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THREE ESSAYS IN RISK MANAGEMENT IN FINANCIAL INSTITUTIONS

YANOCHKIN Anton

UNIL | Université de Lausanne

FACULTÉ DES HAUTES ÉTUDES COMMERCIALES

DÉPARTEMENT DE COMPTABILITE ET CONTRÔLE

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THÈSE DE DOCTORAT

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pour l'obtention du grade de
Docteur en Sciences Économiques, « mention Management »

par

Anton YANOCHKIN

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Prof. Daniel Oyon

Jury

Prof. Michael Rockinger, Président
Prof. Michael Burkert, expert interne
Prof. Raul Barroso, expert externe
Prof. Antonio Davila, expert externe

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IMPRIMATUR

Sans se prononcer sur les opinions de l'auteur, le Conseil de la Faculté des Hautes Etudes Commerciales de l'Université de Lausanne autorise l'impression de la thèse de Monsieur Anton Yanochkin, titulaire d'un Bachelor ès Sciences en Management de l'Université de Lausanne, titulaire d'un Master ès Sciences en Comptabilité, Contrôle et Finance, de L'Université de Lausanne et de l'Université de Genève, en vue de l'obtention du grade de docteur en Sciences économiques, mention « Management ».

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Lausanne, le 7 juin 2012

Le doyen

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Doctorat en Sciences Economiques,
mention « Management »

Par la présente, je certifie avoir examiné la thèse de doctorat de

Anton YANOCHKIN

Sa thèse remplit les exigences liées à un travail de doctorat.
Toutes les révisions que les membres du jury et le soussigné ont demandées
durant le colloque de thèse ont été prises en considération
et reçoivent ici mon approbation.

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Et reçoivent ici mon approbation.

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Signature : _____ Date : 7 juin 2012

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Table of Contents

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Introduction

In certain countries households avoid placing their money on bank accounts because, they simply do not trust the stability and efficiency of national banking system. The capital flows in such countries between lenders and borrowers are flawed. Banks cannot carry out their principal function – to collect and distribute efficiently capital in the economy. International regulators, such as the Basel Committee on Banking Supervision (BCBS) have a primary duty to produce recommendations to increase the soundness of national banking systems and, as a consequence, to stringent an overall world financial sector stability. Recent financial crises showed that the turmoil in the banking industry immediately spills over the sector and dramatically affects the overall economic stability. Over the past twenty years, the banking regulation was evaluating around two distinct trends: capital adequacy requirements and closer "supervisory monitoring" of bank business activities (Tarullo, 2008). These trends converge in Basel II New Capital Accord (BCBS, 2004a) released by BCBS in 2004 and implemented in near one hundred countries in 2008. This document, compared to its predecessor, Basel I Capital Accord issued in 1988 (BCBS, 1988), contains a much more "expansive set of recommendations" (Barth, Caprio Jr, & Levine, 2008). The first pillar of Basel II, probably the most developed and the most important, sets the rules and approaches to determine the minimum capital levels that banks should have to preserve their solvency. Together with the minimum capital requirements, Basel II requires banks to satisfy precisely defined qualitative standards for risk management. Among others, banks that intend to implement the advanced risk measurement approaches should convince their supervisors that a) their board of directors and senior management are actively involved in the risk management framework; b) their risk management system is closely integrated in day-to-day operations; and c) they have a regular communication of risk exposures and loss experience to business managers (BCBS, 2004a).

The rationales of these rules are: a) to protect national economies against financial distress; b) to reduce the information asymmetry between bank shareholders and depositors; and c) to preserve a certain market discipline (Berger, Herring, & Szegö, 1995). The efficiency of such capital regulation was always of a big interest for practitioners and researchers (Barth, Caprio Jr, & Levine, 2004; Cihák & Schaeck, 2010; Jacques & Nigro, 1997). Researchers' findings on this subject diverge drastically. While stringent capital requirements are associated with less non-performing loans (Barth et al., 2004) and greater cost efficiency (Pasiouras, Tanna, & Zopounidis, 2009), several studies suggest that they are not robustly linked with the stability of the banking system (Barth et al., 2008; González, 2005). Jacques and Nigro (1997) and Shrieves et al. (1992) stress that risk-sensitive capital standards are the efficient tools to increase capital ratios and to reduce an excessive risk-taking in commercial banks. In contrast, Rime (2001) infers that regulatory pressures are positively related with bank level of capital, but have no impact on its risk-taking strategies.

