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Dimensions of Bank Capital Regulation: A Cross-Country Analysis*

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Abstract

This paper identifies the main dimensions of capital regulation. We use survey data from 142 countries from the World Bank's (2013) database covering various aspects of bank regulation. Using multiple explorative factor analysis, we identify two main dimensions of capital regulation: complexity of capital regulation and stringency of capital regulation. We show that even countries with a common legal and regulatory framework differ substantially in terms of capital regulation. For example, the level of stringency of capital regulation varies substantially across the EU countries, potentially distorting the level playing field.

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1. Introduction

In the wake of the global financial crisis and the euro area debt crisis, bank capital regulation is changing as regulators strive to establish a more unified regulatory framework in banking. Setting uniform capital regulation around the globe appears to be a daunting task that has faced both practical difficulties as well as opposition from the financial industry. A tempting question is whether the efforts by regulators and policymakers are warranted, given the current state of affairs in bank capital regulation. Two aspects of this question demand further scrutiny. First, if implementation of the outgoing (Basel I and Basel II) accords has resulted in a significant diversity of bank capital standards across different countries, this could undermine the level-playing-field objective that bank capital standards are trying to address. Second, documentation of the current state of affairs in bank capital standards across countries is valuable in its own right because any future change in standards that may occur as a result of new regulations (i.e., Basel III) can be measured against this benchmark.

This paper addresses the question of the "current state of affairs" by analyzing different dimensions of bank capital regulation across countries. We identify the two most pronounced dimensions of capital regulation: complexity and stringency of bank capital regulation. We show that substantial differences in bank capital regulation exist between countries along these two dimensions despite the earlier streamlining efforts (Basel I and II) by regulators and policymakers. Moreover, we find that the dimensions of bank capital regulation vary substantially even between countries with largely common legal and regulatory frameworks, such as the EU countries. This may have distorted capital flows within the EU single capital market in the past and induced some of the excessive risk-taking behind the pre-crisis lending booms in several EU economies.

We analyze the "current state of affairs" of bank capital regulation based on the most recent, yet underexplored, World Bank (2013) database. It covers a wide set of characteristics of the regulatory and supervisory frameworks across 142 countries in 2010 and 2011. In addition to using the most recent data, the innovation of our approach is in focusing on one aspect of bank regulation—in particular, on capital regulation—and analyzing it in greater detail. We are able to adopt this more focused approach compared to

earlier studies by exploiting a substantially higher number of variables in the new version of the database in comparison to its predecessors.

Our analytical tool is constructed through a two-step approach. The first step uses exploratory factor analysis to identify the most pronounced dimensions of capital regulation based on quantitative and qualitative variables of bank capital regulation from the World Bank database. In order to avoid dropping observations (countries) due to missing values and to fully explore the cross-sectional heterogeneity in the dataset, we use the recently developed multiple imputations method to substitute predicted values for missing values. In the second step, we utilize graphical and cluster analysis to map observations (countries) and to determine the main groupings of countries according to the identified dimensions of capital regulation.

We are not aware of other studies that use exploratory factor analysis combined with cluster and graphical analysis to discern dimensions of capital regulation in banking and analyze cross-country differences. We acknowledge that, by using imputation methods, we are necessarily making a compromise in the accuracy of our results; however, the key advantage is that we can fully map all 142 countries in our dataset. We specifically address the question of accuracy by excluding those bank capital regulation variables with the most missing values and graphically analyzing standard errors of the main dimensions of capital regulation due to imputations.

The rest of the article is structured as follows. Section 2 reviews the rationale for bank capital regulation and places our study in the context of existing research of bank capital standards. Section 3 describes the descriptive statistics of our dataset. Section 4 presents the methodology that we employ; in particular, the imputation method and the exploratory factor analysis. Section 5 describes the analysis and results. Section 6 concludes the article.

2. The rationale for bank capital regulation

Motivation for our study stems from the recent convergence of academic opinion towards an agreement that banks should operate with higher levels and better quality of capital and that capital regulation should aim towards these goals while minimizing the opportunities for regulatory arbitrage (Anat Admati et al. 2011, Matej Marinč, Mojmir Mrak, and Vasja Rant 2012).

Banking literature usually gives two arguments for bank capital regulation. First, having higher capital mitigates negative externalities due to systemic risk (see Viral V. Acharya, Hamid Mehran, and Anjan V. Thakor 2012). Second, agency problems (between a bank and its depositors due to information asymmetries, deposit insurance, and other safety nets) are exacerbated if a bank is undercapitalized (see, e.g., Paul S. Calem and Rafael Rob 1999). The common feature of both arguments is that banks are not able to properly internalize the externalities of their behavior on debt holders (including depositors), other banks, and the public at large, which become residual claimants in the case of bank failure.

Bank capital acts as a buffer to cushion potential future bank losses and to minimize negative spillovers to other stakeholders apart from bank owners (see Abel Elizalde and Rafael Repullo 2007; Allen N. Berger and Christa H. S. Bouwman forthcoming). In addition, bank capital acts as an incentive device. Because bank owners of a well-capitalized bank have much to lose, they avoid excessive risk taking and properly account for risk. Bank capital regulation can be used to better align banks' private incentives with those of the general public.

Both of these alternative views of bank capital (buffer vs. incentive device) can be seen as distinct possible objectives for bank capital regulation and point to three important insights. First, the quantity of capital matters. Because bank owners and managers perceive private advantages in maintaining highly leveraged capital structures, they are not likely to increase their capital ratios willingly. This implies a strong role for regulation in determining the stringency of capital requirements.

Second, the quality of capital matters as well. Because the disciplining role of equity is the greatest for those forms of capital that stand first to lose in the case of capital impairments, capital requirements should predominantly focus on demanding more high-quality capital. In this respect, contingent capital, such as hybrid securities that convert to common equity and subordinate debt, may be inferior to common equity. In the case of a systemic crisis, the role of high-quality capital increases even further. Ex-ante anticipation of implicit government guarantees may render contingent capital (and/or subordinate debt) ineffective with respect to market discipline, which is its purported raison d'être. Instead, its true motivation may well be in the

banks' desire to reap the tax-based government subsidies. This again points to the need for high quality of bank capital.

Third, risk-based capital regulation is a double-edged sword. On the one hand, it may help to align private and social incentives in banking (see, e.g., Rafael Repullo 2004). On the other hand, it may also be an important source of regulatory arbitrage and, in combination with diverse forms of capital, increase the complexity of capital regulation. The problem is that the actual nature of risk is dynamic and constantly shifting (Arnoud W. A. Boot and Matej Marinč 2008, Matej Marinč 2013), and that neither the banks nor the regulators have perfect foresight. If capital standards are measured exclusively on a risk-weighted basis, banks can try to raise their equity returns by loading up on underpriced risks that do not carry adequate risk weights in the regulatory framework. In a similar fashion, banks may become eager to liquidate risky assets once the risks are recognized in the regulatory framework. The global financial crisis has provided ample evidence of capital arbitrage. Viral V. Acharya and Philipp Schnabl (2009) even see capital arbitrage as one of the culprits of the global financial crisis.

The use of banks' internal risk assessment models as well as reliance on external credit ratings can further aggravate the problems of regulatory arbitrage as well as increase the complexity of capital regulation. This points to a tradeoff between a risk-based and a more rudimentary approach to bank capital standards and has led some researchers to suggest that a simple and sufficiently high capital requirement on an unweighted basis (i.e. a "leverage ratio") might actually do a better job at containing risks and keeping the banking system well capitalized and safe than an intricate network of risk-weighted requirements and calculation methods (Charles Goodhart 2013).

The discussion above points to at least two possible dimensions of bank capital regulation: stringency and complexity. Stringency is related to the issues pertaining to the quantity of capital, whereas complexity covers the elements on the assets side of banks' balance sheets (i.e., the intricate calculation methods of risk-weighted assets) as well as the elements on the liabilities side (i.e., diverse "forms" and "tiers" of "capital").

Research on financial intermediation has diverse views about the role of unification of bank regulation along the above mentioned dimensions. A unified regulatory framework creates a level playing field, where banks are bound by the same rules. Ideally, common regulation would prevent

regulatory arbitrage in which banks exploit the loopholes in local regulation to gain an unfair competitive advantage over banks bound by different regulatory rules. However, regulatory frameworks with different capital requirements may be needed in substantially diverse banking systems (see Viral Acharya 2003, Kenneth J. Kopecky and David VanHoose 2012).

In practice, international streamlining of bank capital regulation started in 1988 with the creation of the Basel I capital accord, which introduced the basic "one-size-fits-all" risk-weighted approach to capital adequacy, and continued in 2004 with the Basel II capital accord, which increased customization and reliance of bank capital standards on banks' risk taking and market discipline. Starting in 2011, the Basel III capital accord marks a substantial policy shift towards a more stringent system of bank capital standards in order to preserve financial stability and prevent future financial crises (Basel Committee on Banking Supervision 2012).

