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Dimensions of Bank Capital Regulation: A Cross-Country Analysis

Summary: 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.

Key words: Bank regulation, Capital regulation, Bank capital, Capital structure.

JEL: G20, G21, G28, G32, G38, H81, K23.

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 Basel 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)¹ 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 1 reviews the rationale for bank capital regulation and places our study in the context of existing research of bank capital standards. Section 2 describes the descriptive statistics of our dataset. Section 3 presents the methodology that we employ; in particular, the imputation method and the exploratory factor analysis. Section 4 describes the analysis and results. Section 5 concludes the article. All the tables and figures are in the Appendix.

¹ **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).

1. 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 R. 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 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 2013). 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. 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 Marinč 2008; 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. 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 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 (James R. Barth, Gerard Caprio Jr., and Ross Levine 2003, 2004, 2008, 2013) were performed using older versions of the World Bank (2010)² database. Fotios Pasiouras, Chrysovalantis

² **World Bank.** 2010. "Bank Regulation and Supervision."

<http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20345037~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html> (accessed March 9, 2013).

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.

2. 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 Barth, Caprio Jr., and Levine (2012), Martin Čihák et al. (2013) and, recently, Marinč and Rant (forthcoming). 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; Berger et al. 2008; Elijah Brewer III, George G. Kaufman, and Larry D. Wall 2008; Mark J. Flannery and Kasturi P. Rangan 2008; Christoph Memmel and Peter Raupach 2010; Reint Gropp and Florian Heider 2011), 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 columns 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 fourth column of Table 1 shows the mean values of questions with standard deviation in the fifth column. The sixth and seventh columns show minimum and maximum values of variables. The eighth and ninth columns show two factors from factor analysis (see Section 3.2 for further explanation).

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.

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.

3. Methodology

3.1 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 Joseph L. Schafer (1997) and Roderick J. A. Little and Rubin (2002). 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.

3.2 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; 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.

4. Analysis

4.1 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).

4.2 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; (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, Akhtar Siddique, and Xian Sun forthcoming), in which complexity of capital regulation is high. In contrast, less-developed financial systems need control-oriented direct regulation (Boot, Silva Deželan, and Todd T. Milbourn 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).

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 Hommes et al. 2012; David K. 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 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 and 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.

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).

We also performed a cluster analysis using Joe H. Ward's Jr. (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).

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 and institutional development together with the characteristics of the banking system (see Xiaoqiang Cheng and Patrick Van Cayseele 2010; João S. Andrade and Adelaide Duarte 2011; Ivan Ribnikar and Marko Košak 2011; Verbič et al. 2011; Kosta Josifidis, Radmila Dragutinović Mitrović, and Olgica Ivančev 2012; Hasan and Marinč forthcoming) 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 A. O'Hara 2012, 2013).

5. 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 World Bank 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.

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Appendix

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

Note: 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.

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

Table 2 Correlation Matrix (Part 1/4)

	q01_04_01	q01_04_02	q01_04_03	q01_05_00	q03_01_00_02	q03_01_00_03	q03_02_00_02	q03_02_00_04	q03_03_01_02	q03_04_01_02	q03_05_01	q03_06_00a
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**
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
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
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**
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
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
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
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**
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
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**
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
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
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
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
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
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
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
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*
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
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
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
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
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
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**
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
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
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
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

Table 2 Correlation Matrix (Part 2/4)

	q03_06_01	q03_07_00	q03_08_00	q03_12_00	q03_17_00_01	q03_17_00_02	q03_17_00_03	q03_17_00_04	q03_17_00_05	q03_18_00_01	q03_18_00_02	q03_18_00_03
q01_04_01												
q01_04_02												
q01_04_03												
q01_05_00												
q03_01_00_02												
q03_01_00_03												
q03_02_00_02												
q03_02_00_04												

