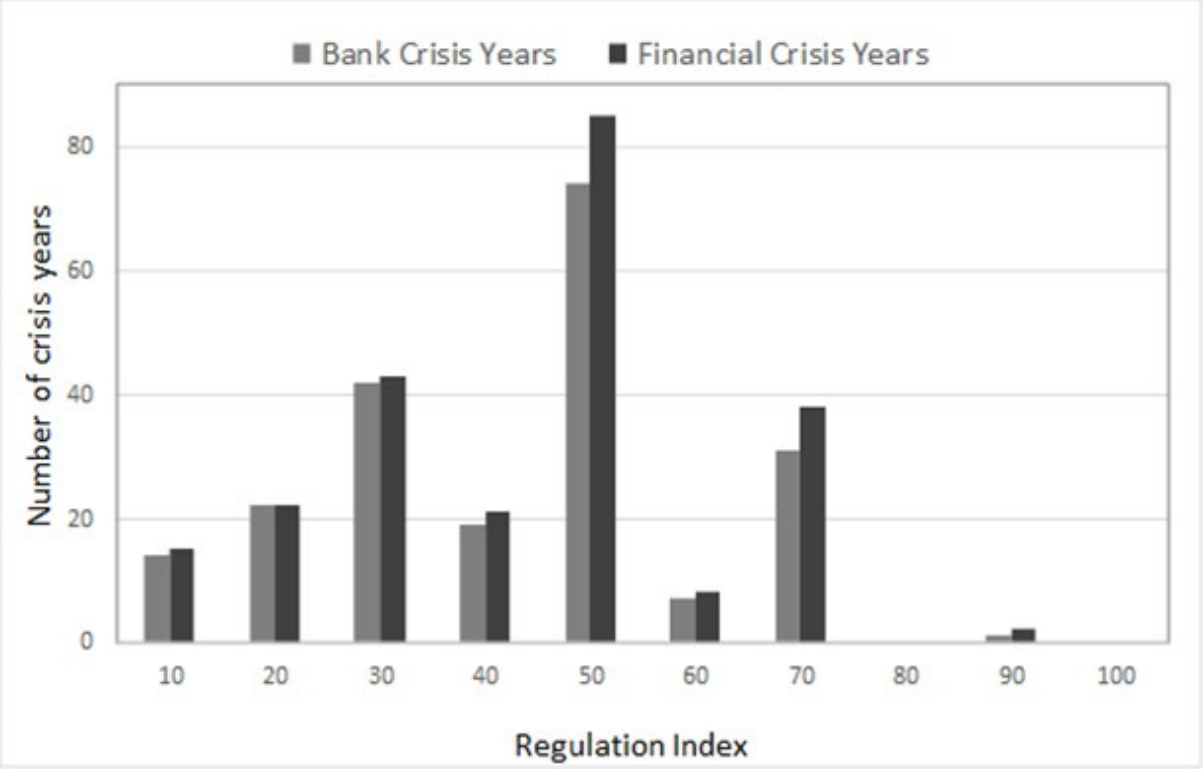
NOTES: Pooled Probit regressions: 138 countries, 1996-2017. *CRISIS* = 1 banking crisis 0, otherwise. *ALL_CRISIS* = 1 banking, sovereign debt crisis or twin crises, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017). *EU* = 1 EU member country, 0 otherwise. *EURO* = 1 eurozone member country, 0 otherwise. Prefix *L* indicates a one-year lagged variable. See Appendix B for the complete list of variables. Pseudo R^2 and LL Model report McFadden's R^2 and the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification F-test. *FREG* is the statistics of a joint F-test on *REG* terms. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Table 10: Regressions with different data frequency (compare to Table 4)

