On-site audits, enforcement actions, and bank risk-taking

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Abstract

This paper investigates the role of enforcement actions, in terms of on-site audits and sanctions, in containing bank risk-taking. First a direct relationship is considered, while the combined effect of regulations and enforcement is analyzed thereafter. An inverted U-shaped relationship is established in examining the direct effect of audits on bank risk, whilst the relationship between risk and sanctions is found to be linear and negative. Concerning the combined effect of regulations and enforcement on bank risk-taking, we contend that enforcement and market discipline are important and complementary mechanisms in reducing bank risk. This does not hold for capital requirements that are proven an ineffective mechanism in controlling bank risk, even when they are supplemented with a high volume of on-site audits and sanctions.

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1. Introduction

The recent financial turmoil has stimulated substantial research attempting to identify the reasons of the crisis. Many interrelated explanations have been proposed,[1] but one of the most interesting involves supervisory inertia. The contemporary theoretical discussion eventually and increasingly embraces various arguments on this issue and places the role of (in)efficient supervision among the most prominent factors that contributed to the financial crisis (see e.g. Blanchard, 2008; Caprio et al., 2008). Spurred by this discussion, the present paper investigates empirically the role of regulatory enforcement in shaping bank risk-taking.

Provoked by the papers of Jackson (2005), Jackson and Roe (2008) and Coffee (2007) we determine enforcement output through the employment of data on on-site examinations (audits) and enforcement actions (sanctions). A number of reasons are provided on why we believe that the use of these enforcement outputs allows us to capture the effectiveness-alertness of bank supervisors in a direct, realistic and precise manner.[2] To this end, we build a new panel dataset that contains information on audits and sanctions for 17 countries over the period 1998-2007. This period begins after the Asian and Russian financial crises and ends in the dawn of the recent financial turmoil, thus providing ample room to identify whether enforcement actions (or non-actions) are related to the increased risk-taking by banks. As such, this paper examines first and foremost whether audits and sanctions have a negative and direct impact on bank risk-taking. Phrased differently, we ask whether supervisors that inspect banks regularly through on-site examinations and impose sanctions are able to restrain banks' risk-taking appetite.

At a secondary level, we examine the interrelation between the quality of banking supervision and the other two pillars of Basel II, namely capital adequacy requirements and market discipline-transparency. More specifically, we seek to assess whether it is the effective enforcement of the capital adequacy and disclosure regulation that is principally of essence to constrain banks' risky behavior. This second purpose of the paper is motivated by two facts. First, in the well-known database of Barth et al. (2001 and updates) that quantifies elements of bank regulation in the last decade, USA is among the top-rated countries; yet

[1] Intense financial innovation, excessive leverage, inadequate risk management systems, deficient accounting, capital adequacy and liquidity rules, defective corporate management compensation systems and loopholes in the regulation of influential market participants, like hedge funds and credit rating agencies, have all been recognized as features-failures of the existing financial architecture and held accountable for the unfolding market disorder.

[2] Related previous research on this issue focuses on measures like official investigatory powers and supervisory independence as reflected on law on the books, or somehow secondary-nonspecific measures like general "rule of law" and "government efficiency" indices generated on the basis of private rating agencies' evaluations.

USA is also the country where the financial turmoil initiated. The indices in this database include qualitative characteristics of bank regulation, but they do not include information on the number of enforcement actions per bank on an annual basis.[3] This may be important if one considers that on-site examinations and sanctions are probably the single most important constituent of enforcement. Second, there exists a large, whilst inconclusive literature on the effect of regulations pertaining to capital requirements and market discipline on bank risk-taking. We briefly review this literature and show that it mainly examines the direct effect of regulation indices on various proxies of bank risk or capitalization. Therefore, the many differences in the findings could be partially owing to the fact that countries with a good regulatory environment may not necessarily also have good enforcement of these laws. Given these issues it seems interesting to analyze how effective is the combined effect of law on the books and enforcement actions in shaping bank risk.

Note that from this perspective our research is different from most of the contemporary literature that separates the three Basel II components and seeks to study the impact that each one of these has on banking stability or performance. Our research approach is not only in harmony with but, at the same time, constitutes an evaluation of the rather neglected guiding principle adopted by the Basel Committee (Basel Committee, 2006) according to which market discipline (Pillar 3) supplements both minimum capital adequacy requirements (Pillar 1) and the supervisory review process (Pillar 2). The Basel Committee has taken the unambiguous position that the three pillars should not be viewed as being separate initiatives but rather as complementary parts of the general attempt to enhance the capital adequacy framework and its overall effectiveness and operation (Basel Committee, 2000). Indeed, improved disclosure allows both market participants and supervisors to assess key pieces of information on the capital adequacy of banks (especially after considering that Basel II provides for the use of internal methodologies in calculating capital requirements), thus allowing better monitoring of risky conduct.

In an effort to examine (i) the direct effect of enforcement actions and (ii) their combined effect with regulations on bank risk, we use bank-level data to measure risk. Risk is measured in terms of both risk of default (Z-index) and credit risk. The estimation results indicate that the impact of on-site examinations on either measure of bank risk is non-linear.

[3] In particular, these indices are constructed on the basis of answers to certain questions concerning the regulatory environment. One of these questions asks whether an external audit by certified/licensed auditor is a compulsory obligation for banks. Therefore the indices do not encompass information on the *actual-de facto* supervisory alertness; they only capture *formal-de jure* supervisory effectiveness. See also discussion in Section 3 below.

A remarkable finding is that the threshold level of audits above which its relationship with risk becomes negative is quite higher than the average audits per bank actually taking place in most western-type countries. In contrast, sanctions have a linear negative effect on risk. Concerning the combined effect of regulations and enforcement actions on bank risk-taking, we find that both the enforcement actions considered and regulation pertaining to market discipline are complementary mechanisms in reducing bank risk. However, a quite surprising result is that regulation of capital requirements does not have either a direct effect on risk or a combined one with enforcement actions. This result is in line with those analysts and researchers that are quite skeptic about the role of capital requirements in containing bank risk (Kim and Santomero, 1988; Financial Stability Forum, 2008; IMF, 2009).

The rest of this paper is organized along the following lines. Section 2 comments on the related literature and the theoretical background and forms explicitly the research questions. Section 3 describes the sample and variables to be used in the empirical analysis. In Section 4 the direct impact of enforcement actions on bank risk-taking is analyzed. Section 5 considers the combined effect of regulations and enforcement actions on bank risk. Finally, Section 6 concludes the paper.

2. Related literature and theoretical underpinnings

2.1. The disciplinary effect of supervisory enforcement

In general, existing literature considers the impact of enforcement actions on bank discipline, not risk-taking. In this section we review this literature, so as to make inferences regarding the potential enforcement-bank risk nexus. Wu (1969) has probably been the first to notice that bank examiners' criticisms on business loans are reasonably accurate, thus offering a good *ex ante* measure of loan quality. Wu's statement has been corroborated ever since by several studies (see e.g. relatively recent studies of Berger et al., 2000; DeYoung et al., 2001; and references therein), which tend to reach the general conclusion – with some, insignificant variations and different degrees of confidence – that on-site audits exercise a disciplinary role upon banks principally in three ways. First, they force the production of more accurate financial reports on the part of examined banks; second they enhance market discipline through public disclosure of the audits' findings; and third, they improve supervisory discipline as audits' discoveries may form the basis for the application of remedial actions by supervisory authorities.