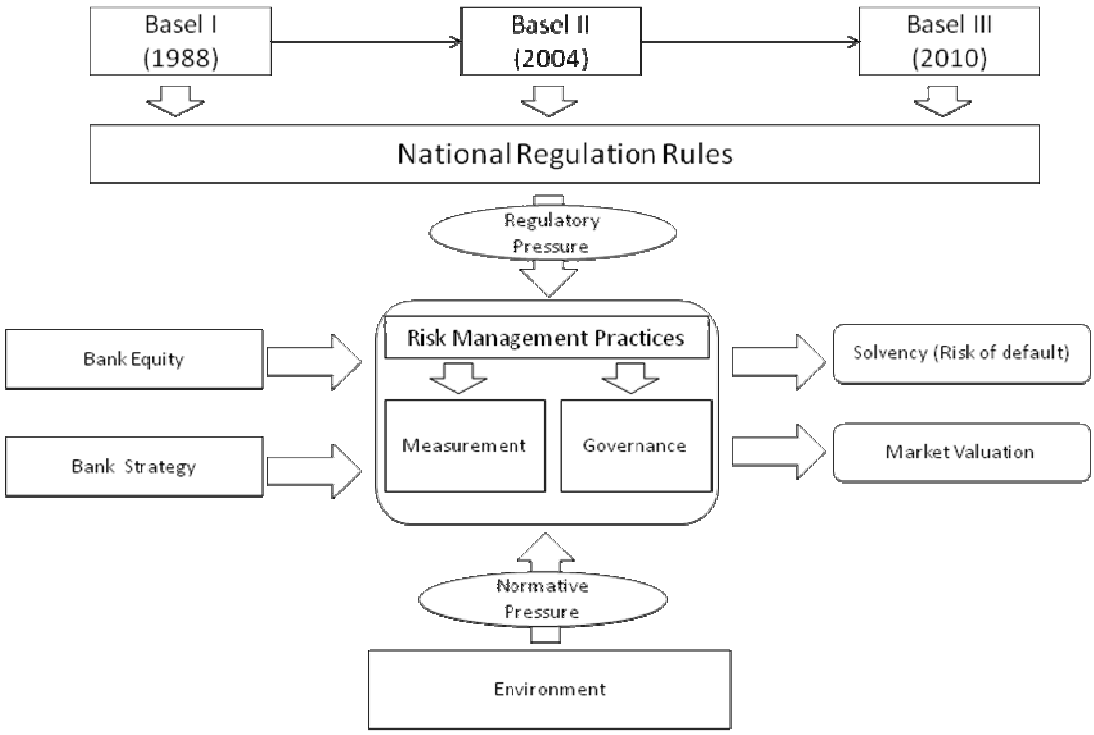
Contrarily, the qualitative side of bank risk management has not attracted much attention from academicians. Nevertheless, several studies had made a first attempt to assess how the compliance with Basel II core principles in their qualitative dimension affects bank behaviour (Aebi, Sabato, & Schmid, 2011; Ellul & Yerramilli, 2010; Gatzert, Schmeiser, & Schuckmann, 2008). These studies outline the importance of the bank risk management systems for future performance. Ellul and Yerramilli (2010) report, that the bank attention to its risk management function is paid-off by lowering its overall risk of default by restraining an excessive risk-taking. Aebi et al. (2011) suggest that the presence of chief risk officer reporting directly to the board of directors is positively associated with bank performance, measured by stock returns and returns on bank equity. One of potential problems to conduct the research on this topic is the lack of risk management information. The Pillar 3 of Basel II stating the rules for risk management information disclosures is one "the least developed"

(Barth et al., 2008) and is not uniformly understood by banks. Banks' reporting on risk management differs considerably from one unit to another especially if banks are headquartered in different countries and depend on different national rules. Despite of these difficulties, all these topics are relevant and should be investigated more precisely.

Thesis outline

This thesis is based on three independent essays about risk management in financial institutions. The aim of this dissertation is to bring some empirical evidence on how bank risk management systems behave under the pressure of external regulation, whether the sophistication in risk management impact positively bank solvency and market valuation, and to what extent the compliance with the current regulation is efficient to predict bank future performance. The main regulation rules on which we grounded this dissertation are Basel II New Capital Accord mentioned above. The Figure 1 gives a general idea on the interrelation of different components used in this work. Then, I present under the form of abstracts accompanied by graphical illustrations (Figure 1.2., Figure 1.3., and Figure 1.4.) the main ideas of each essay.