As a reflection of the increasing international interest in bank capital regulation, several studies analyzing its characteristics (Barth, Caprio, and Levine 2003, Barth, Caprio, and Levine 2004, Barth, Caprio, and Levine 2008, 2013) were performed using older versions of the World Bank (2008) database. Fotios Pasiouras, Chrysovalantis Gaganis, and Constantin Zopounidis (2006) form several indexes describing different dimensions of bank regulation. They confirm that bank credit ratings are affected by several characteristics of bank regulation, such as capital requirements, restrictions on bank activities, and official disciplinary power. Jeroen Klomp and Jakob de Haan (2012) find that banking regulation and supervision affect high-risk banks but not low-risk banks. Manthos D. Delis, Iftekhar Hasan, and Pantelis Kazakis (2012) show that stricter capital requirements may have a negative effect on credit availability and may increase income inequality.

3. Data description

We begin our analysis by describing the summary statistics of the data. We utilize the latest survey by the World Bank on "Bank regulation and supervision" (World Bank, 2013), first used by James R. Barth, Gerard Caprio Jr., and Ross Levine (2012) and Martin Čihák et al. (2012). The survey follows previous surveys that cover a wide set of characteristics of regulatory and supervisory frameworks across countries in 1999, 2002, and 2005/2006. The survey contains the most recent data from 2010/2011. It

covers 142 countries and 791 different variables that describe several dimensions of bank regulation. These include entry into banking, ownership, capital, activities, external auditing requirements, bank governance, liquidity and diversification requirements, depositor (savings) protection schemes, asset classification, loss provisioning and write-offs, accounting and information disclosure, bank insolvency procedures, supervision, banking sector characteristics, and consumer protection.

We narrow the wide scope of the survey to analyze the dimensions of capital regulation. To do this, we select 59 out of 791 variables in the database that deal more narrowly with capital regulation. In the World Bank (2013) database, quantitative measures of capital regulation (e.g., the level of minimum capital requirements across countries) are complemented by a wide range of qualitative issues. These relate to such issues as the quality of capital, regulatory powers with respect to capital regulation, and accounting rules that apply to bank capital, all of which are gauged by a wide range of questions in the database. Several influential studies analyze the behavior of banks in setting their capital ratios (Juan Ayuso, Daniel Perez, and Jesus Saurina 2004, Allen N. Berger et al. 2008, Elijah Brewer, George G. Kaufman, and Larry D. Wall 2008, Mark J. Flannery and Kasturi P. Rangan 2008, Reint Gropp and Florian Heider 2011, Christoph Memmel and Peter Raupach 2010), but they mostly focus on quantitative aspects of capital regulation and rely on a minimum capital requirements ratio. Another advantage of our study is therefore also the inclusion of many qualitative issues.

To prevent a multicollinearity problem in imputation analysis, we further narrow our focus and select 40 questions. In particular, we drop 19 questions with the most missing variables, such that all the remaining variables have at least 89 observations. The summary statistics of the selected questions are presented in Table 1. The first and second column of Table 1 present the identifying names of variables and their pertaining questions. Several variables are binary in nature because they originate from yes/no questions. If a question has a yes/no answer, yes is coded as 1 and no as 0. The third column shows the number of observations. Note that all variables except two have missing values. The third column of Table 1 shows the mean values of questions with standard deviation in the fourth column. The fifth and sixth columns show minimum and maximum values of variables. The

seventh and eighth columns show two factors from factor analysis (see Section 3.2 for further explanation).

INSERT TABLE 1

The descriptive statistics from Table 1 reflect the basic description of capital regulation around the world and therefore deserve special attention. Variables 1–4 describe the limitations on the sources of funds to be used as bank capital. In particular, the nature of the banking business determines the minimum capital entry requirements in 51% of countries (Variable 1), the sources of funds to be used as capital are verified by the regulator/supervisor in 94% of countries (Variable 2), bank capital can be injected with assets other than cash or government securities in 33% of countries (Variable 3), and the initial capital contributions by prospective shareholders can be in the form of borrowed funds in 33% of countries (Variable 4).

Variables 5–33 describe the main characteristics of capital adequacy regimes including decomposition of bank regulatory capital. In particular, 56% of countries used Basel II as a regulatory capital adequacy regime (Variable 5). Fifteen percent of countries employed leverage ratio in their regulatory capital adequacy regime (Variable 6). Seventy-nine percent of countries accounted for market risk (Variable 7) and 38% of countries accounted for risks other than credit, market or operational risks in their minimum capital requirements (Variable 8). The average minimum required risk-based regulatory capital ratio in 2009 was 9% (Variable 9), whereas the average actual risk-based capital ratio was 18% (Variable 10). The average actual Tier 1 capital ratio in 2008 was 15% (Variable 11).

In 56% of countries, banks are required to perform an internal assessment of their capital adequacy against their economic capital (Variable 13). In 88% of countries, agencies have power to require additional capital above the minimum required capital (Variable 14). Thirty-eight percent of countries apply different risk weights than those in Basel I for corporate, mortgage, consumer, and government loans (Variable 15). Legally allowed parts of regulatory capital are: common equity in 84% of countries (Variable 17), Tier 1 capital in 94% of countries (Variable 18), Tier 2 capital in 88% of countries (Variable 19), Tier 3 capital in 36% of countries (Variable 20), and others in 10% of countries (Variable 21). Variables 22–33 further explain the allowed ingredients of regulatory capital, including Tier 1 and Tier 2 capital.

Variables 34–40 further describe capital regulatory frameworks, including the relationship with market disclosure, supervisory powers, and insolvency procedures. In particular, lending to a single borrower is limited to 24% of a bank's regulatory capital on average (Variable 34). In 79% of countries, banks disclose their regulatory capital and capital adequacy ratios to the public (Variable 35). In 67% of countries, the supervisory agency can use forbearance (Variable 36). In 94% of countries, the supervisory agency can suspend dividends to bank shareholders (Variable 37). An early intervention framework with an automatic trigger exists in 86% of countries (Variable 38). A breach of minimum regulatory capital adequacy ratio is used for initiating automatic actions in 94% of countries (Variable 39). Seventy-nine percent of countries use bank leverage ratios in their assessment of systemic risk (Variable 40). Table 2 presents a correlation matrix of variables together with the statistical significance of correlation coefficients.

INSERT TABLE 2

These descriptive statistics demonstrate that capital regulation is far from being one-dimensional. In addition to quantitative aspects such as the level of capital requirements, capital regulation is defined by an entire range of qualitative aspects that pertain to the infusion of capital in a bank, the decomposition of bank capital, and the relationship between bank capital, supervisory powers, market disclosure, and insolvency proceedings. Although it is true that the minimum required risk-based regulatory capital does not fall below 8% as prescribed by the Basel accord, the variability of quantitative and qualitative aspects of capital regulation between countries is substantial.

4. Methodology

4.1. Imputation method: multivariate normal regression

Before proceeding to identify the dimensions of bank capital regulation, it is necessary to address the problem of missing values because almost all variables from the World Bank (2013) database contain missing variables. Listwise elimination of observations (i.e., countries) with missing values creates several problems. First, information present in non-missing values of the deleted observations is lost, which leads to lower effectiveness of the estimation. Second, the sample size shrinks substantially with listwise

elimination, creating the potential for biased estimates. Third, comparison between countries with as little as one missing observation is no longer possible.

Several imputation methods have been developed to mitigate the problems of missing data (Donald B. Rubin 1976). We employ multiple imputations to create imputed datasets. In particular, we apply the Bayesian iterative Markov chain Monte Carlo (MCMC) procedure to generate imputed values through data augmentation using multivariate normal regression. We follow the lead of Roderick J. A. Little and Donald B. Rubin (2002) and Joseph L. Schafer (1997). The iterative MCMC procedure works by replacing missing data with draws from the predictive distribution of the missing data constructed from the observed data. In particular, the iteration process through a data augmentation procedure is used and the imputation is performed after the iteration process reaches a stationary distribution. Schafer (1997) argues that the MCMC procedure is also advocated for data that include categorical variables.

The correlation matrix converges after 110 iterations. The imputed correlation matrix was used as a basis for the explorative factor analysis. In addition to the matrix of Pearson correlation coefficients, we also performed factor analysis based on the matrix of tetrachoric, polychoric, and polyserial correlation coefficients (Ulf Olsson, 1979). Despite the substantial increase in computational complexity, the results were qualitatively unchanged.

4.2. Factor analysis

Having addressed the problem of missing values, we use factor analysis to identify the main dimensions that describe capital regulation across countries. Factor analysis is a statistical method that reduces the number of variables by describing the variability among observed variables through the unobserved latent variables called factors (see, e.g., Ian T. Jolliffe 2002 and Jushan Bai and Serena Ng 2008).