In contrast, the empirical research focusing directly on the impact of supervisory sanctions upon banking discipline has been exceptionally scarce – not to say non-existent. In

fact, the importance of official, supervisory remedies has predominantly been elaborated on a theoretical root *via* the lens of the general law and compliance theory or approached in an indirect manner by part of the aforementioned research concerning on-site audits. From the theoretical standpoint, the materialization of legal standards (law on the books) through the employment of effective corrective measures is viewed as the means that gives the law "teeth to bite" and offers meaning to the otherwise "blank letter" of legal rules (see e.g. Black, 2001; Berglöf and Claessens, 2004). DeYoung et al. (2001) and Prescott (2004), among others, make the critical remark that the positive relationship between the frequency of on-site audits and banking discipline could be traced in several links, one of which is the fact that the information gained by supervisors following examinations enables them to impose direct costs upon imprudent banks through the application of appropriate remedial measures. A slight variation of the above argument is that on-site audits may transit to the market "regulatory discipline information". In other words, an unanticipated change of rating accompanied by regulatory restrictions or relieves, depending on the direction of the rating, may affect bank value. In the event of a rating downgrade and concomitant introduction of regulatory restrictions, the value of the bank is likely to decrease thus exerting disciplining power (Berger and Davies, 1998).

All in all, the research so far suggests that the frequency of on-site audits and the number of supervisory sanctions do, indeed, seem to have a positive correlation with banking discipline. Does, by extension, discipline extends to banks containing their risk-taking appetite? On this basis we can formulate our first research question as follows:

Question 1: Is the quality of supervisory enforcement, dictated as the number of on-site audits and sanctions, negatively linked with bank risk-taking?

2.2. The role of regulations

As already pointed out, our work employs additionally an integrated approach concerning the interplay between regulation and enforcement. To put it another way, besides the direct effect of enforcement on bank risk, we also investigate the combined effect that regulation and enforcement may have. This strategy is in line with the targets of the Basel Committee, which has explicitly stated that the three pillars of the Basel II framework should not be viewed as separate initiatives but rather as complementary parts of the general attempt to enhance the international capital adequacy regime (Basel Committee, 2000). Indeed, enhanced public disclosure about the nature, components and features of capital (Pillar 3 on

disclosure) not only improves market discipline and transparency by providing market participants with important information about the banks' risk exposures, risk assessment processes and, by implication, ability to absorb losses (Pillar 1 on capital adequacy), but also offers valuable assistance to the competent public authorities in efficiently exercising their supervisory duties (Pillar 2 on supervisory review).

In giving a role to regulations, our paper appears to be related with a broad literature on the direct impact of regulations, in terms of capital requirements and market discipline, on bank risk.[4] A division of this literature shares the view that increased transparency and the concomitant enhanced market discipline contribute significantly to the safeguarding of banking stability by limiting informational asymmetries, boosting private monitoring, facilitating supervisory oversight and thus forcing banks to adopt a more prudent risk-taking behavior (see e.g. Beck et al., 2006). Others, however, appear rather unconvinced, offering at least two reasons for such distrust. First, and considering that banks' returns are positively correlated, increased disclosure of information may undermine banking system fragility as depositors may overreact to adverse information about other banks and initiate a run on their bank (see e.g. Chen and Hasan, 2006). Second, compliance with information disclosure regulation not only entails direct (e.g. establishing and operating efficient information production and verification systems) and indirect (e.g. appropriation of disclosed information by rivals) costs, but may also reduce financial stability, as information leakage leads to pervasive free-riding of monitoring information and, by implication, to reduced profit margins (Hyytinen and Takalo, 2002).

Research on the relationship between capital adequacy regulation and banking stability is voluminous, yet the results are again mixed. The conventional view holds that capital adequacy regulation – especially concerning risk-weighted capital requirements – promotes banking stability in two ways: it serves as a cushion against unanticipated losses that threaten the solvency of banks and reduces banks' risk taking appetite by forcing the rebalancing of banks' portfolio in favor of safer assets (see e.g. Furlong and Keeley, 1989; Repullo, 2004). On the other hand, others suggest that risk-independent capital requirements may cause banks to hold a non-optimal asset portfolio as they are agnostic to the individual banks' different preference structures and allow risk-loving banks to bypass the restrictions via financial leverage and/or business risk (see e.g. Kim and Santomero, 1988). Furthermore, issuing equity to satisfy mandatory capital standards may lead to dilution of insiders'

[4] A different part of the literature deals with the relationship between deposit insurance and banks' risk-taking incentives (e.g. Demirgüç-Kunt and Detragiache, 2002; Fernández and González, 2005).

ownership and a fall of banks' stock price and market value, thus inciting supervisory authorities to abstain from effectively enforcing capital regulation (Besanko and Kanatas, 1996).

All things considered, therefore, the empirical and theoretical literature seems to have failed to reach consensus regarding the direct impact of capital regulation and disclosure requirements on banking stability. We contend that a field that probably deserves more attention as a possible explanatory factor of the diverse research outcomes is the role of enforcement of the aforementioned types of banking regulation. This is in line with Gilbert (1991) and Swindle (1995) who find that the impact of capital regulation depends on the quality of enforcement (which is not uniform). Breuer (2004) suggests that regulatory and supervisory improvements alone cannot reduce financial system risk unless they are complemented by accurate and timely information on banks' status. As sustained by Flannery and Thakor (2006), there are interesting linkages between informational transparency, regulatory supervision and capital requirements, with the former facilitating supervision and impinging on the design of capital requirements. Van Hoose (2007) reaches the interesting conclusion that capital regulation does not necessarily produce a regulator's preferred outcome if not accompanied by supervisory or market discipline. Blum (2008) reports that truthful revelation of banks' risks presumes that supervisors are able to detect and sanction dishonest banks. Finally, Borio and Zhu (2008) notice that, despite its increasing importance, research on the interaction between capital regulation and supervision and their influence on the behavior of the financial system is still rather limited. Given the above theoretical considerations it seems that the appropriate strategy is to examine the combined effect of enforcement and regulations on bank risk-taking. Thus, our second research question is formulated as follows:

Question 2: Is the combined effect of regulations and enforcement actions important in shaping bank risk-taking?

3. Data

We build a new dataset that encompasses information on sanctions and on-site bank examinations in seventeen countries over the period 1998-2007. The countries included are Australia, Bulgaria, Czech Republic, Germany, Greece, Hong Kong, Korea, Latvia, Luxembourg, Portugal, Romania, Russia, Serbia, Spain, Turkey, Ukraine and USA. The choice of these countries is motivated by the availability of data on examinations and

sanctions, as well as from the fact that they are representative of banking systems with different legal, regulatory and institutional origins. The latter element enhances the richness and the variability of the data on regulations. Bank risk is captured at the bank level, which yields richer information on individual bank strategies.

Information by country on the average number of supervised banks during the sample period and the actual number of banks for which the risk indicators are constructed is included in Table 1.[5] All data for the bank level variables are collected from Bankscope. We limit the empirical analysis to the unconsolidated statements of banks in order to reduce the possibility of introducing aggregation bias in the results. Only supervised banks are included in the sample and the percentage of banks in the sample to the total number of banks supervised is approximately equal to 76 per cent. During the sample period a number of M&As and bank failures took place, which are taken into account in our dataset so as to avoid selectivity bias. Also, the data were reviewed for reporting errors or other inconsistencies (zero or negative values for the variables used) and some observations are excluded accordingly.