Table 2 Correlation Matrix (Part 4/4)

	q11_01_00_10	q11_03_00	q11_03_01_01	q12_22_01a
q01_04_01				
q01_04_02				
q01_04_03				
q01_05_00				
q03_01_00_02				
q03_01_00_03				
q03_02_00_02				
q03_02_00_04				
q03_03_01_02				
q03_04_01_02				
q03_05_01				
q03_06_00a				
q03_06_01				
q03_07_00				
q03_08_00				
q03_12_00				
q03_17_00_01				
q03_17_00_02				
q03_17_00_03				
q03_17_00_04				
q03_17_00_05				
q03_18_00_01				
q03_18_00_02				
q03_18_00_03				
q03_18_01_01				
q03_18_01_02				
q03_18_01_03				
q03_18_02				
q03_18_03_01				
q03_18_03_02				
q03_18_03_03				
q03_18_03_04				
q03_18_03_05				
q07_01_01				
q10_05_01_04				
q11_01_00_02				
q11_01_00_10	1.00			
q11_03_00	-0.03	1.00		
q11_03_01_01	0.07	-0.05	1.00	
q12_22_01a	0.15*	-0.02	-0.05	1.00

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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

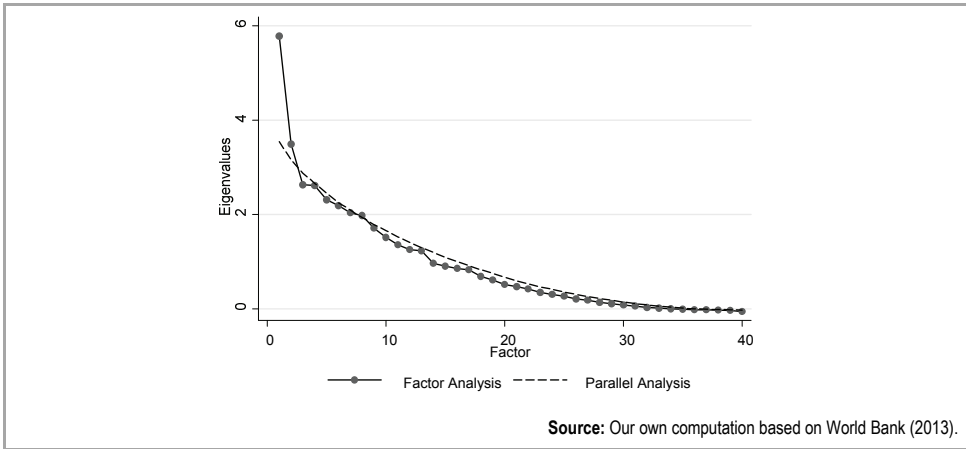


Figure 1 Parallel Analysis of the Original Data based on Horn's (1965) Test

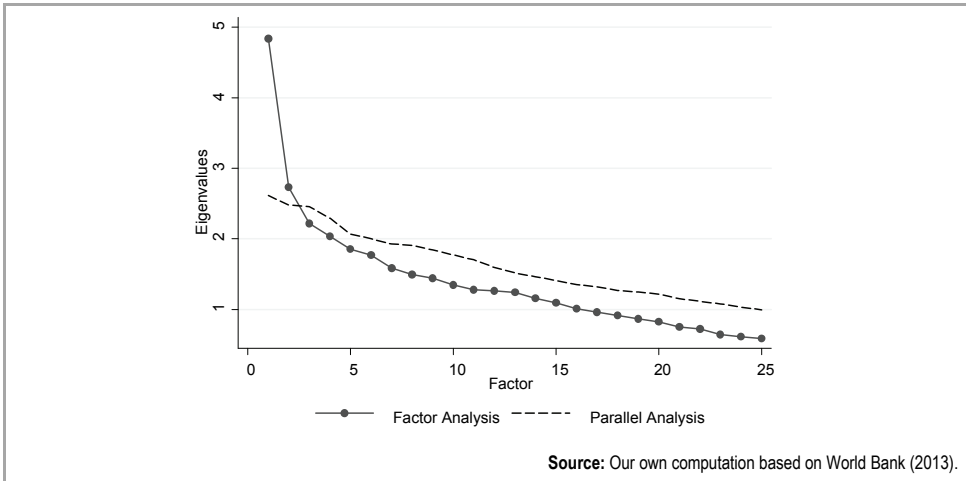
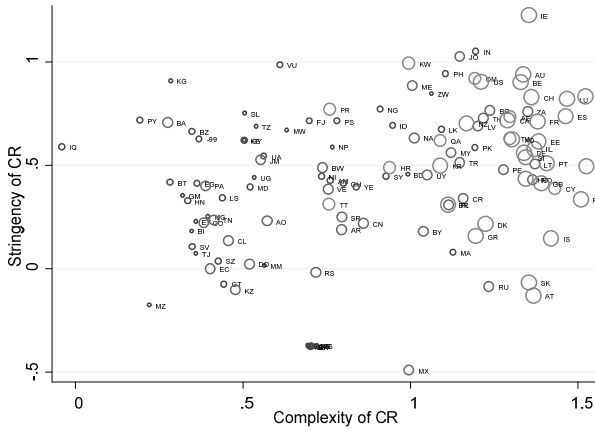


