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On-site audits, sanctions, and bank risk-taking: An empirical overture towards a novel regulatory and supervisory philosophy

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Abstract

This paper investigates the role of banking supervision, measured in terms of enforcement outputs (i.e., on-site audits and sanctions) in containing bank risk-taking. Our results on the direct banking supervision–risk-taking correlation show an inverted U-shaped relationship between on-site audits and bank risk, while the nexus between enforcement actions and risk appears linear and negative. With respect to the combined effect of efficient supervision and banking regulation (in the form of capital and transparency requirements) we find that effective supervision and disclosure prerequisites are important and complementary mechanisms in reducing bank fragility, by contrast to capital requirements which are proven rather futile in controlling bank risk, even when supplemented with a higher volume of on-site audits and enforcement actions.

JEL Classifications: G21; G32; G38
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1. Introduction

The recent financial turmoil has stimulated substantial research attempting to identify the reasons of the crisis and propose recovery measures. A handful of more or less interrelated explanations have been proposed,[1] but one of the most interesting that has been consistently gaining ground involves supervisory inertia (e.g., Blanchard, 2008; Caprio et al., 2008). Spurred by this reorientation of theoretical discussion towards the efficiency of banking supervision,[2] our paper investigates empirically the relationship between supervisory effectiveness (or supervisory alertness) and banks' risk-taking incentives.

Provoked by the papers of Jackson (2005), Jackson and Roe (2008) and Coffee (2007) we determine supervisory effectiveness by measuring enforcement outputs through the employment of data on enforcement actions (sanctions) and on-site audits. We believe that the use of enforcement outputs allows us to capture the effectiveness-alertness of bank supervisors in a more direct and precise manner in comparison to previous research that primarily focuses on law-on-the books indices (e.g., official investigatory powers and supervisory independence as reflected on law on the books) or somehow secondary-nonspecific measures (e.g., general "rule of law" and "government efficiency" indices generated on the basis of private rating agencies' evaluations). To this end, we build a new panel dataset that contains information on on-site audits and enforcement actions 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 the effectiveness of banking supervision is related to the increased risk-taking by banks observed in recent years. As such, this paper examines first and foremost whether on-site audits and enforcement actions have a negative and direct impact on bank risk-taking. Phrased differently, we ask whether supervisors that inspect banks more regularly and adopt a more forceful enforcement attitude are better positioned to restrain banks' risk-taking appetite.

At a derivative 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. Two reflections have inspired this latter objective of the paper. First, according to the prevailing perception mainly instigated by the notorious law and finance research of La Porta et al. (e.g., 1998 and 2006), common law countries appear to outperform civil law countries as far as regulatory and supervisory quality in the

financial services field is concerned. Somehow paradoxically, nonetheless, it is precisely the core of the common law system, i.e., US and UK that originated and suffered the most from the current financial turmoil. We are concerned, therefore, that the proxies used by empirical research for supervisory quality could only capture *formal-de jure* as opposed to *actual-de facto* supervisory alertness. Second, we are aware that a considerable amount of empirical research examines the effect of banking regulation pertaining to capital requirements and market discipline on bank risk-taking, yet the results are rather mixed. After briefly reviewing the relevant literature, we discern that is it mainly the direct effect of banking regulation indices on various proxies of bank risk or capitalization that is scrutinized. Consequently, we have reasons to suspect that the aforementioned inconclusive findings could be partially attributed to the different level of supervisory effectiveness across countries. It seems interesting, therefore, to analyze the combined effect of banking regulation and supervision on bank risk.

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 independent 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 distinct 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 banking supervision and (ii) its combined effect with banking regulations (i.e., capital and transparency requirements) 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. A remarkable finding is that the threshold level of audits beyond which its relationship with risk becomes negative is quite higher than the average number of examinations per bank actually taking place in most

western-type countries. In contrast, enforcement actions exert a linear negative impact on risk. Turning our attention to the effect of interplay between banking regulation, supervision and risk we obtain two appealing inferences for regulatory and supervisory policy-making. First, it appears that transparency regulation exercises a significant disciplinary effect upon banks' risk-taking appetite both directly and when viewed in a combined fashion with effective banking supervision. Second, and quite surprisingly, our results fail to establish a similar correlation for capital adequacy requirements, that is, capital regulation, either directly or through its effective supervision, does not seem to significantly curtail risk-taking by banks. Essentially, our findings purport that regulatory and supervisory insistence on capital vis a vis transparency regulation rather exaggerates and, as a result, the pendulum of regulatory and supervisory attention should swing towards enhancing market discipline.