3.1. On site examinations and sanctions

Data on on-site audits and supervisory enforcement actions are obtained from the annual reports produced by the national supervisory authorities that are responsible for the conduct of banking supervision within each jurisdiction (the supervisory authorities for each country are reported in Table 1). The actual variables employed are constructed as the number of on-site audits and sanctions per bank in the supervisory jurisdiction in each country, in each year. This is the first study that employs a panel of cross-country data for these variables.[6] The panel is unbalance, with a total of 145 observations. Note that we encapsulate *actual-de facto* banking supervisory effectiveness by employing data from on-site examinations and enforcement actions. We have valid reasons to believe that, by gauging enforcement outputs, we are able to capture supervisory effectiveness in a more accurate and pragmatic manner.

Specifically, the pioneering work of Jackson (2005) and Jackson and Roe (2008) acknowledges that the enforcement inputs that they use (i.e., regulatory budgets and staffing) provide a rough approximation of supervisory efficiency due to inherent problems

[5] The number of both the supervised banks and the banks included in the sample naturally differs on a yearly basis. The full sample reporting the numbers on a yearly basis is available on request.
[6] The dataset of Barth et al. (2001, 2004, 2008) provides data in specific years for on-site examinations only and therefore it does not allow a study on the basis of panel data.

concerning data inconsistency and completeness. In this context, it is suggested that it would be more useful to "collect information on the *actual* enforcement activities" including enforcement actions and on-site examinations (Jackson and Roe, 2008). Second, enforcement inputs do not tell the full story about supervisory efficiency, as even adequately-funded supervisors may well be "captured" by the regulated entities and thus display enforcement sluggishness (Coffee, 2007).

Owing to the lack of data, related works so far have been attempting to approach supervisory effectiveness in an indirect manner. For example, La Porta et al. (2006) measure "public enforcement quality" in securities markets by examining five official attributes of supervisory authorities (i.e., independence, dismissal of supervisors' key members, range of supervised sectors, power to promulgate regulations, scope of supervisory-investigatory powers, ability to impose non-criminal and criminal sanctions). Yet, as the data is derived from law on the books, the results merely capture *formal-de jure* supervisory effectiveness as opposed to *actual-de facto* supervisory alertness (Jackson and Roe, 2008).[7] The same goes for the papers of Neyapti and Dincer (2005) and Dincer and Neyapti (2008) measuring the quality of banking supervision. The work of Noy (2004) should also fall within the same methodological division as it measures supervisory quality *via* the employment of three different proxies, namely, the degree of corruption, the state of political freedom and the level of Central Bank independence.

The estimations that have been made jointly by the IMF and the World Bank for the Financial Sector Assessment Program (FSAP) to measure supervisory effectiveness and which have been employed by a noteworthy part of various literatures (e.g. Das and Quintyn, 2002; Čihák and Tieman, 2008) occupy a somehow middle ground between evaluating the letter of the law and utilizing surveys. The IMF and the World Bank consider that examining the degree of compliance with the 25 Basel Committee Core Principles for effective banking supervision ("Basel Core Principles", "BCPs") constitutes a reliable benchmark against which the effectiveness of bank supervisory regimes can be assessed. To this end, the FSAP involves assessments of the letter of law while also requiring examiners to meet with supervisors and private sector participants in conjunction with third party expert review of the draft assessments. Nonetheless, in attempting to strike the aforementioned delicate balance between the two research methodologies, the FSAP appears to borrow, to a certain

[7] As noticed by Jackson and Roe (2008), a supervisor that enjoys wide investigatory powers may avoid making use of these powers in practice, thus displaying a low enforcement record. In this case, therefore, the "investigatory power" index based upon law on the books may well provide a flattering picture of supervisory effectiveness.

extent, the shortcomings of each of them; that is an element of rigidity and incompleteness as a result of ignoring enforcement of formal rules and an aspect of subjectivity due to the intervention of experts' opinions. In addition, striving to assess compliance with inherently vague and broadly drafted principles like those of the BCPs leaves much room for manoeuvre and different interpretations, thus casting doubt on the reliability of the final evaluations (Das and Quintyn, 2002).

Our intuition to select data for the remedial measures imposed and on-site inspections conducted by banking supervisory authorities as a substitute for the efficacy of enforcement and, by extension, of supervisory effectiveness is consistent with our objective to capture *actual-de facto* supervisory alertness and is further supported by both Basel II and relevant research. According to the second pillar of the Basel II, supervisory review is expected to assess banks' internal capital adequacy assessments and strategies, risk management and control systems, as well as credit institutions' ability to monitor and ensure compliance with regulatory capital ratios (Basel Committee, 2006). To this end, supervisory review should involve some combination of on- and off-site inspections, discussions with bank management, review of external auditors' work and periodic reporting. In case that supervisors are not satisfied with the result of the review process, appropriate remedial measures should be taken making use of the formal enforcement powers conferred upon them (Hüpkes et al., 2005; Basel Committee, 2006). On-site inspections, in particular, occupy a central position within the supervisory arsenal, as they enable supervisors to detect signs of management deficiencies before financial performance deteriorates, while also providing independent verification of both internal control/ risk management systems' quality and the reliability of information produced by banks (Basel Committee, 2002; Bernanke, 2006). It should come as no surprise, therefore, that on-site examinations along with off-site monitoring and enforcement actions are considered as the main tools that supervisors enjoy in order to ensure the stability of the system (Quintyn and Taylor, 2002).

3.2. Bank risk-taking

We proxy the risk-taking behavior of banks by both the ratio of non-performing loans to total loans (*npl*) and the Z-index, in alternative specifications. The first measure reflects the quality of bank assets, i.e. the potential adverse exposure to earnings and asset market values owing to deteriorating asset quality. Since a portion of non-performing loans will probably result in losses for the bank, a high value for this ratio is unwanted. In fact, the higher this ratio, the more capital a bank normally requires to support the loan portfolio. It is

thought that a target number for this variable is 1.5 per cent; however, the trend is the most important thing to observe because bank risk is inherently dynamic in nature. Data for this variable are obtained from Bankscope and descriptive statistics are given in Table 2. The mean value equals 0.023, with countries like Bulgaria, Romania, Hong Kong and Korea obtaining high values in the beginning of the sample period[8] and countries like Australia and Germany having the lower *npl* ratios.

The Z-index, in turn, represents a more universal measure of bank risk-taking and is defined as $Z = (ROA + EA)/\sigma(ROA)$, where *ROA* is the rate of return on assets, *EA* is the ratio of equity to assets and $\sigma(ROA)$ is an estimate of the standard deviation of the rate of return on assets. To calculate the standard deviation of *ROA* we use data on *ROA* from the two previous years and we verified that using three or four years produces very similar results. This risk measure is monotonically associated with a measure of bank's probability of failure and has been widely used in the empirical banking and finance literature (see e.g. Boyd et al., 2006). A higher Z indicates that the bank is more stable (more distant from insolvency). Since Z is highly skewed, we use its natural logarithm, which is normally distributed. Z obtains a mean value equal to 3.81 in our sample. The correlation of the Z-score with *npl* is negative and takes a value of -0.689, while low Z-scores are reported in countries with high credit risk (e.g. the Asian countries in the first years of our sample and some transition countries). High average *Z*-scores are reported in 2006 owing to high profitability.[9]

In additional robustness checks we confirmed our baseline results when using other measures of risk such as the ratio of loan loss provisions to total loans or the simple volatility of the return on assets $\sigma(ROA)$. The first measure reflects the adequacy of provisions to cover potential loan losses. The advantage of suing this variable is that it incorporates banks' forecasts about future levels of credit risk. Yet, a potential disadvantage is that provisioning rules differ between countries, so that observed data may not be directly comparable across banks. $\sigma(ROA)$, in turn, is more useful in studies that want to separate the volatility of assets from the volatility of leverage. Therefore, we report the results on the basis of *npl* and Z, while the rest of the regressions are available on request.