We applied the principal factor method with orthogonal, varimax rotation method (Henry F. Kaiser 1958). This method produces completely independent factors (with no correlation between factors). We also applied an oblique promax rotation method that allows correlation between factors. However, the correlation between factors is −0.1171, which is below the cutoff point of 0.32 that would warrant oblique rotation to be applied due to

greater than 10% overlap in variance among factors (Barbara G. Tabachnick and Linda S. Fidell 2007, p. 646).

In order to determine the optimal number of common factors, we performed a parallel analysis, first suggested by John L. Horn (1965); see also James C. Hayton, David G. Allen, and Vida Scarpello (2004). According to Horn (1965), the optimal number of factors corresponds to the number of factors that have eigenvalues above the ones predicted by the parallel analysis. In Figures 1 and 2, Horn's (1965) parallel analysis is performed on both the unimputed and the imputed dataset, respectively. The eigenvalues of the first two factors in both figures are above the eigenvalues as predicted by the parallel analysis. This indicates that the first two factors should be chosen in the factor analysis. We estimate them using the imputed correlation matrix. These two estimated factors represent two distinct dimensions of bank capital regulation.

INSERT FIGURE 1 AND FIGURE 2

5. Analysis

5.1. Complexity and stringency of capital regulation

Before turning to the analysis of the cross-country differences in bank capital regulation, we provide an explanation of the meaning of both factors. This can be obtained from the factor loadings, which are presented in Table 1 (columns 8 and 9). Factor loadings are essentially correlation coefficients between the observed variables and the underlying factors as well as weights to compute the observed variables as a linear combination of the factors and an error term. Variables with higher absolute (positive or negative) values of factor loadings on a particular factor are more important in explaining the meaning of that factor, whereas variables with factor loadings close to zero are irrelevant. The combination of factor loadings for different observed variables can therefore be used to explain the meaning of both factors. Following Paul Kline (2002, p. 52), we have mainly focused in the interpretation of factors on the questions in which factor loadings are higher than 0.3.

Factor 1 has the highest factor loadings on variables pertaining to questions that can best be identified as describing the complexity of capital regulation (Factor 1 loadings are presented in column 8 of Table 1). In

particular, Factor 1 is *moderately to strongly positively* correlated (coefficients between 0.5 and 0.8) with the use of the Basel II capital framework (question 5), with inclusion of hybrid debt capital instruments as part of Tier 1 capital (question 22), with accounting for market risk in minimum capital requirements (question 7), with legally allowing Tier 3 capital as part of regulatory capital (question 20), and with the requirement that the banks perform an internal assessment of their capital adequacy against their economic capital (question 13); it is also *weakly to moderately positively* correlated (coefficients between 0.3 and 0.5), with the option that goodwill can be deducted from regulatory capital (question 29), with the option that minimum capital requirements account for other risks apart from market risk (question 8), with legally allowing Tier 2 capital as part of regulatory capital (question 19), with the possibility that capital can be injected into banks with assets other than cash or government securities (question 3), and with public disclosure of banks' regulatory capital and capital adequacy ratio (question 35). At the same time, Factor 1 is *weakly to moderately negatively* correlated (coefficients between −0.3 and −0.5) with quantitative measures of minimum risk-based capital requirements and actual capital adequacy (questions 9 through 11). As can be seen from the most pronounced factor loadings, Factor 1 can be interpreted as the factor that describes how complex capital regulation in a specific country is. Hence, Factor 1 is referred to as the Complexity of capital regulation (Complexity of CR).

Factor loadings of Factor 2 are shown in column 9 of Table 1. Factor 2 is *moderately positively* correlated (coefficients around 0.5) with inclusion of hybrid debt capital instruments and general provisions as part of Tier 2 (as opposed to Tier 1) capital (questions 25 and 26), with the ability of the supervisory agency to use forbearance (question 36), and with the use of a regulatory leverage ratio (question 16). It is also *moderately negatively* correlated (coefficients around −0.5) with the fraction of revaluation gains allowed as part of capital. Moreover, Factor 2 is *weakly to moderately positively* correlated (coefficients between 0.3 and 0.5) with quantitative measures of minimum risk-based capital requirements and actual capital adequacy (questions 9 and 10), with the requirement that the banks perform an internal assessment of their capital adequacy against their economic capital (question 13), and with deduction of unrealized losses in fair valued

exposures from regulatory capital (question 12). Factor 2 can be identified as the factor that describes how stringently capital regulation is applied in a specific country. Hence, Factor 2 is referred to as the Stringency of capital regulation (Stringency of CR).

5.2. Cross-country comparison

We now compare factor scores across countries. We are particularly interested in factor scores depending on various characteristics of countries such as income level, EU membership, and geographic position.

Figure 3 depicts the level of complexity and stringency of capital regulation across countries. It is clear that the dispersion of complexity and stringency is substantial across countries. Complexity of capital regulation ranges from −0.04 for Iraq to 1.53 for Italy. Stringency of capital regulation ranges from −0.49 for Mexico to 1.23 for Ireland. This points to the substantial variability in capital regulation across countries and suggests that there is a need for further unification.

In Figure 3 we have also divided countries into five groups, depending on the gross national income per capita: 1. high income, OECD, 2. high income, non-OECD, 3. upper middle income, 4. lower middle income, and 5. low income. The groups are represented by the size of the circular marker: the higher the income group, the bigger the size of the marker. Interestingly, Figure 3 shows that low-income countries are characterized by lower complexity of capital regulation, whereas high-income countries are characterized by higher complexity of capital regulation. In contrast, the variation of stringency of capital regulation is high between the countries within both income groups.

The observation that complexity of capital regulation is higher in high-income countries compared to low-income countries may be driven by financial development. That is, complexity of capital regulation seems to be higher in countries with highly developed financial systems. This corresponds to the notion that the developed financial systems need incentive-driven and market-based regulation (Hasan, Siddique, and Sun 2012), in which complexity of capital regulation is high. In contrast, less-developed financial systems need control-oriented direct regulation (Arnoud W. A. Boot, Todd T. Milbourn, and Silva Deželan 2001), with low complexity of capital regulation. Further research, however, is needed to

infer the causality of the positive relationship between the development of the financial system and complexity of capital regulation.

Figure 4 depicts factor scores across the EU and non-EU countries. We can see that the variation of complexity of capital regulation across the EU countries is low. The EU countries are jointly characterized by the high complexity of capital regulation. In contrast, the stringency of capital regulation varies substantially across the EU countries, with Austria and Slovakia having the lowest stringency of capital regulation (−0.13 and −0.07, respectively), and Ireland and Belgium having the highest stringency of capital regulation (1.22 and 0.90, respectively).

INSERT FIGURE 3 AND FIGURE 4

It can be concluded on the basis of Figure 4 that the unification of capital regulation in the EU has occurred along the dimension of complexity of capital regulation, but to a lesser extent along the dimension of stringency of capital regulation. This presents a potential cause for concern for two reasons. First, in order to harmonize capital regulation and establish a level playing field among banks, it seems important that stringency (and perhaps to a lesser extent also complexity) of capital regulation should be streamlined across the EU countries.

Second, broad agreement among academics has been reached recently that the level of capital in banking needs to be elevated to substantially higher levels in order to safeguard the stability of the financial system and to prevent future crises (Admati et al. 2011, Cars H. Hommes et al. 2012, David Miles, Jing Yang, and Gilberto Marcheggiano 2012). According to this view, EU countries with low levels of capital stringency are more susceptible to financial instability. The problem is that, if financial instability occurs in some countries, it may spread across the borders throughout the entire EU. This calls for harmonization to more stringent levels of capital regulation.

Figure 5 shows the factor scores and their standard errors due to the multiple imputation for countries in our sample. Standard errors due to the imputation of missing data are obtained by analyzing the differences of factors obtained by imputation through the Markov chain Monte Carlo (MCMC) procedure. If several variables are missing, standard error due to imputation is higher in comparison to the case where only a few (or none) of the variables are missing.

Figure 6 depicts the levels of complexity and stringency of capital regulation for countries of the former Yugoslavia that are contained in the World Bank (2013) database. The countries vary substantially in the levels of complexity and stringency of capital regulation. Bosnia-Herzegovina has the lowest complexity of capital regulation and Slovenia the highest. Serbia has the lowest stringency of capital regulation, whereas Montenegro has the highest.

INSERT FIGURE 5 AND FIGURE 6

The caveat is in place. The imputation method imputes the missing values with draws from the predictive distribution based on the observed data. This is a random process and the estimates obtained are not exact values. Standard errors that occur due to the imputation of missing data are presented by the intervals in Figures 5 and 6. However, the standard errors due to imputation are sufficiently small and the inference about the relative position of countries of the former Yugoslavia can still be made.