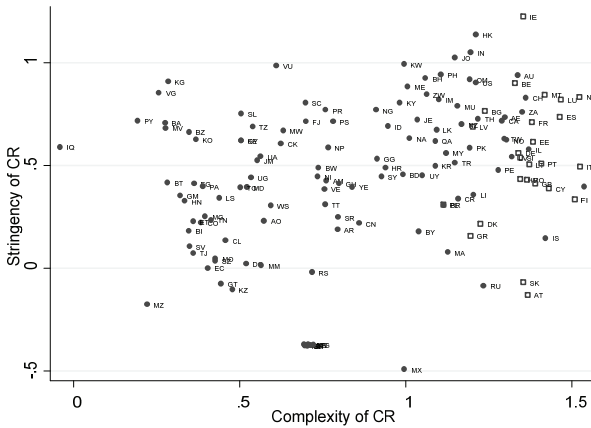
Figure 2 Parallel Analysis of the Imputed Data Based on Horn's (1965) Test



Note: The size of the circle indicates the level of income in the specific country. There are five sizes: (i) high-income, OECD; (ii) high-income, non-OECD; (iii) upper-middle-income; (iv) lower-middle-income; (v) low-income.

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

Figure 3 Factor Scores among Countries with Different Income Levels



Note: EU countries are denoted by squares, and non-EU countries by circles.