Figure 1: All components used in the dissertation empirical analyses.



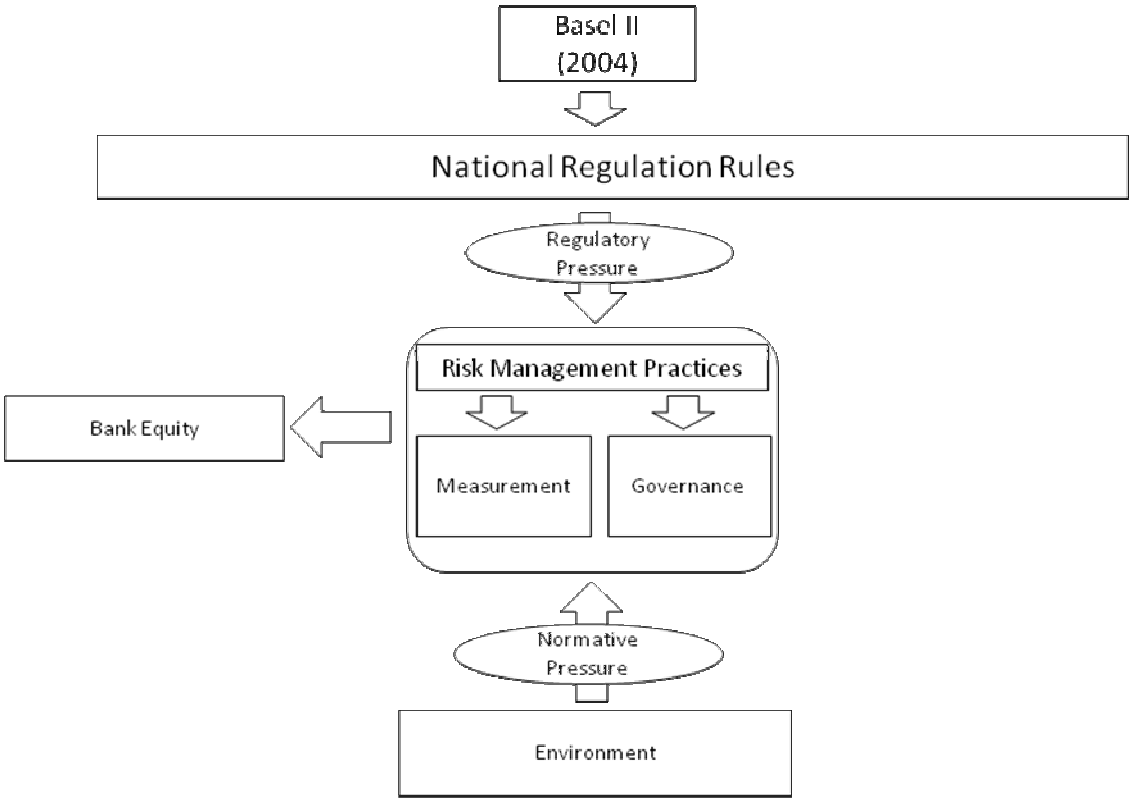
Essay 1

The choice to adopt risk-sensitive measurement approaches for operational risks: the case of Advanced Measurement Approach under Basel II New Capital Accord

Abstract

This paper investigates the choice of the operational risk approach under Basel II requirements and whether the adoption of advanced risk measurement approaches allows banks to save capital. Among the three possible approaches for operational risk measurement, the Advanced Measurement Approach (AMA) is the most sophisticated and requires the use of historical loss data, the application of statistical tools, and the engagement of a highly qualified staff. Our results provide evidence that the adoption of AMA is contingent on the availability of bank resources and prior experience in risk-sensitive operational risk measurement practices. Moreover, banks that choose AMA exhibit low requirements for capital and, as a result might gain a competitive advantage compared to banks that opt for less sophisticated approaches.

Figure 1.2.: The components used in empirical analysis in the first chapter of the dissertation.