	10 two-year averages, 1997-2017			7 three-year averages, 1997-2017			5 four-year averages, 1996-2016		
VARIABLES	**HYP2**	**HYP2**	**HYP2**	**HYP2**	**HYP2**	**HYP2**	**HYP2**	**HYP2**	**HYP2**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
GDPpc	0.1964***	0.2427***	0.2512***	0.1633**	0.2179***	0.2149***	0.1653**	0.1718**	0.1599*
TOP5	-0.0132***	-0.0125**	-0.0111*	-0.0144***	-0.0139***	-0.0112**	-0.0083#	-0.0079	-0.0055
IQI	-1.2451	-0.7776	-2.9956**	-0.8630	-0.9024	-3.4902***	-0.2925	-0.1631	-1.4448
GFC	0.0207	0.0245	-0.0967	-0.1589	-0.2277	-0.3162#	0.5341**	0.5211**	0.5094**
POST-GFC	-0.8644***	-0.8172***	-0.8747***	-1.2626***	-1.3531***	-1.4398***	-0.0110	-0.0194	-0.0175
EU	1.3083***	1.3401***	1.0534***	0.8450***	0.8594***	0.5835**	1.0355***	1.0457***	0.7486***
INF		0.0580***	0.0650***		0.0035#	0.0027		0.0149	0.0126
CAB		-0.0169	-0.0233#		-0.0232*	-0.0288*		-0.0042	-0.0066
BAS			0.0074***			0.0066***			0.0035
GINI			-2.8364*			-3.4595***			-2.3728#
ENGLISH			0.3019			0.1175			-0.1128
MUSLIM			-0.0060			-0.0099*			-0.0033
REG	**0.0468****	**0.0611*****	**0.0802*****	**0.0369***	**0.0375***	**0.0451****	**0.0480****	**0.0515****	**0.0550****
REG2	**-0.0005****	**-0.0007*****	**-0.0010*****	**-0.0004***	**-0.0004***	**-0.0005****	**-0.0005***	**-0.0005***	**-0.0006***
Constant	-1.3557*	-2.3423***	-0.6462	-0.7538	-0.9334	1.5504	-2.2803**	-2.5107**	-1.0003
Observations	817	771	708	800	744	692	485	454	432
Pseudo R^2	0.276	0.306	0.324	0.178	0.200	0.236	0.227	0.225	0.238
LL Model	-147.8	-139.3	-130.7	-173.1	-162.9	-152.2	-117.5	-115.4	-111.6
AIC	313.6	300.6	291.5	364.1	347.8	334.5	253.1	252.8	253.2
BIC	356	351.7	359.9	406.3	398.5	402.6	290.7	298.1	314.3
F^{ALL}	87.15	86.54	82.96	60.21	64.72	67.47	59.13	56.79	57.23
Prob(F^{ALL})>F	0	0	0	0	0	0	0	0	0
F^{REG}	5.161	7.753	10.45	3.618	3.396	4.514	4.044	4.303	4.446
Prob(F^{REG})>F	0.0760	0.0210	0.00500	0.164	0.183	0.105	0.132	0.116	0.108

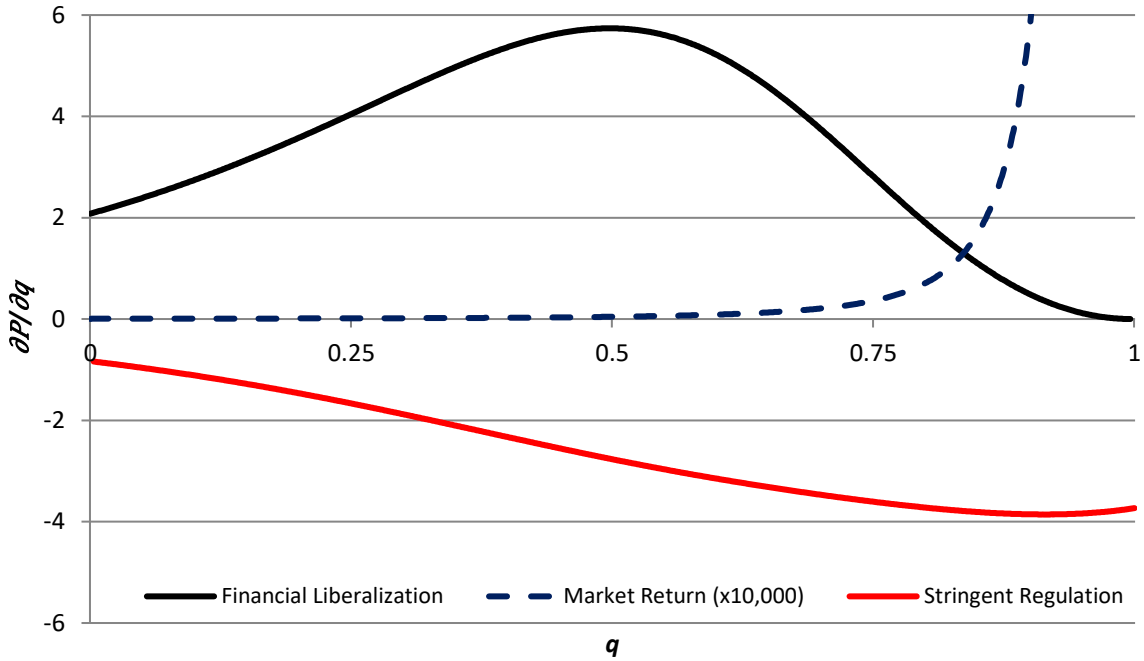
NOTES: Pooled Probit regressions: 138 countries, 1996-2017. *CRISIS* = 1 for banking crisis years, 0 otherwise. *GFC* identifies the period around the Great Financial Crisis (2008-2012). *POST-GFC* identifies the period after the Great Financial Crisis (2013-2017) *EU* = 1 for EU member countries, 0 otherwise. See Appendix B for the complete list of variables. Pseudo R^2 and LL Model report McFadden's R^2 and the log-likelihood function of the model. AIC and BIC refer to Akaike and Bayesian Information Criterion. F^{ALL} is the statistics of the full specification F-test. F^{REG} is the statistics of a joint F-test on *REG* terms.
*** p<0.01, ** p<0.05, * p<0.10, # p<0.15.