Figures 7 and 8 plot the dimensions of capital regulation on the world map. Specifically, Figure 7 plots the complexity of capital regulation across countries. Higher complexity is represented by more intense color. Figure 8 plots the stringency of capital regulation across countries. Higher stringency is represented by more intense color. A completely white area means that the country is not represented in the World Bank (2013) database. Figure 7 indicates that the complexity of capital regulation is quite uniform in geographically closely located countries. In contrast, Figure 8 shows that the stringency of capital regulation varies considerably more across geographically closely located countries (see, e.g., the EU area).

INSERT FIGURE 7 AND FIGURE 8

We also performed a cluster analysis using Ward's (1963) method (we also used the *k*-means partition clustering method, but the two clusters stay largely the same with some modifications on the borders between the two clusters). We used a dendrogram to identify two main clusters (Figure 9). In Figure 10, the complexity and stringency of capital regulation is shown for countries separated into two clusters as predicted by the cluster analysis. Two main clusters differ particularly with respect to the complexity of capital regulation. Interestingly, all EU countries and all highly developed countries are in the cluster with high complexity of capital regulation (compare Figures 3 and 4 with Figure 10).

INSERT FIGURE 9 AND FIGURE 10

The question left for further research is what has contributed to the pressing differences in capital regulation across countries. A detailed, qualitative analysis of the legislative process in a selected small number of countries may help us understand why the differences in capital regulation across countries persist. The macroeconomic development together with the characteristics of the banking system (see Kosta Josifidis, Radmila Dragutinović Mitrović and Olgica Ivančev 2012, Miroslav Verbič et al. 2011, João Sousa Andrade and Adelaide Duarte 2011, Ivan Ribnikar and Marko Košak 2011) may shape the bank regulatory landscape. The regulatory landscape together with the quality of the institutional environment may then influence stability of the financial system (see Angelos A. Antzoulatos 2012, Phillip Anthony O'Hara 2012 and 2013).

6. Conclusions

This paper empirically reviews the dimensions of capital regulation across countries. Using exploratory factor analysis, it identifies two main dimensions: complexity and stringency of capital regulation.

We show that countries differ substantially with respect to both complexity and stringency of capital regulation. Although similar levels of complexity correspond to similar levels of development (which also include financial development) and geographical proximity, differences in stringency do not follow any such pattern. In particular, stringency of capital regulation varies substantially even between countries with largely harmonized legal and regulatory frameworks, such as the EU countries. This is somewhat surprising in light of the initiatives of the European Commission to establish a unified legal and regulatory landscape in banking through the common capital regulatory framework, yet it is also understandable, given that the past regulatory environment of Basel I and, particularly, Basel II allowed more flexibility in achieving capital standards.

The question is also whether implementation of Basel III standards impacts our findings. Our analysis is based on data from 2010 and 2011 when Basel III standards have not yet been implemented into national legislations (see Basel Committee on Banking Supervision 2011). As of April 2013, several countries already adopted Basel III based capital regulations and applied it to banks (see Basel Committee on Banking Supervision 2013).

We anticipate that implementation of Basel III will on average increase complexity and stringency of capital regulation along the notion that Basel III framework goes along the path of increasing the quantity and quality of bank capital (see Marinč, Mrak, and Rant 2012). In addition, it would be interesting to analyze whether Basel III standards will unify capital regulation across countries. However, the quantitative analysis of these questions is left for the future research when new data from WorldBank database, covering the period of Basel III implementation, becomes available.

Our study shows that countries should continue to push for further harmonization of capital regulation. Implementation of the Basel III accord presents the first opportunity to come closer to the common capital regulatory framework with a more synchronized stringency and complexity of capital regulation. We point to the need to also carefully examine the qualitative aspects of the regulation and supervisions of capital requirements. Relying only on quantitative aspects (such as on minimum capital requirements) may not be enough.

References

Acharya, Viral V. 2003. "Is the International Convergence of Capital Adequacy Regulation Desirable?" *Journal of Finance*, 58(6): 2745–2782.

Acharya, Viral V., Hamid Mehran, and Anjan V. Thakor. 2012. "Caught between Scylla and Charybdis? Regulating Bank Leverage When There Is Rent-Seeking and Risk-Shifting." CEPR Discussion Papers No. 8822, February, 2012.

Acharya, Viral V., and Philipp Schnabl. 2009. "How Banks Played the Leverage "Game."" in: *Restoring Financial Stability: How to Repair a Failed System*, ed. by Viral V. Acharya and Matthew Richardson. Hoboken, NJ: Wiley: 83–100.

Admati, Anat R., Peter M. DeMarzo, Martin F. Hellwig, and Paul C. Pfleiderer. 2011. "Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is not Expensive." Rock Center for Corporate Governance at Stanford University Working Paper 86, March 23.

Antzoulatos, Angelos A. 2012. "Policy Responses to the European Debt Crisis Treating the "Symptoms" or the "Disease"?" *Panoeconomicus*, 59(5): p. 529–552.

Ayuso, Juan, Daniel Perez, and Jesus Saurina. 2004. "Are Capital Buffers Pro-Cyclical? Evidence from Spanish Panel Data." *Journal of Financial Intermediation*, 13(2): 249–264.

Bai, Jushan, and Serena Ng. 2008. "Large Dimensional Factor Analysis." *Foundations and Trends in Econometrics*, 3(2): 89–163.

Barth, James R., Gerard Caprio Jr., and Ross Levine. 2003. *Rethinking Bank Regulations: Till Angels Govern*. Cambridge: Cambridge University Press.

Barth, James R., Gerard Caprio Jr., and Ross Levine. 2004. "Bank Regulation and Supervision: What Works Best?" *Journal of Financial Intermediation*, 13(2): 205–248.

Barth, James R., Gerard Caprio Jr., and Ross Levine. 2008. "Bank Regulations Are Changing: For Better or Worse?" *Comparative Economic Studies*, 50: 537–563.

Barth, James R., Gerard Caprio Jr., and Ross Levine. 2012. "The Evolution and Impact of Bank Regulations." World Bank Policy Research Working Paper No. 6288, December 2012.

Barth, James R., Gerard Caprio Jr., and Ross Levine. 2013. "Bank Regulation and Supervision in 180 Countries from 1999 to 2011." Working paper. January 2013.

Basel Committee on Banking Supervision. 2011. "Progress Report on Basel III Implementation." October, Bank for International Settlements.

Basel Committee on Banking Supervision. 2012. "Report to G20 Finance Ministers and Central Bank Governors on Basel III implementation." October, Bank for International Settlements.

Basel Committee on Banking Supervision. 2013. "Progress Report on Implementation of the Basel Regulatory Framework." April, Bank for International Settlements.

Berger, Allen N., and Christa H. S. Bouwman. Forthcoming. "How Does Capital Affect Bank Performance during Financial Crises?" *Journal of Financial Economics*.

Berger, Allen N., Robert DeYoung, Mark J. Flannery, David K. Lee, and Özde Öztekin. 2008. "How Do Large Banking Organizations Manage Their Capital Ratios?" *Journal of Financial Services Research*, 34(2): 123–149.

Boot, Arnoud W. A., and Matej Marinč. 2008. "The Evolving Landscape of Banking." *Industrial and Corporate Change*, 17(6): 1173–1203.

Boot, Arnoud W. A., Todd T. Milbourn, and Silva Deželan. 2001. "Regulation and the Evolution of the Financial Services Industry." In: *Challenges for Central Banking*, ed. by Anthony M. Santomero, Staffan Viotti, and Anders Vredin, 39–58. Norwell, MA: Kluwer.

Brewer, Elijah, George G. Kaufman, and Larry D. Wall. 2008. "Bank Capital Ratios across Countries: Why Do They Vary?" *Journal of Financial Services Research*, 34(2): 177–201.

Calem, Paul S., and Rafael Rob. 1999. "The Impact of Capital-Based Regulation on Bank Risk-Taking." *Journal of Financial Intermediation*, 8(4): 317–352.

Čihák, Martin, Asli Demirgüç-Kunt, Maria Soledad Martínez Pería, and Amin Mohseni-Cheraghlou. 2012. "Banking Regulation and Supervision around the World: Crisis Update." Policy Research Working Paper, Washington, DC: World Bank.

Delis, Manthos D., Iftekhar Hasan, and Pantelis Kazakis. 2012. "Bank Regulations and Income Inequality: Empirical Evidence." Research Discussion Papers No 18/2012, Bank of Finland.