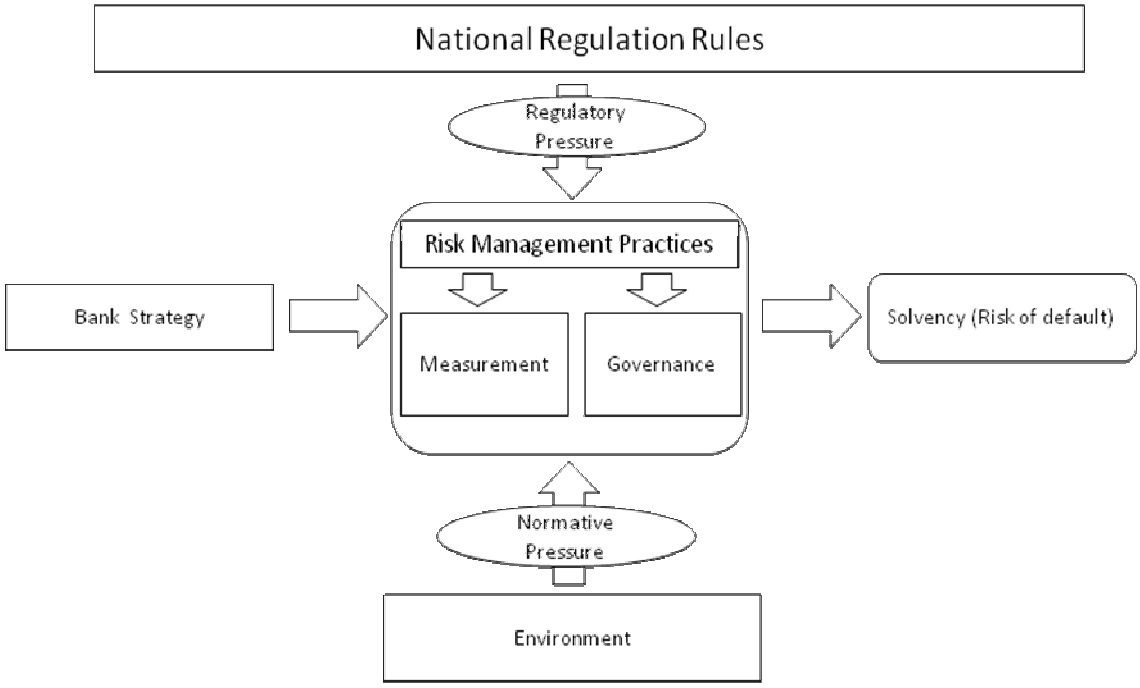
Essay 2

Internal Risk Controls and their Impact on Bank Solvency

Abstract

Recent cases in financial sector showed the importance of risk management controls on risk taking and firm performance. Despite advances in the design and implementation of risk management mechanisms, there is little research on their impact on behavior and performance of firms. Based on data from a sample of 88 banks covering the period between 2004 and 2010, we provide evidence that internal risk controls impact the solvency of banks. In addition, our results show that the level of internal risk controls leads to a higher degree of solvency in banks with a major shareholder in contrast to widely-held banks. However, the relationship between internal risk controls and bank solvency is negatively affected by BHC growth strategies and external restrictions on bank activities, while the higher regulatory requirements for bank capital moderates positively this relationship.

Figure 1.3.: The components used in empirical analysis in the second chapter of the dissertation.