Figure 1: Number of banking and financial crisis years measured by Regulation Index



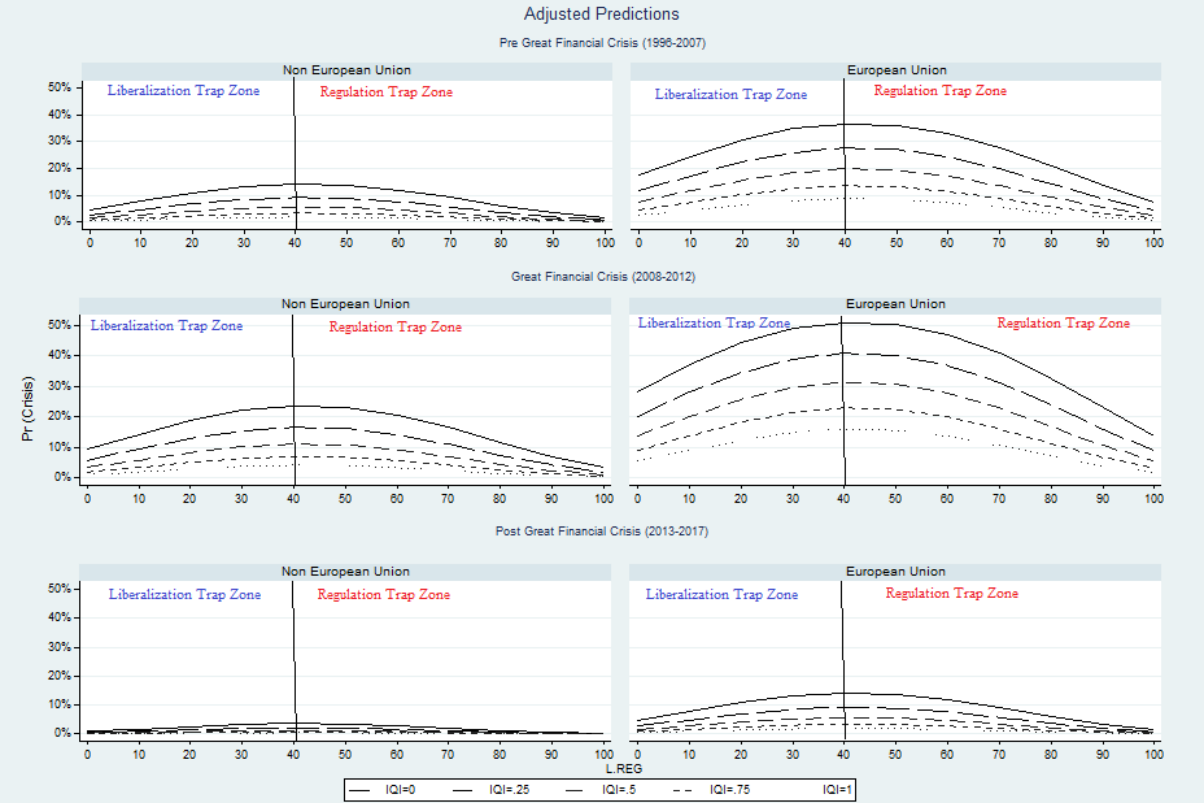
Note: the period is 1996-2017; the regulation index is computed as 100 – FFI, where FFI is the Financial Freedom Index. Multiple peaks suggest group heterogeneity.

Figure 2: Impact of regulation on the probability of a crisis under three scenarios.