Elizalde, Abel, and Rafael Repullo. 2007. "Economic and Regulatory Capital in Banking: What Is the Difference?" *International Journal of Central Banking*, 3: 87–117.
Flannery, Mark J., and Kasturi P. Rangan. 2008. "What Caused the Bank Capital Build-Up of the 1990s?" *Review of Finance*, 12(2): 391–429.
Goodhart, Charles. 2013. "Ratio Controls Need Reconsiderations." *Journal of Financial Stability*, 9(3): 445–450.
Gropp, Reint, and Florian Heider. 2011. "The Determinants of Bank Capital Structure." *Review of Finance*, 15: 29–74.
Hasan, Iftekhar, Akhtar Siddique, and Xian Sun. 2012. "Monitoring the "Invisible" Hand of Market Discipline: Capital Adequacy Revisited." Unpublished work.
Hayton, James C., David G. Allen, and Vida Scarpello. 2004. "Factor Retention Decisions in Exploratory Factor Analysis: A Tutorial on Parallel Analysis." *Organizational Research Methods,* 7(2): 191–205.
Hommes, Cars H., Tatiana Kiseleva, Yuri Kuznetsov, and Miroslav Verbič. 2012. "Is More Memory in Evolutionary Selection (De)stabilizing?" *Macroeconomic Dynamics*, 16(3), p. 335-357.
Horn, John L. 1965. "A Rationale and a Test for the Number of Factors in Factor Analysis." *Psychometrika*, 30: 179–185.
Jolliffe, Ian T. 2002. *Principle Component Analysis*. 2nd ed. New York: Springer.
Josifidis, Kosta, Radmila Dragutinović Mitrović, and Olgica Ivančev. 2012. "Heterogeneity of Growth in the West Balkans and Emerging Europe: A Dynamic Panel Data Model Approach." *Panoeconomicus*, 59(2): p. 157–183.
Kaiser, Henry F. 1958. "The Varimax Criterion for Analytic Rotation in Factor Analysis." *Psychometrika*, 23: 187–200.
Kline, Paul. 2002. An Easy Guide to Factor Analysis, London: Routledge.
Klomp, Jeroen, and Jakob de Haan. 2012. "Banking Risk and Regulation: Does One Size Fit All?" *Journal of Banking & Finance*, 36: 3197–3212.
Kopecky, Kenneth J., and David VanHoose. 2012. "Can Capital Requirements Induce Private Monitoring That Is Socially Optimal?" *Journal of Financial Stability*, 8(4): 252–262.
Little, Roderick J. A., and Donald B. Rubin. 2002. Statistical Analysis with Missing Data. 2nd ed. Hoboken, NJ: Wiley.

Marinč, Matej. 2013. "Banks and Information Technology: Marketability vs. Relationships." *Electronic Commerce Research*. 13: 71–101.
Marinč, Matej, Mojmir Mrak, and Vasja Rant. 2012. "How Much Bank Capital Is Enough: Reconciling the Views of Academics and Regulators." *Bančni Vestnik*, 11: 83–90.
Memmel, Christoph, and Peter Raupach. 2010. "How Do Banks Adjust Their Capital Ratios?" *Journal of Financial Intermediation*, 19(4): 509–528.
Miles, David, Jing Yang, and Gilberto Marcheggiano. 2012. "Optimal Bank Capital." *The Economic Journal*, 122: 2163–2202.
O'Hara, Phillip Anthony. 2012. "Institutional Regimes, Long Wave Systemic Risk and Great International Crisis of 2008–2012." *Panoeconomicus*, 59(1): p. 1–12.
O'Hara, Phillip Anthony. 2013. "Policies and Institutions for Moderating Deep Recessions, Debt Crises and Financial Instabilities." *Panoeconomicus*, 60(1), p. 19–49.
Olsson, Ulf. 1979. "Maximum Likelihood Estimation of the Polychoric Correlation." *Psychometrika*, 44: 443–460.
Pasiouras, Fotios, Chrysovalantis Gaganis, and Constantin Zopounidis. 2006. "The Impact of Bank Regulations, Supervision, Market Structure, and Bank Characteristics on Individual Bank Ratings: A Cross-Country Analysis." *Review of Quantitative Finance and Accounting*, 27: 403–438.
Repullo, Rafael. 2004. "Capital Requirements, Market Power, and Risk-Taking in Banking." *Journal of Financial Intermediation*, 13(2): 156–182.
Ribnikar, Ivan, Košak, Marko. 2011. Transition, Privatization and Monetary Arrangements in the Countries Founded on the Territory of Former Yugoslavia, *Zbornik radova Ekonomskog fakulteta u Rijeci*, 29(2): 333–353.
Rubin, Donald B. 1976. "Inference and Missing Data." *Biometrika*, 63: 581–592.
Schafer, Joseph L. 1997. *Analysis of Incomplete Multivariate Data*. Boca Raton, FL: Chapman & Hall/CRC.
Tabachnick, Barbara G., and Linda S. Fidell. 2007. *Using Multivariate Statistics*. 5th ed. Upper Saddle River, NJ: Pearson Allyn & Bacon.
Verbič, Miroslav, Majcen, Boris, Ivanova, Olga, Čok, Mitja. 2011. R&D and economic growth in Slovenia : a dynamic general equilibrium approach with endogenous growth. *Panoeconomicus*, 58(1): 67–89.

Ward, Joe H., Jr. 1963. "Hierarchical Grouping to Optimize an Objective Function." *Journal of the American Statistical Association*, 58: 236–244.
World Bank. 2010. "Bank Regulation and Supervision." updated June 2008, http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20345037~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html (accessed March 9, 2013).
World Bank. 2013. "Bank Regulation and Supervision Survey." http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTGLOBALFINREPORT/0,,contentMDK:23267421~pagePK:64168182~piPK:64168060~theSitePK:8816097,00.html (accessed March 9, 2013).

Table 1: Summary statistics and factor scores (Yes = 1, No = 0)