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 banking supervision on bank risk-taking is analyzed. Section 5 considers the combined effect of banking supervision and banking regulations on bank risk. Finally, Section 6 concludes the paper.

2. Related literature and theoretical underpinnings

To set the discussion in context and construct our basic research questions, we offer a brief literature review of the literature that is associated with our work.

2.1. The disciplinary effect of banking supervisory enforcement

The amount of research empirically investigating the disciplinary effect of on-site banking audits has been fairly ample. 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 focusing on the predictive and corrective character of bank examinations regarding loans' quality (e.g., Berger et al., 2000; DeYoung et al., 2001; Bhattacharya et al., 2002; Gunther and Moore, 2003). All of them tend to reach the general conclusion that on-site audits exercise a disciplinary power 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 (e.g., Black, 2001; Bhattacharya and Daouk, 2002). Swindle (1995), 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 transmit 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 suggests that the frequency of on-site audits and the number of supervisory sanctions should have a positive correlation with banking discipline. On this basis we can formulate our first empirical question as follows:

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

2.2. The interrelation between banking stability, supervisory effectiveness and banking regulation

As already discussed, consistent with the contemporary research and regulatory trend, our work employs a more integrated approach concerning the interplay between banking supervision and regulation. To put it another way, besides exploring the direct effect of enforcement on bank risk, we also attempt to offer a more integrated approach of the three

Basel II ingredients by studying whether it is the efficient supervision (Pillar 2) of capital adequacy (Pillar 1) and transparency (Pillar 2) regulation, in particular, that has a bearing on banking stability. From this perspective, our work appears to be also related with that string of literature focusing on the direct relationship between banking regulation in the form of capital adequacy and disclosure requirements, on the one hand, and banking fragility, on the other hand.[3]

A respectable division of the research 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 (e.g., Beck et al., 2006; Nier and Baumann, 2006). Others, however, appear rather unconvinced, offering at least two reasons for such distrust. First, and considering that the returns of banks 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 (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).[4]

The literature 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 (e.g., Furlong and Keeley, 1989; Cuoco and Liu, 2006). On the other hand, another part of the literature seems to display less enthusiasm, contesting 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 (e.g., Kim and Santomero, 1988). Furthermore, issuing equity to satisfy mandatory capital standards may lead to dilution of insiders' 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). Third, it may be the case that

capital adequacy requirements increase risk. As capital regulation reduces future profits, banks have diminished incentives to avoid default since they have less to lose in the case of bankruptcy; moreover, considering that capital rules elevate the value of equity to the banks, the latter are incited to increase risk today in order to acquire a higher amount of equity tomorrow in case of success (Blum, 1999).[5]

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. Empirical and theoretical research has now been progressively shifting its attention to examining the interplay between supervisory-enforcement quality, banking regulation (capital and transparency requirements) and banking fragility. In this context, the work of Gilbert (1991) and Swindle (1995) is particularly stimulating as they find that the impact of capital regulation depends on the quality of enforcement, which is not uniform across different supervisory authorities. On the same line, Decamps et al. (2004) conclude that market discipline is a useful complement to supervision and capital requirements: indirect market discipline (i.e., signals provided by market prices of banks' securities) can modulate the intensity of supervisory interventions – with the exception of periods of crisis where prices become erratic –, while direct market discipline (i.e., modifying the liability structure of banks) can be effective provided that banking supervisors are protected from political interference. 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. Moreover, 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, with Blum (2008) reporting 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.

After considering the aforementioned theoretical and empirical discussion, we assume that it would be interesting and novel to examine the combined effect of supervisory

enforcement (i.e., on-site audits and sanctions) and banking regulation (i.e., capital and transparency requirements) on bank risk-taking. Thus, our second research question is formulated as follows:

Question 2: Is the combined effect of effective supervisory enforcement and banking regulation, in the form of capital and transparency requirements, important in shaping bank risk-taking appetite?

3. Data

As already underlined, a core innovation of our work refers to the construction and employment of a new proxy for supervisory quality that has been based on enforcement outputs. More specifically, in measuring supervisory effectiveness, our study concentrates upon the enforcement constituent of supervision through the collection and elaboration of data on banking supervisory authorities' remedial measures (sanctions) and on-site inspections. 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 variability of our data. 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.[6] 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.[7] The panel for these variables is unbalanced and consists 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.