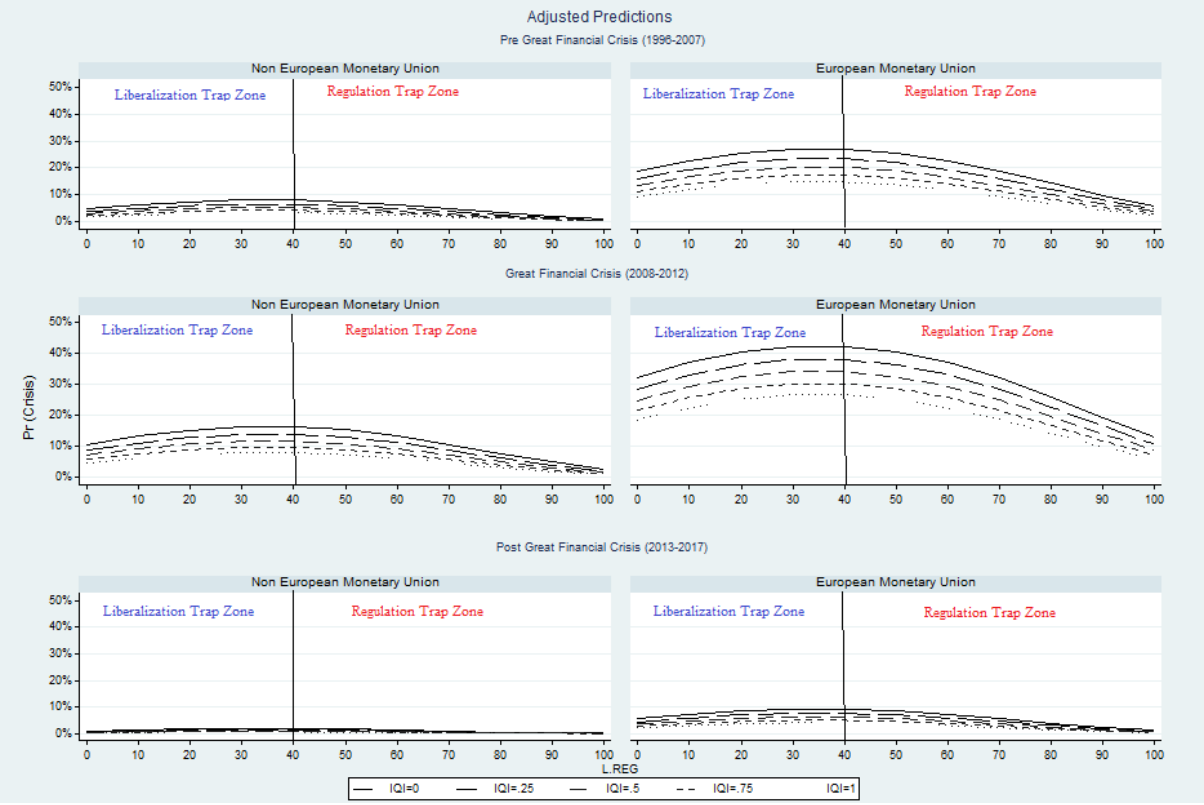
NOTES: $\frac{\partial P}{\partial q}$ is divided by 10,000 under market return scenario. Black, blue, and red curve draw respectively equations (12), (14) and (16). Scenarios are: market return scenario at low levels of q, financial liberalization at medium levels of q, and stringent regulation at high levels of q. This pattern implies an inverted U-shaped relationship between q and P.

Figure 3. Impact of regulation on the probability of a systemic banking crisis, adjusted for institutional quality. EU-vs-Non EU sub-samples by period



Notes: Period 1996-2017¸ *REG*=100-*FFI*, where *FFI=Financial Freedom Index* by Heritage Foundation; pre-crisis non-EU (top left), pre-crisis EU (top right), crisis non-EU (middle left), crisis EU (middle right), post-crisis non-EU (bottom left), and post-crisis EU (bottom right). *IQI* is set at 0 (dotted line), 0.25 (short-dash line), 0.5 (middle-dash line), 0.75 (long-dash line), and 1 (solid line). Graphs based on column 5 of Table 3.

Figure 4. Impact of regulation on the probability of a systemic banking crisis, adjusted for institutional quality. EURO-vs-Non EURO sub-samples by period



Notes: Period: 1996-2017; *REG*=100-*FFI,* where *FFI=Financial Freedom Index* by Heritage Foundation; pre-crisis non-EURO (top left), pre-crisis EURO (top right), crisis non-EURO (middle left), crisis EURO (middle right), post-crisis non-EURO (bottom left), and post crisis EURO (bottom right). *IQI* is set at 0 (dotted line), 0.25 (short-dash line), 0.5 (middle-dash line), 0.75 (long-dash line), and 1 (solid line). Graphs based on column 4 of Table 4.