No.	Variable	Label	Obs	Mean	Std. Dev.	Min	Max	Factor 1	Factor 2	Uniqueness
1	q01_04_01	1.4.1 Does the minimum capital entry requirement vary based on the nature of the banking businesses that are licensed?	141	0.51	0.50	0	1	0.13	-0.24	0.86
2	q01_04_02	1.4.2 Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities?	139	0.94	0.23	0	1	0.02	-0.25	0.77
3	q01_04_03	1.4.3 Can the initial or subsequent injections of capital be done with assets other than cash or government securities?	141	0.33	0.47	0	1	0.37	-0.01	0.71
4	q01_05_00	1.5 Can initial capital contributions by prospective shareholders be in the form of borrowed funds?	140	0.33	0.47	0	1	0.21	0.00	0.87
5	q03_01_00_02	3.1 Which regulatory capital adequacy regimes did you use as of the end of 2010? Basel II	133	0.56	0.50	0	1	0.80	0.13	0.96
6	q03_01_00_03	3.1 Which regulatory capital adequacy regimes did you use as of the end of 2010? Leverage ratio	133	0.15	0.36	0	1	-0.06	0.17	0.96
7	q03_02_00_02	3.2 Which risks are covered by the current regulatory minimum capital requirements in your jurisdiction? Market risk	126	0.79	0.41	0	1	0.60	-0.13	0.79
8	q03_02_00_04	3.2 Which risks are covered by the current regulatory minimum capital requirements in your jurisdiction? Other risks	121	0.38	0.49	0	1	0.42	0.12	0.92
9	q03_03_01_02	3.3.1 What was the minimum required risk-based regulatory capital ratio as of the end of 2009?	136	0.09	0.02	0.08	0.15	-0.33	0.33	0.99
10	q03_04_01_02	3.4.1 What was the actual risk based capital ratio of the banking system as of the end of 2009?	134	0.18	0.11	-0.1	1.18	-0.44	0.39	0.98
11	q03_05_01	3.5 What was the actual Tier 1 capital ratio of the banking system as of the end of 2008?	117	0.15	0.10	0	0.86	-0.50	0.20	0.94
12	q03_06_00a	3.6 The regulatory minimum capital requirements are applied on a consolidated basis at every banking group	133	0.68	0.47	0	1	-0.26	-0.20	0.62
13	q03_06_01	3.6.1 Do you require banks to perform an internal assessment of their capital adequacy against their economic capital?	140	0.56	0.50	0	1	0.51	0.36	0.91
14	q03_07_00	3.7 Can your agency require additional capital that is over-and-above the minimum required capital for individual banks?	139	0.88	0.32	0	1	0.30	0.04	0.89
15	q03_08_00	3.8 Do you apply different risk weights than those in Basel I (corporate lending, mortgage, consumer, govt. loans)?	101	0.38	0.49	0	1	0.03	0.09	0.34
16	q03_12_00	Do you use regulatory leverage ratio (zeros and missing values are mixed)	142	0.37	0.49	0	1	-0.06	0.44	0.74
17	q03_17_00_01	3.17.a Which of the following are legally allowed in regulatory capital? Common equity	130	0.84	0.37	0	1	0.03	0.11	0.71
18	q03_17_00_02	3.17.b Which of the following are legally allowed in regulatory capital? Tier 1	131	0.94	0.24	0	1	0.22	0.09	0.94
19	q03_17_00_03	3.17.c Which of the following are legally allowed in regulatory capital? Tier 2	137	0.88	0.32	0	1	0.41	-0.09	0.63
20	q03_17_00_04	3.17.d Which of the following are legally allowed in regulatory capital? Tier 3	128	0.36	0.48	0	1	0.59	0.15	0.61
21	q03_17_00_05	3.17.e Which of the following are legally allowed in regulatory capital? Other (please explain)	128	0.10	0.30	0	1	-0.15	-0.05	0.63
22	q03_18_00_01	3.18.a Which of the following items are allowed as part of Tier 1 capital? Hybrid debt capital instruments	133	0.36	0.48	0	1	0.67	0.04	0.93
23	q03_18_00_02	3.18.b Which of the following items are allowed as part of Tier 1 capital? Asset revaluation gains (or revaluation reserves)	133	0.13	0.34	0	1	0.19	-0.21	0.77
24	q03_18_00_03	3.18.c Which of the following items are allowed as part of Tier 1 capital? Subordinated debt	132	0.07	0.25	0	1	0.12	-0.19	0.99
25	q03_18_01_01	3.18.1.a Which of the following items are allowed as part of Tier 2 capital? Hybrid debt capital instruments	133	0.70	0.46	0	1	0.24	0.56	0.87
26	q03_18_01_02	3.18.1.b Which of the following items are allowed as part of Tier 2 capital? General provisions	133	0.68	0.47	0	1	-0.20	0.44	0.98
27	q03_18_01_03	3.18.1.c Which of the following items are allowed as part of Tier 2 capital? Asset revaluation gains (or revaluation reserves)	133	0.75	0.43	0	1	0.15	0.33	0.81
28	q03_18_02	3.18.2 What fraction of revaluation gains is allowed as part of capital?	89	0.49	0.31	0	1	0.24	-0.49	0.86
29	q03_18_03_01	3.18.3.a Is goodwill deducted from regulatory capital?	135	0.87	0.33	0	1	0.48	0.02	1.00
30	q03_18_03_02	3.18.3.b Are deferred tax assets deducted from regulatory capital?	129	0.43	0.50	0	1	0.09	0.03	0.82
31	q03_18_03_03	3.18.3.c Are intangibles deducted from regulatory capital?	135	0.81	0.40	0	1	0.35	0.07	0.99
32	q03_18_03_04	3.18.3.d Are unrealized losses in fair valued exposures deducted from regulatory capital?	129	0.65	0.48	0	1	0.34	0.39	0.81
33	q03_18_03_05	3.18.3.e Are investments in the capital of certain banking, financial and insurance assets deducted from regulatory capital?	131	0.84	0.37	0	1	0.33	-0.14	0.97
34	q07_01_01	If banks are limited in lending to a single or interrelated borrowers, what is the limit as a % of a bank's regulatory capital?	136	0.24	0.09	0.1	1	0.16	0.02	0.78
35	q10_05_01_04	10.5.1 Do banks disclose to the public regulatory capital and capital adequacy ratio?	140	0.79	0.41	0	1	0.36	-0.07	0.66
36	q11_01_00_02	11.1.b. Can the supervisory agency use forbearance (i.e. to waive regulatory and supervisory requirements)?	137	0.67	0.47	0	1	-0.05	0.46	0.98
37	q11_01_00_10	11.1.j. Can the supervisory agency require banks to reduce or suspend dividends to shareholders?	139	0.94	0.25	0	1	-0.12	-0.07	0.55
38	q11_03_00	11.3 Does an early intervention framework exist that forces automatic action if regulatory triggers are breached?	139	0.86	0.35	0	1	-0.15	-0.13	0.87
39	q11_03_01_01	11.3.1.a. What triggers are used for initiating automatic actions? Breach of minimum regulatory capital adequacy ratio	118	0.94	0.24	0	1	0.03	0.02	0.97
40	q12_22_01a	12.22.1.b. Which of the following factors do you consider in assessing systemic risk? Bank leverage ratios	142	0.79	0.41	0	1	0.13	-0.04	0.95

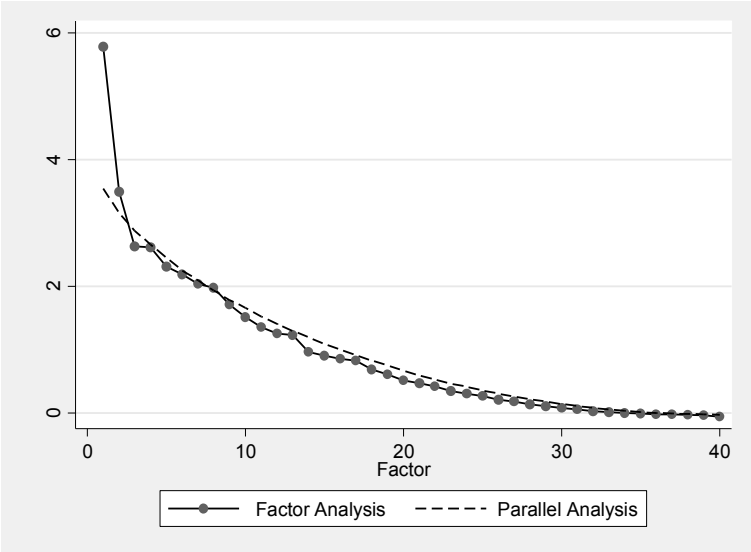
Source: World Bank (2013), own computations; factors are determined based on the factor analysis extraction method using the principal factor method with orthogonal varimax rotation with Keiser normalization on the imputed correlation matrix using the multivariate normal regression imputation method.