3.3. Capital requirements and market discipline

[8] The transition economies of our sample inherited a high volume of non-performing loans from the old centralized regime. For Korea and Hong Kong the 1997 financial crises is responsible for the high values of non-performing loans observed in the beginning of the period.

[9] Descriptive statistics on a country basis for the bank-level variables are available on request.

This paper follows the theoretical considerations of existing literature closely in selecting appropriate data on specific types of regulation in terms of capital requirements and market discipline. To quantify these two classes of regulation we use the approach followed by Barth et al. (2001).[10] We briefly discuss these indices below, while additional information can be found in Appendix A.

The first index *(caprq)* shows the extent of both initial and overall capital stringency. Initial capital stringency refers to whether the sources of funds counted as regulatory capital can include assets other than cash or government securities and borrowed funds, as well as whether the regulatory or supervisory authorities verify these sources. Overall capital stringency indicates whether risk elements and value losses are considered while calculating the regulatory capital. Higher values of *caprq* indicate more stringent capital requirements. The second index (*mdisc*) reflects the degree to which banks are forced to disclose accurate information to the public (e.g. disclosure of off-balance sheet items, risk management procedures, etc.) and whether there are incentives to increase market discipline such as subordinated debt and an absence of deposit insurance schemes. Descriptive statistics for these variables are reported in Table 2.

3.4. Other bank- and country-level control variables

In the estimated equations we control for a number of bank- and country-level variables (see Table 2 for descriptive statistics). At the bank-level we control for liquidity using the ratio of liquid assets to total assets. Banks with higher liquid assets have a less risky portfolio and thus a lower value of non-performing loans. However, these banks may also be less profitable as risk-free assets do not give yield and therefore high liquidity may be associated with lower Z-scores. Also, if liquidity standards are in place then banks may have incentives to take on higher risks, which is a behavior consistent with a moral hazard mechanism. Another bank-specific control variable is bank size, which is proxied by the natural logarithm of real total assets. Larger banks are usually more profitable owing to economies of scale and/or possible market power in loans or deposits. Therefore, we expect a

[10] This approach has been also followed by Fernandez and Gonzalez (2005), Pasiouras et al. (2006) and Buch and DeLong (2008) among others. An alternative would be to use principal component analysis as in Beck et al. (2006). Barth et al. (2004) have followed both approaches, mentioning that on the one hand the drawback of using the summation for the construction of the index is that it assigns equal weight to each of the questions, whereas on the other hand the disadvantage of the first principal component is that it is less obvious how a change in the response to a question modifies the index. While they only report the empirical results on the basis of the latter approach, they mention (p. 218) that "*we have confirmed all this paper's conclusions using both methods*".

positive association of bank size with the Z-score. Yet, larger banks may also have incentives to increase their credit risk if they consider themselves to be in the "too-big-to-fail" group of banks. Therefore, the impact of size on credit risk is ambiguous.

Concerning the variables pertaining to the institutional, regulatory and macroeconomic environment, first note that we employ an index of economic freedom (obtained from the Heritage Foundation), which is designed to measure the degree to which a nation's policies and institutions protect its citizens' economic freedom. In addition, we control for the level of economic development using the real GDP per capita and for price stability and monetary conditions using the inflation rate (both these variables are taken from the World Development Indicators). Finally, we control for restrictions on bank activities, which is again constructed on the basis of the Barth et al. (2001) approach. This index (we name it *actrs*) is determined by considering whether securities, insurance, real estate activities, and ownership of non-financial firms are unrestricted, permitted, restricted, or prohibited (for more information, see Appendix). On the one hand, higher restrictions on bank activities may enforce the separation of financial intermediation functions thereby reducing risks (see e.g. John, et al., 1994). A similar pattern would be observed if higher restrictions generate conflicts of interests in the underwriting process (Kang and Liu, 2007). On the other hand, this separation may lead to diseconomies of scale and reduced profits, which would increase the risk of insolvency (see e.g. Barth et al., 2004). We examine which impact prevails in the empirical analysis that follows.

4. On-site examinations, sanctions and bank risk

4.1. Estimation method

Given the considerations discussed above, the direct relationship between enforcement actions and bank risk-taking is examined in terms of the following equation:

$$r_{it} = \alpha + \delta r_{it-1} + \beta_1 audits_t + \beta_2 sanctions_t + \beta_3 reg_t + \beta_4 b_{it} + \beta_5 c_t + u_{it} \quad (1)$$

where the risk variable *r* of bank *i* at time *t* is written as a function of the lagged dependent variable; time-dependent variables *audits* and *sanctions* that correspond to the number of on-site examinations and sanctions per bank in each year (in logarithmic terms); the indices that reflect the regulatory conditions in the banking systems examined, *reg*; a vector of bank-level control variables, *b*; variables that capture the institutional and macroeconomic conditions common to all banks, *c*; and the error term *u*. Correlations between the variables used in Eq. (1) are not high enough so as to have multicollinearity problems (see Table 3). This is

interesting as regards the *audits* and *sanctions* variables, as it implies that these variables – even though positively correlated – do not capture the same aspect of enforcement.

We should note here that new regulatory initiatives are unlikely to affect the risk-taking behavior of banks in the immediate term. If regulations affect risk-taking, then it is expected that there are lags between establishing new banking laws or taking new policy initiatives (that will be reflected in the corresponding indices) and the time that these laws or initiatives are translated into more sound banking practices. Therefore, to the very best, the regulatory practices of the previous period are expected to impact the contemporaneous level of bank risk-taking. In fact, in the estimations below, we will be using both the first and the second lags of the regulation variables to ensure robustness of the results.

A traditional econometric concern in a simple regression of bank risk is the potential endogeneity of some of the right-hand side variables. In the context of the present analysis, these concerns are well-justified if one considers that a history of high bank risk may force supervisors to improve the quality of enforcement at some point in time. The opposite may also be true: if the supervisor observes a long period of stable risk-taking by banks and the financial and economic environment also seems stable, he may be motivated to relax enforcement thereby raising banks' incentives to increase their risk-taking activities. In these cases, endogenous effects prevail and OLS estimation of Eq. (1) would produce biased estimates.

Another element of potential estimation bias in estimating risk equations is the fact that bank-level risk tends to persist. At least four theoretical reasons can be provided to backup these dynamics. First, persistence may reflect the existence of intense competition, which tends to alleviate the risk-taking of banks (see e.g. Keeley, 1990; Cordella and Yeyati, 2002). Second, relationship-banking with risky borrowers will have a lasting effect on the levels of bank risk-taking, despite the fact that dealing repeatedly with the same customer will improve efficiency. A similar mechanism would prevail if bank networks are in place or if the banking industry is opaque. Third, to the extend that bank risk is associated with the phase of the business cycle, banks may require time to smooth the effects of macroeconomic shocks. Fourth, risks may persist owing to regulation. In particular, deposit guarantees or capital requirements may exacerbate moral hazard issues leading to inefficient and risky investments over a considerable period of time. And, finally, besides these theoretical arguments, the potential impact of stock variables on flow variables may be better approximated by a dynamic formulation (Laeven and Magnoni, 2003).