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

Figure 4 Factor Scores across EU and Non-EU Countries

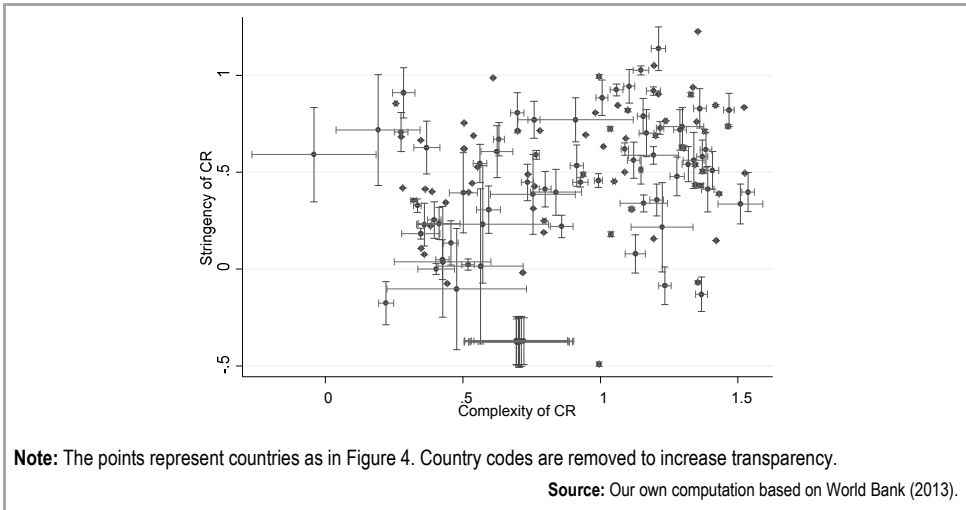


Figure 5 Factor Scores and Their Standard Errors due to MCMC Imputation

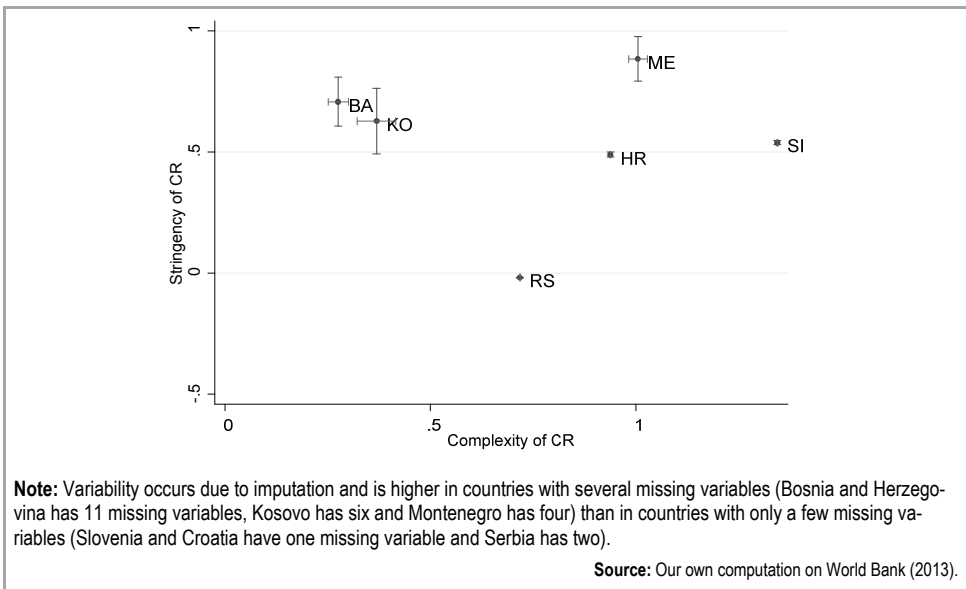


Figure 6 Factors Scores of Countries of the Former Yugoslavia and Standard Errors due to Imputation