More 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 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).[8] 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.

A different method that has been used to assess supervisory quality is through the employment of surveys-questionnaires (e.g., Claessens, 1996; Barth et al., 2001 and 2004; 2008). Without any intention whatsoever to underestimate the contribution of this seminal string of literature, it would be plausible to assume that the answers and the assignment of scores unavoidably entail some degree of judgment and cannot accurately capture actual implementation of law on the books. On the other hand, however, it is worth noticing that the aforementioned measures provide an excellent proxy for the regulatory and supervisory environment (law on the books), hence they will be employed in the empirical analysis that follows as a proxy for the regulatory environment.

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 the literature (e.g., Sundararajan et al., 2001; 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 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 supporting 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 factor 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[9] 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. The particular 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 (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.[10]

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 using 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 seek 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

In order to quantify capital and transparency requirements we use the approach followed by Barth et al. (2001).[11] 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, for example,

via the issuance of subordinated debt and the abolition 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 offer yield and, therefore, high liquidity may be associated with lower Z-scores. Moreover, 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 generation mechanism. An additional 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. As a result, we expect a positive association between bank size and the Z-score. Nonetheless, 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. Consequently, the impact of size on credit risk is ambiguous.

In connection with the variables pertaining to the institutional, regulatory and macroeconomic environment, 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 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. The latter 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, please refer to the Appendix). Theoretical literature has identified both advantages and disadvantages in allowing banks to offer a wide range of financial services, with the emphasis being placed on the provision of investment services (e.g., Gande, 2008). First, conflicts of interests may arise as banks may misstate a borrower's quality and underwrite securities at inflated prices in order to service outstanding loans, as well as

misguide their depositors to acquire such securities (e.g., Kang and Liu, 2007). Furthermore, banking stability may be undermined as entry into new business lines also gives rise to new types of risks for banks (e.g., John et al., 1994; Boyd et al., 1998). On the other hand, however, the preponderance of empirical research not only appears to negate the contention regarding the emergence of conflicts of interests (e.g., Ang and Richardson, 1994; Kroszner and Rajan, 1994), but also suggests that, in the course of monitoring their loans, banks obtain valuable information placing them in a unique position to certify the issuance of securities by their clients (e.g., Puri, 1996). Moreover, integrated banks may enjoy economies of scale and scope in the combined provision of banking and investment services (e.g., Ramírez, 2002), and also become more stable as a result of wider asset diversification (e.g., White, 1986; Benston, 1989; Barth et al., 2004; Angkinand, 2009). We examine which impact prevails in the empirical analysis that follows.

4. The direct impact of banking supervision on bank risk

4.1. Estimation method

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

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

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 potentially new regulatory initiatives are unlikely to affect the risk-taking behavior of banks in the immediate term. If regulations do affect risk-taking incentives, then it is expected that there are lags between adopting 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 materialized 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: in the presence of a prolonged period of prudent risk-taking banking behaviour and stable financial and economic environment, supervisory authorities may become more lax in enforcing banking regulations, 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 calculating 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 (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 extent 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. Finally, above and beyond the aforementioned theoretical considerations, the potential impact of stock variables on flow variables may be better approximated by a dynamic formulation.

Within this framework the choice of a dynamic empirical model (i.e., one including a lagged dependent variable) 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).[12]

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 inferences. Besides accounting for the specified dynamics, the latter 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[13] and bank-level variables serve as instruments. Treating these independent variables symmetrically with the dependent implies that they are assumed to be endogenous, which, essentially, 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 corresponds to the assumption that banks and regulators choose their strategy when they observe the state of the economic environment at the beginning of the period (i.e., the macroeconomic variables are treated as predetermined). Longer lags of the variables are not included because, in that case, 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

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 coefficient on the lagged dependent variable seems to persist to a moderate extent, implying that risk will eventually return to its normal (average) level (see discussion above). The Sargan test for overidentifying restrictions rejects the relevant hypothesis, thus suggesting that the instruments used are valid. Even though some of the equations indicate that first-order autocorrelation (AR1) is present, this does not indicate 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 constant 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).[14]