Within this framework the choice of a dynamic empirical model is well-justified, and the coefficient on the lagged risk variable δ may be viewed as the speed of convergence to equilibrium. A value of δ statistically equal to 0 implies that bank risk is characterized by high speed of adjustment, while a value statistically equal to 1 means that the adjustment is very slow. Values between 0 and 1 suggest that risk persists, but will eventually return to its normal (average) level. Finally, δ takes implausible (negative) values if convergence to equilibrium cannot be achieved, which probably indicates a problem with the dataset (i.e. very small time dimension of the panel).[11]

Given the above, we start with an OLS estimation of Eq. (1), but we resort to the system GMM estimator proposed by Blundell and Bond (1998) for inference. Besides accounting for the specified dynamics, this estimator has two additional virtues. First, it does not break down in the presence of unit roots (for a proof see Binder et al., 2003) and second it accommodates the possible endogeneity between the risk and enforcement variables by means of appropriate instruments. The second and third lags of the dependent, enforcement (audits and sanctions), regulatory[12] and bank-level variables serve as instruments. Treating these independent variables symmetrically with the dependent implies that they are assumed to be endogenous and this is in line with the theoretical discussion above. In addition, we use the first, second and third lags of the GDP per capita and inflation variables as instruments. This treatment of the macroeconomic variables is in line with the assumption that banks and regulators choose their strategy when they observe the state of the economic environment in the beginning of the period (i.e. the macroeconomic variables are treated as predetermined). Longer lags of the variables are not included because then the estimated equations are overidentified. All in all, by providing a series of tests, we show that (i) the estimates are robust, (ii) the equations are not overidentified and (iii) the series are not autocorrelated.

4.2. Estimation results

[11] For more on these issues, see Nerlove (2002).

[12] The variables reflecting different forms of regulation may be predetermined or endogenous depending on the sequence of events of the game played between banks and regulators. In particular, if banks observe the level and type of regulation and then choose their level of risk optimally, regulations should be treated as a predetermined variable. If regulations are indeed predetermined, then the first and longer lags of these variables are valid instruments. However, it may also be the case that in an effort to prevent financial turbulence, regulators enact new laws at the time they observe excess risk-taking. To the extent that the risk-taking of banks explains bank regulatory initiatives of this kind, this will be reflected in our regulation indices of that particular year. Hence, as the treatment of the regulatory variables as endogenous encompasses their treatment as predetermined, we assume that *caprq*, *mdisc* and *actrs* are endogenous variables. For further discussion on these issues, see Bond (2002).

The results from estimating Eq. (1) are provided in Table 4. Equations I-IV include the results of the Z-score regressions and equations V-VIII the results of the *npl* ones. Specifications I and V are estimated using OLS, wile the rest of the equations are estimated using the GMM method described above. The OLS regressions pose an immediate challenge since most of the control variables appear statistically insignificant, thus contradicting our theoretical priors as regards these variables. In contrast, the results based on the GMM method are more appealing, while the specification tests imply that the equations are well-specified. In particular, the Sargan test for overidentifying restrictions rejects the relevant hypothesis, which implies that the instruments used are valid. Even though some of the equations indicate that first-order autocorrelation (AR1) is present, this does not imply that the estimates are inconsistent. Inconsistency would be implied if second-order autocorrelation was present (Blundell and Bond, 1998), but this case is rejected by the test for AR2 errors.

The results of the Z-score and the *npl* equations are very similar in terms of inference and the coefficients usually bear the expected sign. An exception is the coefficient on *audits* in equations II and VI, which shows that on-site examinations do not have a significant impact on the Z-index, while they have a positive effect on credit risk. This result is counterintuitive and, therefore, we opt for a deeper investigation of the impact of on-site examinations in specifications III, IV, VII and VIII. In particular, we consider the existence of non-linearity in the effect of on-site audits on bank risk. Indeed, the results show that the relationship between *audits* and bank risk variables is non-linear (U-shaped in the Z-index regressions and inverted U-shaped in the *npl* ones). Increased sanctions, on the other hand, have a negative and highly significant effect on bank risk, a finding that remains stable among all alternative GMM regressions. Note that we have examined whether the pattern in the sanctions-risk relationship is also non-linear, yet no such evidence is found (the squared term of sanctions is insignificant).[13]

Our results lead to attractive conclusions for policy makers and supervisors alike. First, it appears that enforcement actions do have a statistically significant disciplinary effect upon banks. Therefore, it is corroborated that by imposing direct or reputation costs upon banks supervisory sanctions contribute considerably to constraining banks' risk-taking appetite. On the other hand, our inference on the inverted U-shaped relationship between on-site audits and banking fragility confirms the perception that the frequency of examinations

[13] These results are provided on request.

holds the key. It seems that on-site audits have a negative effect upon risk-taking when their number exceeds a certain threshold. This is either because banks are considering that they have been placed at the spotlight by supervisors – which essentially increases the probability of becoming subject to enforcement actions – or because the market may become suspicious as a result of the intense supervisory scrutiny. In fact, this threshold can be calculated by the absolute value of the ratio of β_1 over two times the coefficient on the squared term of *audits*. This derivative gives a value of 2.18 audits per bank for specification III, 2.12 for specification IV, 2.06 for specification VII and 2.36 for specification VIII. Note that the average value from the four specifications is 2.18, which is higher than the mean audits per bank observed in most countries of our sample (see Table 1). It is interesting noting that in the USA, where the recent financial crises initiated, the number of on-site examinations per bank was 0.81 in 2005, 0.79 in 2006 and 0.74 in 2007. All these imply that regulators should consider to substantially increase the number of on-site examinations (close to the number of two per bank every year) if they seek in it an effective mechanism in reducing either the risk of default or credit risk. Conclusively, our results show that the answer to Question 1 above is an unequivocal yes as regards sanctions. Concerning the number of on-site examinations per bank our analysis shows that regulators in most western type economies need to increase audits if they want to restrain bank risk and this offers an element of consideration regarding the sources of the crisis.

Concerning the rest of the control variables, our findings are close to expectations. A higher volume of liquid assets in bank portfolios reduces Z-scores and increases credit risk. This result is probably explained by the two mechanisms described above. First, banks that hold a high volume of liquid, low yield assets are less profitable and second, a more hazard mechanism may be in place if liquidity requirements are in place. Bank size is positively related with the Z-index, yet its impact on credit risk is insignificant. This shows that larger banks are more profitable possibly owing to economies of scale and/or market power,[14] while the role of size in managing credit risk is negligible. Concerning the macroeconomic variables, in countries with a high level of development (i.e. high GDP per capita) banks have a higher Z-index and credit risk is lower, while high inflation is associated with lower Z-scores and a high volume of non-performing loans. These results are intuitive, since in

[14] Of course this holds to the extent that bank size is positively correlated with bank market power, which is another controversial discussion in banking surrounding the so-called structure-conduct-performance and efficient-structure hypotheses.

developed and financially stable countries bank insolvency problems are less frequent and a lower amount of resources is used by banks to forecast the future levels of inflation.

The basic specifications are augmented in columns IV and VIII by the regulatory variables. Apparently, our results seem to confirm that part of the research discussed in Section 2, which implies a negative correlation between disclosure requirements (*mdisc*) and bank risk-taking while casting doubt on the efficiency of capital regulation (*caprq*) as a disciplinary mechanism. This is not to say, of course, that capital adequacy requirements are redundant but rather that transparency regulation should come at the forefront of regulators' and supervisors' agendas, as it constitutes the prerequisite layer and supplement for effective banking supervision (including supervision of capital requirements) and market discipline (Flannery and Thakor, 2006; Van Hoose, 2007).