APPENDIX A: Details on the theoretical model

The minimization of the portfolio risk by the representative bank is written as

$$\max_{\alpha}\{-\delta_P^2\}\ s.t.\ (1-q)[r_L+\alpha(r_H-r_L)]-\bar{r}\geq 0\ \ and\ \ \ G-\alpha\geq 0. \tag{A1}$$

Its Lagrangian function is:

$$\mathcal{L}(\alpha,\gamma,\lambda)=(1-q)^2[-\alpha^2(\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L)-2\alpha(\rho_{HL}\delta_H\delta_L-\delta_L^2)-\delta_L^2]$$
$$+\gamma\{(1-q)[r_L+\alpha(r_H-r_L)]-\bar{r}\}+\lambda[G-\alpha] \tag{A2}$$

and the Kuhn-Tucker conditions are:

$$\frac{\partial\mathcal{L}}{\partial\alpha}=(1-q)^2[-2\alpha(\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L)-2(\rho_{HL}\delta_H\delta_L-\delta_L^2)]+\gamma(r_H-r_L)(1-q)-\lambda\leq 0 \tag{A3}$$

$$\frac{\partial\mathcal{L}}{\partial\alpha}\alpha=\{(1-q)^2L(\alpha,\gamma,\lambda)-2(\rho_{HL}\delta_H\delta_L-\delta_L^2)]+\gamma(r_H-r_L)(1-q)-\lambda\}\alpha=0 \tag{A4}$$

$$\frac{\partial\mathcal{L}}{\partial\gamma}=[1+r_L+\alpha(r_H-r_L)](1-q)-(1+\bar{r})\geq 0 \tag{A5}$$

$$\frac{\partial\mathcal{L}}{\partial\gamma}\gamma=\{[r_L+\alpha(r_H-r_L)](1-q)-\bar{r}]\}\gamma=0 \tag{A6}$$

$$\frac{\partial\mathcal{L}}{\partial\lambda}=G-\alpha\geq 0 \tag{A7}$$

$$\frac{\partial\mathcal{L}}{\partial\lambda}\lambda=[G-\alpha]\lambda=0 \tag{A8}$$

$$\alpha\geq 0,\gamma\geq 0,\lambda\geq 0 \tag{A9}$$

The system (A3)-(A9) has eight possible solutions:

1) Under financial liberalization ($\gamma=0$, $\lambda=0$, and $\alpha>0$),

$$\hat{\alpha}=\frac{\delta_L^2-\rho_{HL}\delta_H\delta_L}{\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L} \tag{A10}$$

and $0\leq\hat{\alpha}\leq 1$ if $\rho_{HL}<\frac{\delta_L}{\delta_H}$.

2) Under a binding market-imposed constraint ($\gamma>0$, $\lambda=0$, and $\alpha>0$),

$$\hat{\alpha}_\gamma=\frac{(1+\bar{r})-(1+r_L)(1-q)}{(r_H-r_L)(1-q)}=\frac{2(1-q)(\delta_L^2-\rho_{HL}\delta_H\delta_L)+\gamma(r_H-r_L)}{2(1-q)(\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L)} \tag{A11}$$

and $0\leq\alpha\leq 1$ if $-\frac{2(1-q)}{r_H-r_L}(\delta_L^2-\rho_{HL}\delta_H\delta_L)\leq\gamma\leq\frac{2(1-q)}{r_H-r_L}(\delta_H^2-\rho_{HL}\delta_H\delta_L)$.

3) Under a binding regulatory constraint ($\gamma=0$, $\lambda>0$, and $\alpha>0$),

$$\hat{\alpha}_\lambda=G=\frac{2(1-q)(\delta_L^2-\rho_{HL}\delta_H\delta_L)-\lambda}{2(1-q)(\delta_H^2+\delta_L^2-2\rho_{HL}\delta_H\delta_L)} \tag{A12}$$

and $0\leq\alpha\leq 1$ if $-2(1-q)^2(\delta_H^2-\rho_{HL}\delta_H\delta_L)\leq\gamma\leq 2(1-q)^2(\delta_L^2-\rho_{HL}\delta_H\delta_L)$.

4) When both constraints are binding ($\gamma>0$, $\lambda>0$, $\alpha>0$), then both the constraints are binding. $\hat{\alpha}_{\gamma\lambda}=G=\frac{(1+\bar{r})-(1+r_L)(1-q)}{(r_H-r_L)(1-q)}$ is a possible solution, but the optimization degenerates to a single solution point and the bank is not free to choose α.

5-8) In the four remaining cases ($\alpha=0$ with $\gamma=0$, $\lambda=0$; or $\gamma>0$, $\lambda=0$; or $\gamma=0$, $\lambda>0$; or $\gamma>0$, $\lambda>0$), the solution is a narrow bank holding only low-risk assets.