Our results lead to appealing 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 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). Very interestingly, it seems that in the US, where the origins of the recent financial turmoil are traced, the number of on-site examinations per bank has been gradually diminishing from 0.81 in 2005 to 0.79 in 2006 and 0.74 in 2007. Essentially, one cannot resist the temptation to argue that one of the causes for the ongoing subprime crisis has been the lack of adequate, "preventive" auditing of the US

banking system; on the same line, it appears that supervisors should consider to substantially increase the number of on-site examinations (close to the number of two per bank every year according to our sample) if they see in them an effective mechanism to condense either the risk of default or credit risk. Conclusively, our results offer an unequivocal "yes" to Question 1 as far as the impact of enforcement actions is concerned and a qualified defense in the form of an inverted U-shaped relationship concerning the relationship between on-site audits and banking fragility. Evidently, this very last inference indicates that prevention of banking crisis might become more likely to the extent that supervisory authorities adopt a more precautionary approach via intensifying on-site examinations. The recent financial turbulence suggests that the costs associated with the more vigorous implementation of a supervisory policy with a strong deterrent character may be more than outweighed by the benefits of safegurading the safety and soundness of the banking system.

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 that have already been discussed above. First, banks that hold a high volume of liquid, low yield assets are less profitable; and second, a moral hazard mechanism may be prevail 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, presumably owing to economies of scale and/or market power,[15] while the role of size in managing credit risk is negligible. As far as the macroeconomic variables are concerned, it appears that, in countries with a high level of development (i.e., high GDP per capita), banks are assigned with a higher Z-index with credit risk exposure being lower, while high inflation is associated with lower Z-scores and a high volume of non-performing loans. These results are intuitive considering that, in developed and financially stable countries, bank insolvency problems are less frequent and fewer resources are employed 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 appear, on the one hand, to challenge the somewhat prevalent empirical view favoring the universal banking model (see the discussion above under 3.4), but, on the other hand, seem to be in harmony with those worried opinions suspecting that the Glass-Steagall repeal should also be partially blamed for the current financial turmoil (Kuttner, 2007; Zombanakis, 2008; Kaufman, 2009). It is worth noting that in the relevant specifications the economic freedom variable is positively linked to the Z-index and negatively linked to *npl.* This insinuates 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.[16]

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):

$$r_{it} = \underset{(8.25***)}{0.381} r_{it-1} - \underset{(-2.28**)}{0.363} audits_t + \underset{(2.85***)}{1.867} sanctions_t + \underset{(2.39**)}{0.091} audits_t^2 + \underset{(0.82)}{0.193} caprq_{t-1} + \underset{(1.84*)}{0.411} mdisc_{t-1} + \underset{(2.98***)}{0.801} actrs_{t-1}$$

(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 banking supervision and banking regulations on bank risk

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

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

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. Moreover, we only report estimates of the regulatory variables lagged once, as we did not find any changes in the results after using the second lags instead. Again, the Sargan test shows no overidentifying restrictions and the AR2 test no second order autocorrelation.

We consider that our results not only shed some light on the discussion that led to Question 2 but are also particularly inspiring, pointing to a shift of regulatory and supervisory philosophy. 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. 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. The 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).

The findings imply that the regulatory and supervisory perseverance with capital *vis a vis* transparency regulation is unwarranted. By extension, our work appears to 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 (e.g., Financial Stability Forum, 2008; IOSCO, 2008;

Basel Committee, 2009; IMF, 2009). From this perspective, our research 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, whereas size, once more, enters with a positive and significant coefficient in the Z-index regressions (negative and significant coefficient in the *npl* regressions).

6. Conclusions

As the recent subprime crisis unfolds, researchers and policy-makers are struggling to comprehend the causes and articulate exit plans. A proliferation of papers from diverse scientific fields has seen the light of publicity propagating the idea of another "New Deal", of a novel "financial architecture", the common denominator of all being encapsulated into two words: better – and in some cases more – regulation and supervision.

Inspired by the law and finance literature, our work approaches the problem posed by the triptych "banking regulation-supervision-risk" from a different and, we believe, more pragmatic angle. More specifically, we distinguish between banking regulation (i.e., law on the books) and supervision (i.e., actual implementation of law on the books) and move on to assess their individual/ stand-alone and combined effect on the risk-taking behaviour of banks. By placing emphasis on capital and transparency requirements as far as banking regulation is concerned, our work essentially offers an empirical assessment of the effect that the interplay among the three Basel II pillars (i.e., Pillar 1: capital requirements, Pillar 2: transparency/market discipline, Pillar 2: effective supervision) has upon banking fragility. Our innovation to measure supervisory effectiveness by using a panel of cross-country data on enforcement outputs (i.e., on-site audits and enforcement actions) provides us with the opportunity to approach the interrelation among regulation, supervision and risk in a more direct and realistic manner while also offering our work a dynamic character as it allows capturing the evolution-trend of the aforementioned relationship.