Our finding that regulatory restrictions on banking activities tend to reduce risk taking (negative impact of *actrs* on bank risk variables) appear, on the one hand, to challenge the somewhat prevalent empirical view favoring the universal banking model (see e.g. Barth et al., 2004; Ramirez, 2002). On the other hand, these findings may be backed up by the line of research arguing that integrated banks do generate conflicts of interests in the underwriting process (e.g., Kang and Liu, 2007) and may increase risk taking (e.g. John, et al., 1994; Boyd et al., 1998). It is worth noting that in these specifications the economic freedom variable is positively linked to the Z-index and negatively linked to *npl*. This implies that when controlling for activity restrictions, increased economic freedom lowers bank risk, possibly owing to increased flows from abroad and better diversification of bank risk.[15]

We conclude this section by using the second lags of the regulation variables instead of the first lags employed in the estimations so far. To save space, we do not include these results in Table 4 but we report the coefficients on the variables of main interest in the following equation (estimation method is GMM, dependent variable is the Z-index and t-statistics are reported in parentheses):

[15] Despite the fact that this is probably beyond the scope of the present analysis, we proceed a step further on this issue and we examine whether the negative relationship between activity restrictions and bank risk holds regardless of the level of economic freedom of the countries in our sample. Therefore, we additionally estimate an equation that includes an interaction term between the variables *actrs* and *economic freedom*. The results (with the Z-index as dependent variable) suggest that the higher the economic freedom in a country, the less significant the impact of activity restrictions on bank risk. However, we leave it for future research to identify separately the two effects of activity restrictions, as set out in Section 3.4 above, and which one prevails in countries characterized by higher or lower economic freedom.

$$r_{it} = \underset{(8.25***)}{0.381} r_{it-1} - \underset{(-2.28**)}{0.363} audits_t + \underset{(2.85***)}{1.867} sanctions_t + \underset{(2.39**)}{0.091} audits_t^2 + \underset{(0.82)}{0.193} caprq_t + \underset{(1.84*)}{0.411} mdisc_t$$
$$+ \underset{(2.98***)}{0.801} actrs_t \quad \text{(p-values of tests are Wald: 0.000; AR1: 0.092; AR2: 0.025; Sargan: 0.183)}$$

Obviously, the changes in the coefficients with respect to the specifications included in Table 4 are negligible, while the same holds for the credit risk equation. This is probably due to the fact that there are only minor and gradual changes in the regulatory indices over time and therefore the length of the dynamics is not a crucial element in shaping bank risk.

5. The combined effect of regulations and enforcement on bank risk

To answer the second question set out in Section 2, concerning the combined effect of enforcement actions and regulations on bank risk-taking, we consider the following specification:

$$r_{it} = \alpha + \delta r_{it-1} + \beta_1 audits_t + \beta_2 sanctions_t + \beta_3 reg_t + \beta_4 audits_t * reg_t + \beta_5 sanctions_t * reg_t + \beta_6 b_{it} + \beta_7 m_t + u_{it} \quad (2)$$

Unfortunately, the products of *reg* with *audits* and *sanctions* are highly multicollinear with the levels of these variables and cannot be included simultaneously in the regressions. This is a common problem among studies that employ interaction terms and can be partially solved by "centering" the variables. Centering means computing the mean of each independent variable and then replacing each value with the difference between it and the mean. After centering the variables the correlation between the products and their levels falls below 0.50.

Note that *actrs* is not interacted with the enforcement variables, since we are investigating whether and to what extent it is the effectiveness of banking supervision (Pillar 2 of Basel II) in connection with two specific types of regulation constituting the other two pillars of Basel II, namely capital and disclosure regulation, that has a bearing on banking stability. The estimation results are reported in Table 5. The first three specifications correspond to Z-index regressions and the latter three to *npl* regressions. Given the results of the previous section, we resort only to equations that include the squared term of audits and we use the GMM method. Also, we only report estimates of the regulatory variables lagged once, since above we did not find any changes in the results when the second lags were used instead. Again the Sargan test shows no overidentifying restrictions and the AR2 test no second order autocorrelation.

We view our results, as particularly important for the regulatory and supervisory architecture. More specifically, we find that the relationship between effective supervision of

disclosure requirements (i.e. the product of *mdisc* with either *audits* or *sanctions*) and risk-taking is negative and statistically significant. This is in contrast to the combined effect of banking supervision and capital regulation (i.e. the product of caprq with either *audits* or *sanctions*), which appears insignificant. These findings imply that the regulatory and supervisory perseverance with capital *vis a vis* transparency regulation is unwarranted. In addition, the direct impact of *mdisc* on bank risk is negative and significant, *caprq* remains insignificant (much like in Table 4) and the variables *audits* and *sanctions* have the same effect with the one reported in Table 4. Thus, in addition to the individual, direct effect of enforcement and market discipline on bank risk, there is also an amplifying combined effect of these variables. These results carry through irrespective of whether we include only the product of *audits* with *reg* (specifications I and IV), only the product of *sanctions* with *reg* (specifications II and V) or all products simultaneously (specifications III and VI).

In this respect, our research sheds some light on the discussion that led to Question 2 above and has clear policy implications. The findings contradict the "conventional wisdom" – also reflected into Basel II – concerning the supremacy of capital regulation as a risk-control device and seem to be in line with the latest voices that emerged subsequent to the sub-prime crisis placing increasing weight upon more vigorous and better enforced transparency requirements (see e.g. Senior Supervisors Group, 2008; Financial Stability Forum, 2008; IOSCO, 2008; Basel Committee, 2009; IMF, 2009). From this perspective, our work validates the criticism that Caprio et al. (2008) leveled against Basel II for devoting just "16 pages to issues of market discipline and 225 pages to spelling out formulas and strategies impeded in pillar one and options for national discretion authorized in pillar two".

The impact of the rest of the control variables is not altered compared with the results reported in Table 4. A notable exception is the impact of economic freedom, which is now positive and statistically significant in all the Z-index regressions and negative in the *npl* ones. Much like before, higher GDP per capita and lower inflation implies a less risky environment for banks. Finally, as regards the bank-level variables, high levels of liquid assets tend to lower profits and increase risk-taking and size again enters with a positive and significant coefficient in the Z-index regressions (negative and significant coefficient in the *npl* regressions).