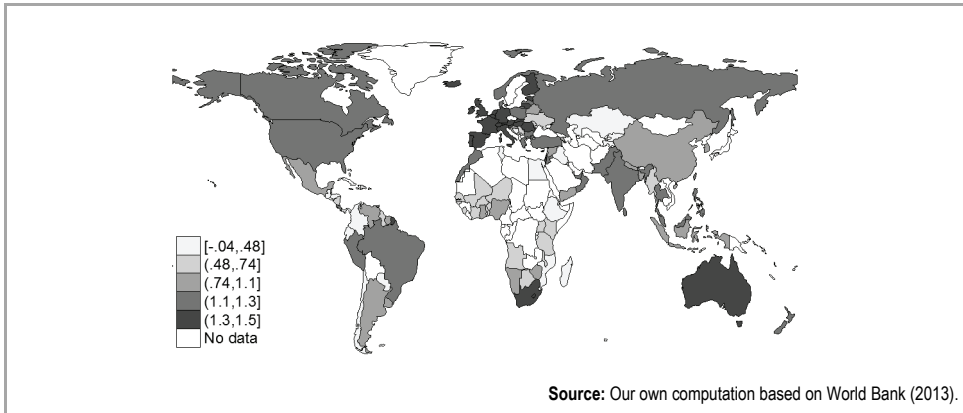


Figure 7 World Map of Complexity of Capital Regulation

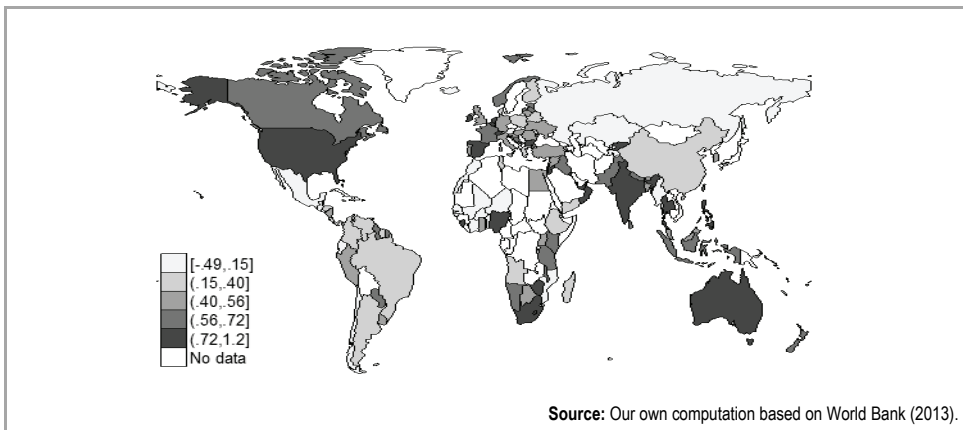


Figure 8 World Map of Stringency of Capital Regulation

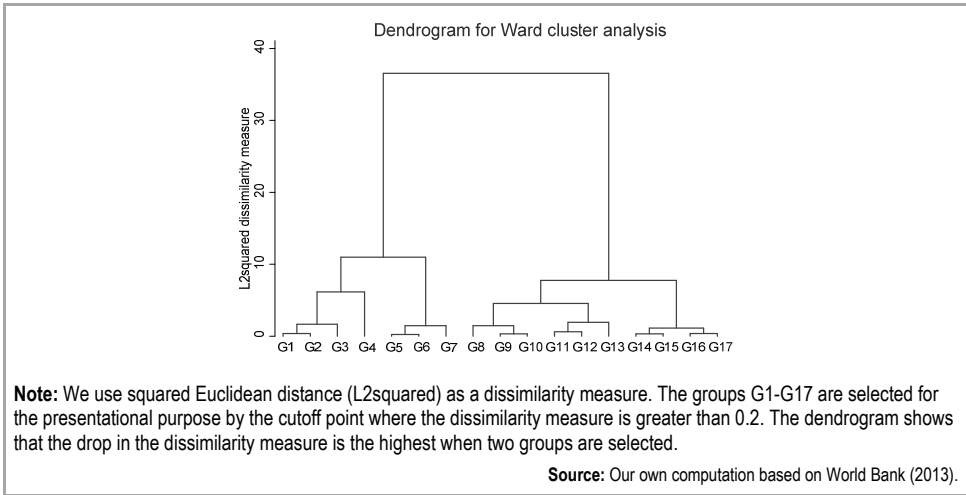


Figure 9 Dendrogram of Cluster Analysis (Ward Method) along the Two Factors of Capital Regulation

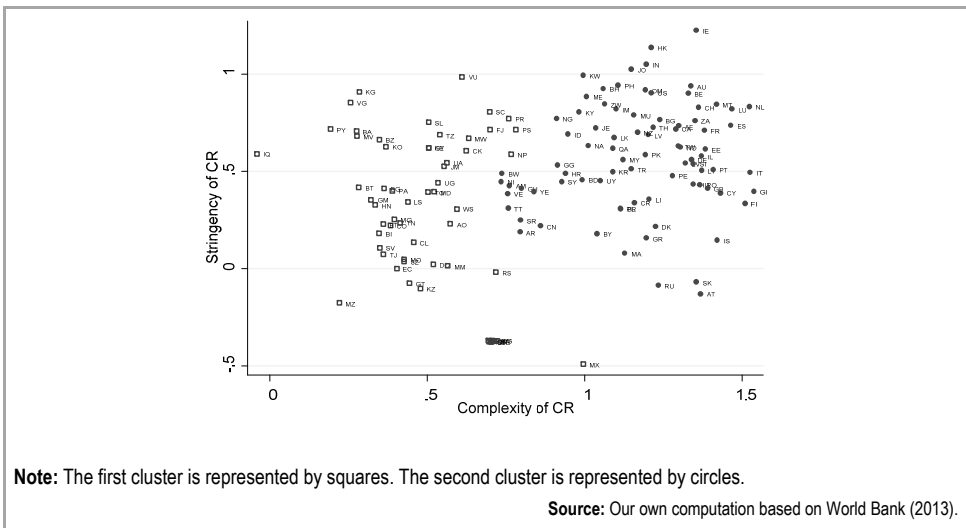


Figure 10 Two Clusters Based on the Ward Cluster Analysis on Two Factors of Capital Regulation