In a financial liberalization regime, the regulator maximizes

$$\max_q V(q) = \max_q (1-q)\left\{1+\beta[1+r_L+\frac{\delta_L^2-\rho_{HL}\delta_H\delta_L}{\delta_H^2+\alpha\delta_L^2-2\rho_{HL}\delta_H\delta_L}(r_H-r_L)](1-PQ)\right\} \quad \text{(A13)}$$

From the FOC

$$\frac{\partial V(q)}{\partial q} = -\{1+k[1-PQ]\} - (1-q)kPQ_G'G_q' = 0 \quad \text{(A14)}$$

with $k = \beta\left[1+r_L+\frac{\delta_L^2-\rho_{HL}\delta_H\delta_L}{\delta_H^2+\alpha\delta_L^2-2\rho_{HL}\delta_H\delta_L}(r_H-r_L)\right] > 0$, we obtain:

$$P = \frac{1+k}{k}\cdot\frac{1}{[Q-(1-q)Q_G'G_q']}. \quad \text{(A15)}$$

Note that $0 < P \leq 1$ if $Q-(1-q)Q_G'G_q' \geq \frac{1+k}{k} > 0$.

Under a binding market-imposed constraint, the regulator maximizes

$$\max_q V(q) = \max_q (1-q)\left\{1+\beta\left[1+r_L+\frac{(1+\bar{r})-(1+r_L)(1-q)}{(r_H-r_L)(1-q)}(r_H-r_L)\right](1-PQ)\right\}. \quad \text{(A16)}$$

From the FOC, $\frac{\partial V(q)}{\partial q} = -1-\beta(1+\bar{r})PQ_G'G_q' = 0$, we extract:

$$P = -\frac{1}{\beta(1+\bar{r})Q_G'G_q'}. \quad \text{(A17)}$$

Note that $0 < P < 1$ if $-\frac{1}{\beta(1+\bar{r})} < Q_G'G_q'$.

Under a binding regulatory constraint, the regulator maximizes

$$\max_q V(q) = \max_q (1-q)\{1+\beta[1+r_L+G(r_H-r_L)](1-PQ)\} \quad \text{(A18)}$$

From the FOC,

$$\frac{\partial V(q)}{\partial q} = -1+A\left[-1-PQ_G'G_q'+P(Q+qQ_G'G_q'\right]$$
$$+B\left[G_q'-G-qG_q'-PG_q'G-PQG_q'+PQG+qPQ_G'G_q'G+qPQG_q'\right] = 0 \quad \text{(A19)}$$

with $A = \beta(1+r_L)$ and $B = \beta(r_H-r_L)$, we extract

$$P = \frac{1+A+B\left(G-(1-q)G_q'\right)}{A\left(Q-(1-q)Q_G'G_q'\right)+B\left[QG-(1-q)\left(Q_G'G_q'G+QG_q'\right)\right]} = \frac{N(q)}{D(q)}. \quad \text{(A20)}$$

$P \geq 0$ unambiguously and less than one, provides

$$1+A+B\left(G-(1-q)G_q'\right) \leq A\left(Q-(1-q)Q_G'G_q'\right)+B\left[QG-(1-q)\left(Q_G'G_q'G+QG_q'\right)\right]. \quad \text{(A21)}$$

APPENDIX B: Details on variables

Table B.1: List of variables, definitions, and sources

Variable	Definition	Source
CRISIS	Dummy variable for the presence of a systemic banking crisis (1=banking crisis, 0=none)	Laeven, L., Valencia, F. (2018). Systemic Banking Crises Revisited. *IMF Working Paper*, WP/18/206.
ALL_CRISIS	Dummy variable for the presence of a systemic banking crisis and/or a sovereign debt default/restructuring (1=crisis, 0=none)	Authors elaboration from Laeven and Valencia (2018)
FFI	Financial Freedom Index (0=repressive, … 100=negligible government interference)	The Heritage Foundation (2019)
IQI	Institutional Quality Index, average of the previous six institutional variables	Authors elaboration from Worldwide Governance Indicators. World Bank (2018)
INF	Inflation, consumer price index (annual %)	World Development Indicator. World Bank (2019)
CAB	Current account balance (% of GDP)	World Development Indicator. World Bank (2019)
GDPpc	GDP per capita in current US$ (divided by 10000)	Authors elaboration from World Development Indicator. World Bank (2019)
GINI	Income inequality index	Lahoti, R., Jayadev, A., Reddy, S. (2016). The Global Consumption and Income Project (GCIP): An Overview. *Journal of Globalization and* Development, 7(1):61-108.
TOP5	Assets of the five domestic largest banks as a share of total domestic commercial banking assets	Global Financial Development Database (GFDD). World Bank (2018)
BAS	Total assets held by deposit money banks as a share of GDP	Global Financial Development Database (GFDD). World Bank (2018)
MUSLIM	Percentage of Muslims on total population in 1980	La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1999). The Quality of Government. *Journal of Law, Economics and Organization, 15(1),* 222-279.
ENGLISH	Dummy variable: 1=British Common Law; 0=otherwise	La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1999). The Quality of Government. *Journal of Law, Economics and Organization, 15(1),* 222-279.
EU	Dummy variable: 1=European Union member; 0=otherwise	Authors elaboration
EURO	Dummy variable: 1=eurozone member; 0=otherwise	Authors elaboration
PERIOD	Dummy variable: 1=year>2007; 0=otherwise	Authors elaboration
TBW	Time required to build a warehouse (days)	Doing Business Project. World Bank (2020)
PE	Public employment over total employment (in percentage)	Authors elaboration from International Labour Organization (2020) statistics
LD	Liberal democracy index[34]	V-Dem Dataset. Variaties of Democracy project (2019)
DD	Deliberative democracy index[35]	V-Dem Dataset. Variaties of Democracy project (2019)