6. Conclusions

[To be added]

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Table 1
Supervisory authorities and average on-site audits and sanctions per bank

Sample countries	Supervisory authorities responsible for the conduct of banking supervision	Audits per bank	Sanctions per bank	Average No. of supervised banks	Average No. of banks in the sample
Australia	Australian Prudential Regulation Authority	0.836	0.060	248.1	205.3
Bulgaria	Bulgarian National Bank	0.606	0.664	33.6	28.3
Czech Republic	Czech National Bank	0.296	0.350	42.1	34.1
Germany	(a) Bundesaufsichtsamt für das Kreditwesen (b) Bundesanstalt für Finanzdienstleistungsaufsicht	0.151	0.021	2586.2	2121.0
Greece	Bank of Greece	3.519	0.418	61.8	49.7
Hong Kong	Hong Kong Monetary Authority	1.096	0.061	237.9	210.3
Korea	Financial Supervisory Service	10.330	3.450	59.3	50.1
Latvia	Financial and Capital Market Commission	1.332	0.248	23.4	19.4
Luxembourg	Commission de Surveillance du Secteur Financier	0.254	1.085	178.5	158.4
Portugal	Banco de Portugal	0.290	0.139	64.5	60.2
Romania	National Bank of Romania	1.356	0.591	40.2	34.7
Russia	Central Bank of the Russian Federation	1.551	1.119	1839.9	1651.2
Serbia	(a) National Bank of Yugoslavia (b) National Bank of Serbia	0.590	0.804	42.5	40.1
Spain	Banco de Espaňa	1.572	0.047	358.9	307.7
Turkey	(a) Bankacilik Düzenleme ve Denetleme Kurumu (b) Banking Regulation and Supervision Agency	3.735	1.086	73.9	68.5
Ukraine	National Bank of Ukraine	4.365	0.187	162.4	145.3
USA	(a) Office of the Comptroller of the Currency (b) Federal Deposit Insurance Corporation	0.741	1.284	11298.2	8022.7

Notes: The table lists the supervisory authorities of the countries included in our sample and reports the average number of audits and sanctions per bank during the sample period. The table also reports the average total number of supervised banks in each country during the sample period and the average actual number of banks used in this study.

Table2
Descriptive statistics

Variable	Mean	Std.Dev.	Min	Max
Z-index	3.810	1.308	-1.223	9.813
npl	0.023	0.045	0.004	0.401
audits	1.700	2.623	0.086	20.254
sanctions	0.639	0.895	0.000	5.278
liquidity	0.043	0.051	0.003	0.482
bank size	13.010	3.031	10.150	20.171
ecfreedom	65.621	11.857	45.700	90.600
gdpcap	13908.9	13855.8	591.0	54482.1
cpi	10.051	15.919	-6.152	88.023
caprq	5.219	1.277	2.000	8.000
mdisc	6.106	1.019	4.000	8.000
actrs	2.169	0.520	1.250	3.250

Notes: The table reports basic descriptive statistics for the variables used in the empirical analysis. The variables are defined as follows: Z-index is defined as ln[Z=(ROA+EA)/σ(ROA)], where ROA is the ratio of profits before tax to total assets and EA is the ratio of equity to total assets; npl is the ratio of non-performing loans to total loans; audits is the number of on-site audits per bank in each year; sanctions is the number of sanctions per bank in each year; liquidity is the ratio of liquid bank assets to total assets; size is the natural logarithm of total bank assets; ecfreedom is the composite index of economic freedom obtained from the Heritage Foundation; gdpcap is the natural logarithm of GDP per capita of the country; inflation is the inflation rate (CPI) of each country; caprq is the Barth et al. (2001) index of capital requirements; mdisc is the Barth et al. (2001) index of market discipline; actrs is the Barth et al. (2001) index of activity restrictions.

Table 3
Correlations between the explanatory variables

	audits	sanctions	liquidity	size	ecfreedom	gdpcap	inflation	caprq	mdisc	actrs
audits	1.000									
sanctions	0.456	1.000								
liquidity	-0.047	0.067	1.000							
bank size	-0.017	0.190	-0.123	1.000						
ecfreedom	-0.139	-0.198	-0.533	-0.023	1.000					
gdpcap	-0.125	-0.152	-0.526	0.021	0.567	1.000				
inflation	0.067	0.090	0.307	0.189	-0.482	-0.503	1.000			
caprq	-0.337	0.112	0.199	0.090	-0.002	0.014	-0.130	1.000		
mdisc	0.288	-0.248	-0.377	-0.112	0.423	0.334	-0.307	0.034	1.000	
actrs	0.157	0.109	0.157	0.175	-0.172	-0.167	0.218	-0.282	-0.089	1.000

Notes: The table reports correlation coefficients between the independent variables used in the empirical analysis. The variables are defined as follows: audits is the number of on-site audits per bank in each year; sanctions is the number of sanctions per bank in each year; liquidity is the ratio of liquid bank assets to total assets; size is the natural logarithm of total bank assets; ecfreedom is the composite index of economic freedom obtained from the Heritage Foundation; gdpcap is the natural logarithm of GDP per capita of the country; inflation is the inflation rate (CPI); caprq is the Barth et al. (2001) index of capital requirements; mdisc is the Barth et al. (2001) index of market discipline; actrs is the Barth et al. (2001) index of activity restrictions.

Table 4
Risk, on-site audits and sanctions

	I	II	III	IV	V	VI	VII	VIII
	Z-index	Z-index	Z-index	Z-index	npl	npl	npl	npl
lagged dependent		0.342	0.371	0.364		0.449***	0.483***	0.453***
		(7.11)	(7.98)	(7.91)		(8.56)	(10.11)	(10.22)
audits	-0.301*	0.123	-0.362**	-0.360**	0.276	0.493**	1.009***	1.141***
	(-1.70)	(0.95)	(-2.23)	(-2.15)	(1.20)	(2.49)	(4.03)	(4.44)
sanctions	1.773**	1.816***	1.891***	1.895***	-0.153	-1.282**	-1.299**	-1.100**
	(2.33)	(2.69)	(3.27)	(3.41)	(-0.18)	(-2.40)	(-2.55)	(-2.28)
audits squared			0.083**	0.085**			-0.245***	-0.233***
			(2.12)	(2.21)			(-3.09)	(-3.01)
liquidity	-0.037	-0.070**	-0.071**	-0.071**	0.226***	0.061**	0.060**	0.066**
	(-1.63)	(-2.43)	(-2.47)	(-2.46)	(2.84)	(2.39)	(2.34)	(2.53)
bank size	0.085**	0.096***	0.096***	0.098***	-0.020	-0.033	-0.037*	-0.041*
	(2.34)	(3.10)	(3.11)	(3.23)	(-0.81)	(-1.67)	(-1.74)	(-1.82)
ecfreedom	-0.004	-0.013	-0.014	0.063**	0.094	-0.011	0.010	-0.192**
	(-0.07)	(-0.64)	(-0.67)	(2.61)	(0.57)	(-0.13)	(0.14)	(-2.58)
gdpcap	0.496	3.026***	3.014***	3.001***	-15.403***	-5.773***	-5.597***	-5.179***
	(0.35)	(3.16)	(3.03)	(2.74)	(-3.78)	(-7.18)	(-7.31)	(-7.55)
inflation	0.010	-0.045**	-0.047**	-0.051**	0.167***	0.141***	0.103***	0.169***
	(0.62)	(-1.99)	(-2.08)	(-2.30)	(2.68)	(4.01)	(3.07)	(5.82)
caprq				0.201				0.114
				(0.79)				(0.37)
mdisc				0.407*				-0.566*
				(1.81)				(-1.91)
actrs				0.830***				-2.680***
				(3.31)				(-3.46)
R-squared	0.298				0.425			
Fixed effects	0.000				0.000			
Wald-test		0.000	0.000	0.000		0.000	0.000	0.000
AR1		0.093	0.101	0.087		0.072	0.069	0.088
AR2		0.021	0.027	0.032		0.001	0.003	0.011
Sargan		0.168	0.172	0.169		0.361	0.228	0.216

Notes: The table presents estimations on the relationship between risk, on-site audits and sanctions. Estimation method is OLS (with fixed effects) for specifications I and V and dynamic panel GMM for the rest. In specifications I, II, III and IV the dependent variable is the Z-index and in specifications V, VI and VII the ratio of nonperforming loans to total loans (npl). The explanatory variables are defined as follows: audits is the number of on-site audits per bank in each year; sanctions is the number of sanctions per bank in each year; liquidity is the ratio of liquid bank assets to total assets; bank size is the natural logarithm of total bank assets; ecfreedom is the composite index of economic freedom obtained from the Heritage Foundation; gdpcap is the natural logarithm of GDP per capita of the country; inflation is the inflation rate (CPI) of each country; caprq is the Barth et al. (2001) index of capital requirements; mdisc is the Barth et al. (2001) index of market discipline; actrs is the Barth et al. (2001) index of activity restrictions. The table reports coefficients with t-statistics in parentheses, the R-squared and Fixed effects (p-value) tests for the panel OLS regressions the Wald test of the joint significance of the coefficients (p-value), the tests for first (AR1) and second (AR2) order autocorrelation and the Sargan test for overidentifying restrictions. *, ** and *** denote significance at the 10, 5 and 1 per cent, respectively.