Table 2: Correlation matrix

	q01_04	q01_04	q01_04	q01_05	q03_01	q03_01	q03_02	q03_02	q03_03	q03_04	q03_05	q03_06	q03_06	q03_07	q03_08	q03_12	q03_17	q03_17	q03_17	q03_17	q03_18	q03_18	q03_18	q03_18	q03_18	q03_18	q03_18	q03_18	q03_18	q03_18	q03_18	q07_01	q10_05	q11_01	q11_01	q11_03	q11_03	q12_22_
q01_04_01	1.00																																					
q01_04_02	0.13	1.00																																				
q01_04_03	0.05	-0.02	1.00																																			
q01_05_00	-0.02	-0.09	0.13	1.00																																		
q03_01_00_02	0.16*	-0.09	0.32***	0.23***	1.00																																	
q03_01_00_03	0.10	0.11	0.05	-0.00	0.03	1.00																																
q03_02_00_02	0.09	-0.04	0.18**	0.13	0.58***	0.05	1.00																															
q03_02_00_04	0.11	0.05	0.10	-0.11	0.36***	-0.09	0.29***	1.00																														
q03_03_01_02	-0.14*	-0.03	-0.25***	-0.05	-0.20**	0.13	-0.16*	-0.10	1.00																													
q03_04_01_02	-0.14	-0.23***	-0.02	-0.01	-0.22**	0.01	-0.19**	-0.19**	0.32***	1.00																												
q03_05_01	-0.03	-0.16*	-0.17*	-0.12	-0.35***	0.11	-0.17*	-0.11	0.30***	0.69***	1.00																											
q03_06_00a	0.06	0.03	-0.06	-0.08	-0.22**	0.08	-0.16*	-0.10	0.10	0.15	0.20**	1.00																										
q03_06_01	-0.05	-0.09	0.23***	0.11	0.56***	-0.01	0.25***	0.26***	-0.12	-0.10	-0.30***	-0.21**	1.00																									
q03_07_00	0.14*	-0.09	0.06	-0.03	0.29***	-0.03	0.17*	0.14	-0.08	-0.10	0.03	-0.06	0.05	1.00																								
q03_08_00	0.11	0.05	-0.04	-0.00	-0.04	0.05	0.11	-0.10	-0.02	-0.03	0.04	0.01	-0.00	0.11	1.00																							
q03_12_00	-0.09	0.00	-0.01	-0.04	0.02	0.35***	-0.06	0.03	0.20**	0.06	0.05	-0.22**	0.15*	0.00	0.06	1.00																						
q03_17_00_01	-0.05	0.06	-0.08	-0.02	-0.08	-0.04	-0.22**	0.08	0.06	-0.21**	-0.18**	0.05	-0.04	0.03	0.05	0.01	1.00																					
q03_17_00_02	0.05	-0.07	0.18**	-0.15*	0.10	-0.16*	-0.02	0.02	-0.09	0.04	0.03	0.08	0.09	0.10	-0.10	-0.05	0.15*	1.00																				
q03_17_00_03	0.19**	0.01	0.06	-0.03	0.25***	0.03	0.21**	0.11	-0.16*	-0.34***	-0.21**	0.04	0.12	0.24***	0.08	0.05	0.16*	0.49***	1.00																			
q03_17_00_04	0.13	0.06	0.14	0.14	0.51***	0.04	0.39***	0.27***	-0.21**	-0.18*	-0.19**	-0.21**	0.33***	0.22**	-0.02	0.06	-0.04	0.06	0.23***	1.00																		
q03_17_00_05	0.04	-0.02	-0.03	-0.09	-0.07	-0.07	-0.08	0.06	0.09	0.08	-0.08	0.00	0.07	-0.18**	0.04	0.04	-0.13	-0.13	-0.20**	-0.13	1.00																	
q03_18_00_01	0.05	-0.11	0.18**	0.16*	0.47***	-0.17*	0.37***	0.33***	-0.27***	-0.21**	-0.36***	-0.28***	0.39***	0.05	0.12	-0.08	0.02	0.19**	0.20**	0.41***	-0.01	1.00																
q03_18_00_02	0.00	-0.02	0.12	0.17*	0.10	0.02	0.14	0.17*	-0.14	-0.06	-0.09	-0.02	0.10	0.06	0.23**	-0.12	-0.09	-0.11	0.05	0.01	-0.04	0.18**	1.00															
q03_18_00_03	0.01	-0.07	0.13	0.27***	0.05	-0.12	0.06	0.10	-0.07	-0.07	-0.06	-0.00	0.00	-0.00	-0.18*	-0.15*	-0.05	-0.07	-0.00	-0.02	-0.09	0.05	0.36***	1.00														
q03_18_01_01	-0.05	-0.10	-0.00	0.12	0.11	0.05	0.06	0.04	0.13	0.01	-0.03	-0.11	0.38***	0.15*	0.09	0.10	0.16*	0.21**	0.11	0.17*	-0.12	0.24***	-0.12	-0.09	1.00												
q03_18_01_02	-0.08	-0.10	-0.05	-0.12	-0.15	0.21**	-0.19**	-0.04	0.20**	0.14	0.11	-0.02	0.10	-0.08	0.03	0.23***	-0.11	0.03	-0.11	-0.12	0.07	-0.11	-0.10	-0.01	0.15*	1.00											
q03_18_01_03	-0.07	0.00	0.10	-0.01	0.07	-0.12	-0.01	0.15*	0.07	0.09	0.02	-0.09	0.25***	-0.03	0.13	-0.06	-0.05	0.07	-0.01	0.12	0.02	0.14	-0.16*	0.09	0.19**	0.21**	1.00										
q03_18_02	0.10	0.09	0.27**	0.02	0.08	0.03	0.07	0.06	-0.17	-0.21*	-0.11	0.10	0.06	-0.10	0.15	-0.13	-0.11	0.14	0.11	0.22**	-0.06	0.14	0.19*	-0.01	-0.25**	-0.13	0.15	1.00									
q03_18_03_01	0.03	-0.00	0.17*	0.13	0.38***	0.11	0.36***	0.12	-0.04	-0.25***	-0.35***	-0.11	0.08	0.10	-0.17*	0.03	0.03	0.01	0.09	0.25***	-0.04	0.17**	-0.00	0.10	0.17*	-0.05	-0.00	-0.09	1.00								
q03_18_03_02	0.06	-0.04	0.01	-0.02	0.11	0.13	0.13	-0.08	0.04	-0.07	-0.04	-0.16*	0.02	0.06	-0.25**	0.07	-0.00	0.18**	0.03	-0.14	-0.05	-0.00	0.03	-0.06	0.05	0.03	-0.11	-0.14	0.28***	1.00							
q03_18_03_03	-0.11	-0.04	0.23***	-0.05	0.26***	-0.11	0.17*	0.10	-0.04	-0.13	-0.19**	0.03	0.11	0.16*	-0.14	0.07	-0.05	0.16*	0.14	0.26***	-0.03	0.03	0.06	-0.03	0.14	-0.13	-0.02	-0.02	0.44***	0.24***	1.00						
q03_18_03_04	-0.12	0.01	0.24***	0.11	0.29***	0.03	0.19**	0.04	0.03	0.10	-0.06	-0.14	0.23***	-0.01	-0.01	0.15*	0.04	0.18*	0.08	0.20**	-0.26***	0.18**	0.02	0.01	0.19**	0.13	0.20**	-0.14	0.25***	0.06	0.24***	1.00					
q03_18_03_05	0.16*	0.24***	-0.00	0.04	0.34***	-0.05	0.22**	0.16*	-0.19**	-0.06	-0.05	-0.08	0.08	0.08	0.03	-0.17*	-0.05	0.00	0.14	0.16*	-0.03	0.11	0.16*	0.04	0.00	-0.15	0.11	-0.02	0.26***	0.01	0.15*	0.17*	1.00				
q07_01_01	-0.06	-0.02	-0.03	0.02	0.16*	-0.14	0.00	-0.05	-0.01	-0.13	-0.13	0.05	0.10	0.19**	-0.06	-0.22**	0.03	0.18**	0.13	0.15*	-0.10	0.09	-0.09	-0.05	0.14	0.01	0.02	0.02	0.04	-0.08	0.10	-0.10	0.03	1.00			
q10_05_01_04	0.06	0.03	0.14	0.06	0.37***	-0.09	0.39***	0.19**	-0.11	-0.05	-0.13	-0.12	0.10	0.09	0.08	-0.07	-0.03	0.03	-0.01	0.27***	0.06	0.30***	0.13	0.06	-0.12	-0.13	0.02	-0.05	0.10	0.12	0.05	0.18**	0.16*	-0.01	1.00		
q11_01_00_02	-0.16*	-0.11	-0.07	-0.02	0.03	0.04	-0.06	0.07	0.02	0.14	-0.05	-0.22**	0.08	0.10	0.14	0.13	0.02	-0.09	-0.19**	-0.09	0.02	0.00	0.02	-0.21**	0.25***	0.33***	0.19**	-0.08	-0.02	0.05	0.02	0.05	-0.09	0.14	-0.15*	1.00	
q11_01_00_10	-0.03	0.18**	-0.01	-0.00	-0.12	0.03	-0.15	0.02	0.14	0.07	-0.06	0.07	-0.12	0.09	0.03	0.03	0.21**	-0.07	-0.01	-0.05	-0.11	-0.24**	-0.08	0.07	-0.05	-0.05	-0.09	-0.06	0.08	-0.00	-0.06	-0.01	-0.12	0.04	-0.07	-0.12	1.00	
q11_03_00	0.01	-0.00	-0.11	0.03	-0.16*	-0.05	-0.11	-0.14	0.10	0.01	0.10	0.02	-0.03	-0.15*	-0.00	0.10	-0.13	-0.11	-0.08	-0.20**	-0.07	-0.23***	-0.03	0.02	-0.04	0.02	-0.20**	-0.01	-0.03	0.01	0.02	-0.04	0.04	0.07	-0.07	-0.15*	-0.03	1.00
q11_03_01_01	0.03	-0.06	0.18*	0.04	-0.09	-0.19**	0.06	-0.12	-0.14	0.04	0.11	0.08	-0.03	0.00	0.18*	-0.08	0.07	0.07	0.11	0.02	-0.03	0.03	-0.01	0.07	0.04	-0.14	-0.03	0.10	0.01	-0.14	-0.02	-0.07	-0.11	0.08	-0.04	-0.09	0.07	-0.05	1.00	
q12_22_01a	-0.01	0.26***	0.02	-0.02	0.11	0.08	0.02	0.01	0.00	0.05	-0.05	-0.04	0.07	0.10	0.06	0.01	0.02	0.10	0.16*	0.11	-0.07	-0.01	0.08	-0.09	-0.16*	-0.17**	0.02	0.02	-0.02	0.16*	0.13	0.12	0.03	-0.01	0.15*	0.01	0.15*	-0.02	-0.05	1.00
:-'* p<0.10	** p<0.(	*** p<0.01"																																				

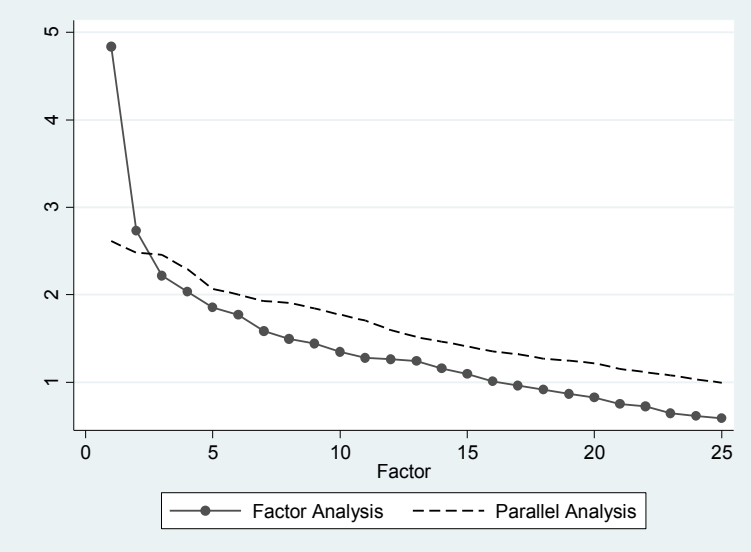
Source: our own computation based on World Bank (2013).