[34] The Liberal Democracy Index captures the importance of protecting individual and minority rights against the tyranny of the state and the majority. It considers constitutionally protected civil liberties, strong rule of law, an independent judiciary, and effective checks and balances that, together, limit the exercise of executive power.

[35] The Deliberative Democracy Index captures how much the common good motivates political decisions as contrasted with emotional appeals, solidary attachments, parochial interests, or coercion. It considers the respectful dialogue among informed and competent participants who are open to persuasion at all levels of the decision-making process.

Table B.2: Details on the Financial Freedom Index

Value	Definition
100	**Negligible government interference**.
90	**Minimal government interference**. Regulation of financial institutions is minimal but may extend beyond enforcing contractual obligations and preventing fraud.
80	Nominal government interference. Government ownership of financial institutions is a small share of overall sector assets. Financial institutions face almost no restrictions on their ability to offer financial services.
70	**Limited government interference**. Credit allocation is influenced by the government, and private allocation of credit faces almost no restrictions. Government ownership of financial institutions is sizeable. Foreign financial institutions are subject to few restrictions.
60	**Significant government interference**. The central bank is not fully independent, its supervision and regulation of financial institutions are somewhat burdensome, and its ability to enforce contracts and prevent fraud is insufficient. The government exercises active ownership and control of financial institutions with a significant share of overall sector assets. The ability of financial institutions to offer financial services is subject to some restrictions.
50	**Considerable government interference**. Credit allocation is significantly influenced by the government, and private allocation of credit faces significant barriers. The ability of financial institutions to offer financial services is subject to significant restrictions. Foreign financial institutions are subject to some restrictions.
40	**Strong government interference**. The central bank is subject to government influence, its supervision of financial institutions is heavy-handed, and its ability to enforce contracts and prevent fraud is weak. The government exercises active ownership and control of financial institutions with a large minority share of overall sector assets.
30	**Extensive government interference**. Credit allocation is extensively influenced by the government. The government owns or controls a majority of financial institutions or is in a dominant position. Financial institutions are heavily restricted, and bank formation faces significant barriers. Foreign financial institutions are subject to significant restrictions.
20	**Heavy government interference**. The central bank is not independent, and its supervision of financial institutions is repressive. Foreign financial institutions are discouraged or highly constrained.
10	**Near repressive**. Credit allocation is controlled by the government. Bank formation is restricted. Foreign financial institutions are prohibited.
0	**Repressive**. Supervision and regulation are designed to prevent private financial institutions. Private financial institutions are prohibited.

Source: https://www.heritage.org/index/financial-freedom.

APPENDIX C: The regulation index *REG* and alternative measures of regulation

Table C.1: Alternative measures of regulation.