We consider that the inferences of our analysis may be of particular value for regulators and supervisors alike, especially in the aftermath of the current financial turmoil. First, it appears that enforcement actions do exert a disciplinary power upon banks, while our finding on the inverted U-shaped relationship between on-site audits and banking fragility indicate that intensifying the frequency of examinations beyond a certain threshold may also constrain risk-taking. Second, from a regulatory point of view, we obtain evidence of a statistically significant, negative relationship between disclosure requirements and bank risk-taking, whereas no such correlation is substantiated as far as capital regulation is concerned. On the same line, we conclude that strengthening banking supervision of transparency requirements offers an important apparatus against excessive risk-taking on the part of banks, while, by contrast, the combined effect of efficient banking supervision and capital requirements fails to provide statistically significant results. All in all, it seems not only that regulatory and supervisory persistence with capital adequacy constraints is rather unwarranted, but also that regulatory and supervisory agendas should be re-oriented placing more weight on the adoption and effective implementation of disclosure requirements. Essentially, therefore, our proposal for more transparency regulation and market discipline coincides with the recent comment made by Caprio et al. (2008) that the fundamental goal of supervisors should be to ensure that risks are fully understood and fairly priced by investors. Finally, our finding that regulations placing restrictions on banking activities are negatively correlated with risk-taking encourages the supporters of a Glass-Steagall-type regulation.

Our work might provide stimulus for further research and fine-tuning in many respects. To begin with, obtaining more data on enforcement outputs would allow the classification of our results according to legal origins (i.e., common law, civil law, German-Scandinavian legal systems) and, thus, provide a more direct link and opportunity for interesting comparisons with the rest of the law and finance literature employing data from law on the books or questionnaires. Moreover, it would be interesting to look into the data on enforcement outputs and discern the areas of regulations enjoying less compliance, as well as categorize the types of enforcement actions taken by supervisors (e.g., criminal v. administrative proceedings) and assess their effect on risk-taking. Finally, after acquiring and elaborating data on private actions, it would also be interesting to assess their role as risk-control devices and their interrelationship with public enforcement mechanisms (e.g. if and to what extent more and better supervised transparency regulation also facilitates the bringing of private actions).

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.

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Endnotes

[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] Our work clearly distinguishes between banking supervision and regulation. Regulation is taken to encompass formal rules that are adopted by an official, public authority (law on the books). Banking supervision is a much more complex concept comprising, in generic terms, two components. First, the so-called prudential supervision seeks to maintain stability and confidence in the banking system. This is achieved through a licensing system allowing supervisors to identify the population to be supervised and to control entry into the banking system. To obtain and maintain a license, banks need to abide by certain prudential requirements covering, *inter alia*, capital and liquidity adequacy, major shareholders' and board directors' suitability, the efficiency of organization and internal controls, as well as the appropriateness of legal structure. The second component refers to enforcement, that is, securing compliance with the legal framework on banks and their activities *via* the detection of violations and the imposition of remedial measures (Basel Committee, 2002).

[3] 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; Laeven and Levine, 2008).

[4] The work of Cordella and Yeyati (1998) and Bliss and Flannery (2002) could well be characterized as representing a more modest and compromised position between the two spectrums.

[5] The research of Calem and Rob (1999) and Laeven and Levine (2008) represent an attempt for reconciliation of the two opposing views.

[6] 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.

[7] The dataset of Barth et al. (2001, 2004, 2008) provides data concerning on site examinations only for specific years. As a result, it does not allow a study on the basis of panel data nor does it include data on sanctions.

[8] 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.

[9] 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 crisis is responsible for the high values of non-performing loans observed at the beginning of the period.

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

[11] This approach has been also followed by Fernandez and Gonzalez (2005) and Pasiouras et al. (2006), 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 (at p. 218) that "*we have confirmed all this paper's conclusions using both methods*".

[12] For more on these issues, see Nerlove (2002, 273-304).

[13] 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).

[14] These results are provided on request.

[15] 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.

[16] Despite the fact that this is probably beyond the scope of the present analysis, we proceed a step further on this issue and 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.

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 (c) Federal Reserve Board	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
inflation	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; bank size is measured by 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; bank size is measured by 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
The direct effect of on-site audits and sanctions on bank risk

	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, VII and VIII 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 (the latter two 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 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.