Figure 1: Parallel analysis of the original data based on Horn's (1965) test



Source: our own computation based on World Bank (2013).

Figure 2: Parallel analysis of the imputed data based on Horn's (1965) test

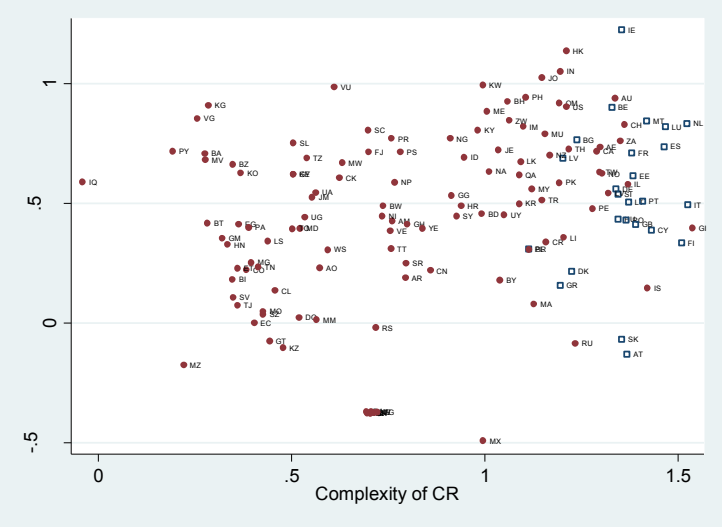


Source: our own computation based on World Bank (2013).

Figure 3: Factor scores among countries with different income levels

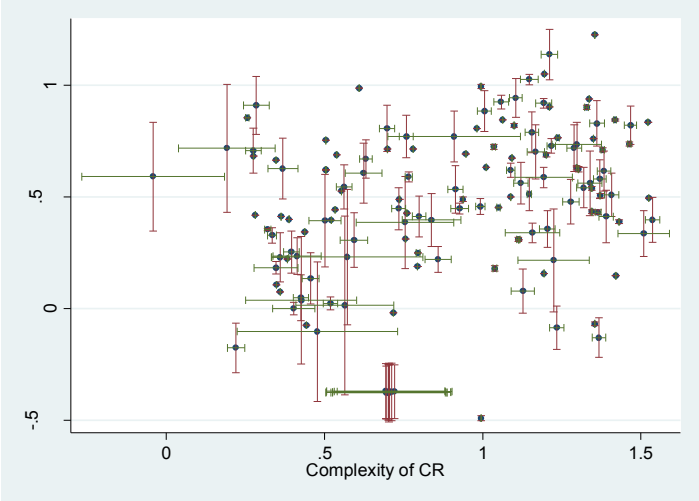
Source: our own computation based on World Bank (2013). The size of the circle indicates the level of income in the specific country. There are five sizes (low income, lower middle income, upper middle income, high income: non OECD, high income: OECD).

Figure 4: Factor scores across EU and non-EU countries



Source: our own computation based on World Bank (2013). EU countries are denoted by squares, and non-EU countries by circles.

Figure 5: Factor scores and their standard errors due to MCMC imputation

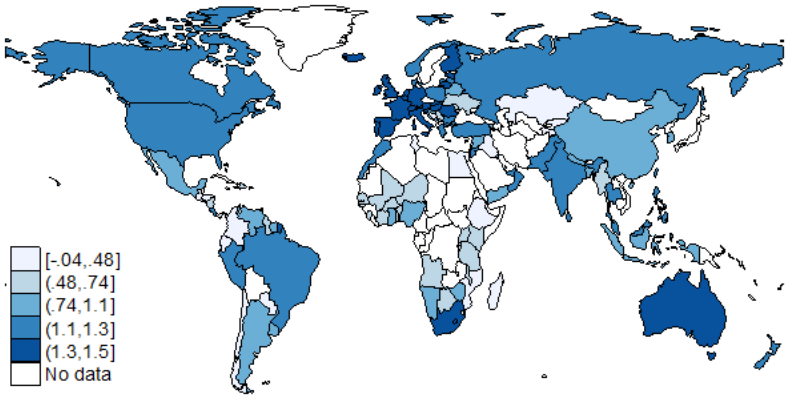


Source: our own computation based on World Bank (2013). The points represent countries as in Figure 4. Country codes are removed to increase transparency.

Figure 6: Factors scores of countries of the former Yugoslavia and standard errors due to imputation

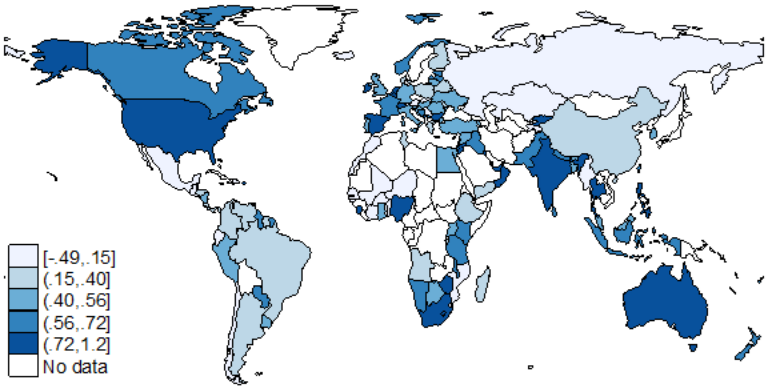
Source: our own computation on World Bank (2013). Variability occurs due to imputation and is higher in countries with several missing variables (Bosnia-Herzegovina has 11 missing variables, Kosovo has six, and Montenegro has four) than in countries with only a few missing variables (Slovenia and Croatia have one missing variable and Serbia has two).

Figure 7: World map of complexity of capital regulation



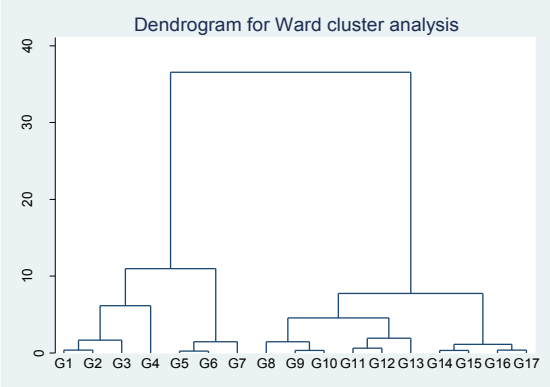
Source: our own computation based on World Bank (2013).

Figure 8: World map of stringency of capital regulation



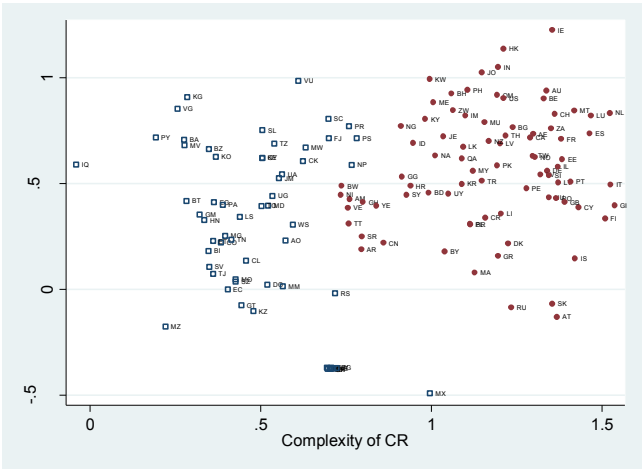
Source: our own computation based on World Bank (2013).

Figure 9: Dendrogram of cluster analysis (Ward method) along the two factors of capital regulation



Source: our own computation based on World Bank (2013). We use squared Euclidean distance (L2squared) as a dissimilarity measure. The groups G1–G17 are selected for the presentational purpose by the cutoff point where the dissimilarity measure is greater than 0.2. The dendrogram shows that the drop in the dissimilarity measure is the highest when two groups are selected.

Figure 10: Two clusters based on the Ward cluster analysis on two factors of capital regulation



Source: our own computation based on World Bank (2013). The first cluster is represented by squares. The second cluster is represented by circles.