Variable	Definition	Source
Financial liberalization index (Abiad et al.)	It ranges from 0 to 21, where higher values denote a more liberal financial sector and covers 91 countries up to 2005.	Abiad, A., Detragiache, E., Tressel, T. (2010). A New Database of Financial Reforms. *IMF Staff Papers*, 57(2):281-303
Financial regulation index (Barth et al.)	It covers 180 countries for the period 1999- 2011. It is obtained by aggregating four indexes (Capital Regulatory Index, Overall Financial Conglomerates Restrictiveness, Entry into Banking Requirements and Overall Restrictions on Banking Activities)	Barth, J.R., Caprio, G., Levine, R. (2013). Bank regulation and supervision in 180 countries from 1999 to 2011. Journal of Financial Economic Policy, 5(2):111-219.
Credit market regulation (Hiel)	It measures interest rate controls, ranging from 0 to 10 where higher values denote a less stringent regulation. It is available up until 2007 for OECD countries.	Prados De La Escosura, L. (2016). Economic freedom in the long run: evidence from OECD countries (1850–2007). The Economic History Review, 69(2), 435-468.
Financial Institution-Targeted Instruments index (Cerutti et al. (a))	It measures if regulation requires banks to hold more loan-loss provisions during upturns, requires banks to hold more capital during upturns, limits banks from exceeding a fixed minimum leverage ratio, requires Systemically Important Financial Institutions to hold a higher capital level than other financial institutions, limits the fraction of liabilities held by the banking sector or by individual banks, limits the fraction of assets held by a limited number of borrowers, imposes reserve requirements, taxes revenues of financial institutions, reduces vulnerability to foreign-currency risks and limits credit growth directly. It ranges between 0 and 10 and is available from 2000 to 2013 for 119 countries.	Cerutti, E., Claessens, S., & Laeven, L. (2017). The use and effectiveness of macroprudential policies: New evidence. Journal of Financial Stability, 28, 203-224.
Macroprudential Index (Cerutti et al. (b))	In addition to the definition of the Financial Institution-Targeted Instruments index it considers whether regulation constrains household indebtedness by enforcing or encouraging a limit (Debt-to-Income ratio) and constrains highly levered mortgage downpayments by enforcing or encouraging a limit or by determining regulatory risk weights (Loan-to-Value cap). It ranges between 0 and 12 and is available for 119 countries in the period 2000-2013.	Cerutti, E., Claessens, S., & Laeven, L. (2017). The use and effectiveness of macroprudential policies: New evidence. Journal of Financial Stability, 28, 203-224.
Average commercial credits restrictions (Fernández et al. (a))	It evaluates the presence of rules and regulations for international transactions for operations directly linked with international trade or with the rendering of international services. It is available for 100 countries over the period 1995 to 2013 and ranges between 0 and 1.	Fernández, A., Klein, M. W., Rebucci, A., Schindler, M., & Uribe, M. (2016). Capital control measures: A new dataset. IMF Economic Review, 64(3), 548-574.
Average financial credits restrictions (Fernández et al. (b))	It evaluates the presence of rules and regulations for international transactions for financial credit and credits other than commercial credits granted by all residents, including banks, to nonresidents, or vice versa. It is available for 100 countries over the period 1995 to 2013 and ranges between 0 and 1.	Fernández, A., Klein, M. W., Rebucci, A., Schindler, M., & Uribe, M. (2016). Capital control measures: A new dataset. IMF Economic Review, 64(3), 548-574.
Average Reserve requirement index (Federico et al.)	It measures the restrictiveness of legal reserve requirements. It is available for 65 countries between 1970 and 2019. It ranges between 0 (lower requirements) and 1 (higher requirements).	Federico, P., Vegh, C. A., & Vuletin, G. (2014). Reserve requirement policy over the business cycle (No. w20612). National Bureau of Economic Research.

Table C.2: Correlation between *REG* and alternative indexes of regulation.

Index	Correlation with REG	Description	Coverage	
			Period	Countries
REG	**1.000**	Comprehensive index of regulation	1995-2020	186
Abiad et al.	**0.635*****	Financial liberalization index	1970-2005	91
Barth et al.	**0.226*****	Comprehensive measure of financial regulation	1999-2011	180
Hiel	**0.313*****	Credit Market Regulation index	1850-2007	21
Federico et al.	**0.249*****	Average reserve requirements index	1970-2019	65
Cerutti et al.	**0.073*****	Macroprudential Index	2000-2013	119
Fernández et al. (a)	**0.491*****	Average Commercial Credits Restrictions index	1995-2013	100
Fernández et al. (b)	**0.443*****	Average Financial Credits Restrictions	1995-2013	100

NOTES: Abiad et al. is the rescaled financial liberalization index by Abiad et al. (2010). Barth et al. is the comprehensive measure of financial regulation by Barth et al. (2013). Hiel is the rescaled Hiel Credit Market Regulation index by Prados De La Escosura (2016). Federico et al. is the average reserve requirements index by Federico et al. (2014). Cerutti et al. is the Macroprudential Index by Cerutti et al. (2017). Fernández et al. (a) is the Average commercial Credits Restrictions index by Fernández et al. (2016). Fernández et al. (b) is the Average Financial Credits Restrictions index by Fernández et al. (2016). The indexes are rescaled if their definitions are such that higher values imply a less stringent regulation, for purposes of comparability with REG. See Table C.2 for complete definition and sources.

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