Table 5
The combined effect of regulation and enforcement on bank risk-taking

	I	II	III	IV	V	VI
	Z-index	Z-index	Z-index	npl	npl	npl
lagged dependent	0.328***	0.341***	0.334***	0.388***	0.401***	0.449***
	(6.25)	(6.89)	(6.40)	(9.72)	(10.20)	(10.73)
audits	-0.387**	-0.391**	-0.392**	3.269***	3.254***	3.205**
	(-2.45)	(-2.51)	(-2.53)	(2.86)	(2.79)	2.68
sanctions	1.881***	1.864***	1.872***	-0.820**	-0.817**	-0.820**
	(3.10)	(2.98)	(3.05)	(-2.32)	(-2.23)	(-2.37)
audits squared	0.097**	0.102**	0.103**	-0.046***	-0.041***	-0.045***
	(2.55)	(2.60)	(2.62)	(-3.19)	(2.82)	(-3.21)
liquidity	-0.071**	-0.073**	-0.073	0.065**	0.064**	0.065**
	(-2.50)	(-2.55)	(-2.56)	(2.40)	(2.35)	(2.42)
bank size	0.098***	0.097***	0.098***	-0.039*	-0.040*	-0.033
	(3.13)	(3.11)	(3.12)	(-1.83)	(-1.86)	(-1.65)
ecfreedom	0.071***	0.070***	0.072***	-0.201**	-0.217**	-0.220**
	(2.71)	(2.70)	(2.73)	(-2.48)	(-2.61)	(-2.65)
gdpcap	3.001***	3.012***	3.011***	-5.145***	-5.105***	-5.133***
	(3.10)	(3.15)	(3.15)	(-7.03)	(-6.32)	(-6.71)
inflation	-0.047**	-0.052**	-0.048**	0.165***	0.167***	0.166***
	(-2.09)	(-2.14)	(-2.09)	(5.10)	(5.23)	(5.20)
caprq	0.252	0.214	0.227	-0.121	-0.015	-0.120
	(0.91)	(0.83)	(0.85)	(-0.69)	(0.05)	(-0.71)
mdisc	0.623**	0.639**	0.638**	-0.787**	-0.780**	-0.792**
	(2.18)	(2.27)	(2.27)	(-2.33)	(-2.25)	(-2.41)
actrs	0.912**	0.921**	0.916**	-2.550***	-2.562***	-2.573***
	(2.45)	(2.51)	(2.48)	(-3.12)	(-3.41)	(-3.59)
audits*caprq	-0.026		0.031	-0.133		-0.146
	(-0.10)		(0.17)	(-1.10)		(-1.31)
audits*mdisc	0.827**		0.815*	-0.367***		-0.381***
	(1.98)		(1.85)	(-2.85)		(-2.95)
sanctions*caprq		0.330	0.345		-0.180	-0.321
		(0.72)	(0.79)		(-0.60)	(-0.87)
sanctions*mdisc		0.986***	1.003***		-1.826***	-1.877***
		(2.91)	(3.00)		(-3.44)	(-3.61)
Wald-test	0.000	0.000	0.000	0.000	0.000	0.000
AR1	0.103	0.091	0.093	0.135	0.122	0.147
AR2	0.027	0.031	0.029	0.040	0.033	0.041
Sargan	0.207	0.301	0.286	0.224	0.205	0.219

Notes: The table presents estimations on the relationship between risk, on-site audits and sanctions. Estimation method is GMM for dynamic panels. In specifications I, II and III the dependent variable is the Z-index and in specifications IV, V and VI the ratio of nonperforming loans to total loans (npl). The explanatory variables are defined as follows: audits is the number of on-site audits per bank in each year; sanctions is the number of sanctions per bank in each year; liquidity is the ratio of liquid bank assets to total assets; bank size is the natural logarithm of total bank assets; ecfreedom is the composite index of economic freedom obtained from the Heritage Foundation; gdpcap is the natural logarithm of GDP per capita of the country; inflation is the inflation rate (CPI) of each country; caprq is the Barth et al. (2001) index of capital requirements; mdisc is the Barth et al. (2001) index of market discipline; actrs is the Barth et al. (2001) index of activity restrictions. The table reports coefficients with t-statistics in parentheses, the R-squared and Fixed effects (p-value) tests for the panel OLS regressions the Wald test of the joint significance of the coefficients (p-value), the tests for first (AR1) and second (AR2) order autocorrelation and the Sargan test for overidentifying restrictions. *, ** and *** denote significance at the 10, 5 and 1 per cent, respectively.

Appendix. Information on regulatory variables

Variable	Category	Description
caprq	Capital requirements	This variable is determined by adding 1 if the answer is yes to questions 1-6 and 0 otherwise, while the opposite occurs in the case of questions 7 and 8 (i.e. yes=0, no =1). (1) Is the minimum required capital asset ratio risk-weighted in line with Basle guidelines? (2) Does the ratio vary with market risk? (3-5) Before minimum capital adequacy is determined, which of the following are deducted from the book value of capital: (a) market value of loan losses not realized in accounting books? (b) unrealized losses in securities portfolios? (c) unrealized foreign exchange losses? (6) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (7) Can the initial or subsequent injections of capital be done with assets other than cash or government securities? (8) Can initial disbursement of capital be done with borrowed funds?
mdisc	Market discipline	This variable is determined by adding 1 if the answer is yes to questions 1-7 and 0 otherwise, while the opposite occurs in the case of questions 8 and 9 (i.e. yes=0, no =1). (1) Is subordinated debt allowable (or required) as part of capital? (2) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries? (3) Are off-balance sheet items disclosed to public? (4) Must banks disclose their risk management procedures to public? (5) Are directors legally liable for erroneous/misleading information? (6) Do regulations require credit ratings for commercial banks? (7) Is an external audit by certified/licensed auditor a compulsory obligation for banks? (8) Does accrued, though unpaid interest/principal enter the income statement while loan is non-performing? (9) Is there an explicit deposit insurance protection system?
actrs	Restrictions on banks activities	The score for this variable is determined on the basis of the level of regulatory restrictiveness for bank participation in: (1) securities activities (2) insurance activities (3) real estate activities (4) bank ownership of non-financial firms. These activities can be unrestricted, permitted, restricted or prohibited that are assigned the values of 1, 2, 3 or 4 respectively. We use an overall index by calculating the average value over the four categories.

Note: The individual questions and answers were obtained from the World Bank database developed by Barth et al. (2001) and updated in more recent studies by the same authors.