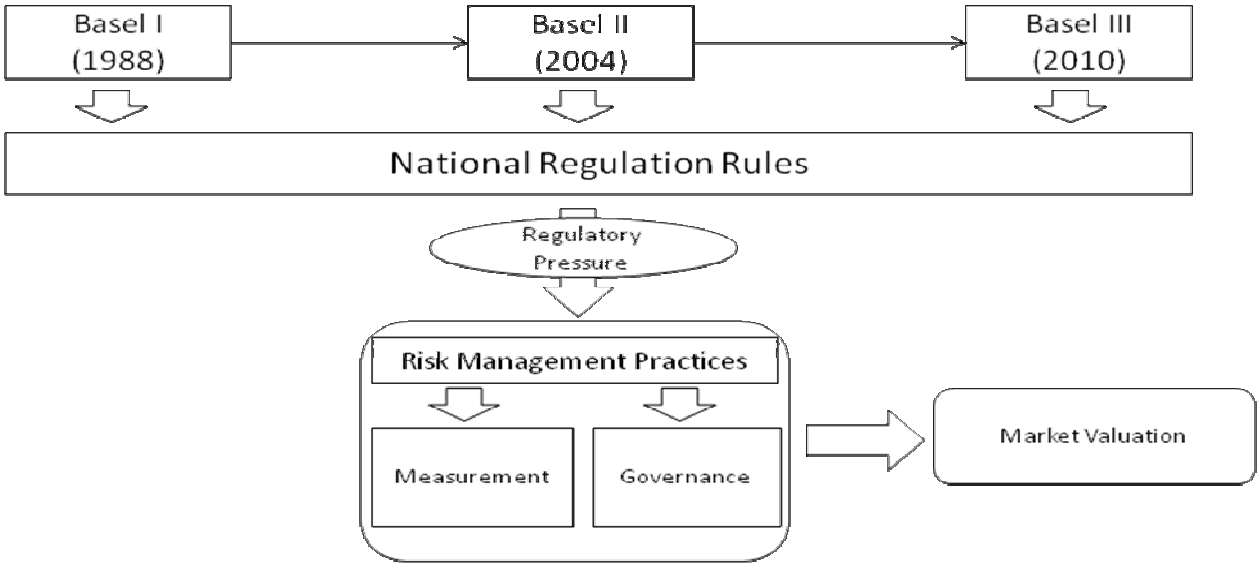
Essay 3

The Impact of the Sophistication of Risk Measurement Approaches under Basel II on Bank Holding Companies Value

Abstract

Previous research showed the importance of external regulation on banks' behavior. Some inefficient standards may accentuate risk-taking in banks and provoke a financial crisis. Despite the growing literature on the potential effects of Basel II rules, there is little empirical research on the efficiency of risk-sensitive capital measurement approaches and their impact on bank profitability and market valuation. Based on data from a sample of 66 banks covering the period between 2008 and 2010, we provide evidence that prudential ratios computed under Basel II standards predict the value of banks. However, this relation is contingent on the degree of sophistication of risk measurement approaches that banks apply. Capital ratios are effective in predicting bank market valuation when banks adopt the advanced approaches to compute the value of their risk-weighted assets.

Figure 1.4.: The components used in empirical analysis in the third chapter of the dissertation.



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Essay 1:

The choice to adopt risk-sensitive measurement approaches for operational risks: the case of Advanced Measurement Approach under Basel II New Capital Accord

1. Introduction

As a major provider of external finance to economic agents, banks play a central role in the financial intermediation. But today, they are no longer alone in this business. Over the last thirty years, globalization and technological progress decreased the cost advantage of banks in acquiring funds and engendered new types of players such as hedge funds and private equity firms (Edwards & Mishkin, 1995). To defend their competitive positions, banks responded in two major ways. First, they expanded their traditional lending activities to less creditworthy borrowers. Second, they developed new, fee-based activities. All these changes made the banking sector more fragile, increasing existing credit risks and creating new types of risks related to a growing sophistication of banking operations. In these circumstances, the major challenge posed to regulators is twofold: the need to secure the banking system from systemic crisis while letting it to evolve like other industries. Recent financial crisis showed that it is not a trivial task. Inappropriate regulations might not be only inefficient, but could also have counterproductive effects (Barth, Caprio Jr, & Levine, 2001; Barth et al., 2004).

Nowadays, regulators concentrate their efforts around two dimensions: the restrictions on activities that banks may engage in, and the minimum capital requirements that banks should possess (Besanko & Kanatas, 1996; Boyd, Chang, & Smith, 1998). Although national regulatory bodies adopted the prescriptions of Basel Committee on Banking Supervision (BCBS), the activity restriction rules remain to a large extent different from one country to another. According to Barth et al. (2008), these restrictions relate primarily to securities trading, insurance operations and real estate activities in a large number of countries. Restrictions have always attracted the academic interest and numerous studies were conducted to assess and compare the effectiveness of various national supervisory systems on bank behavior, profitability, and risk (Fernandez & Gonzalez, 2005; Laeven & Levine, 2009; Pasiouras et al., 2009). Generally, empirical findings suggest that more restrictive regulations,

at least, have no desirable impact on risk-taking of banks. Capital regulation is another dimension of banking supervision. With the Basel Capital Accord (Basel I), minimum capital standards for internationally active banks were for the first time stated. It offered an unsophisticated approach for the measurement of bank credit risk exposures. The introduction of this capital accord was generally considered as an important step forward in banking regulation. Nevertheless, academic research suggests that its main objective to diminish the probability of systemic crisis was not attained (Calem & Rob, 1999; Rime, 2001). Following some amendments of Basel I, including the capital requirements for market risk, Basel Committee on Banking Supervision (BCBS) released in 2004 the Basel II New Capital Accord, formally called "International Convergence of Capital Measurement and Capital Standards: A Revised Framework" (BCBS, 2004b). This document addressed three types of risk - credit risk, market risk and operational risk - and is structured of three pillars: 1) Minimum risk-based capital requirements; 2) Supervisory review of an institution's capital adequacy and internal assessment process; 3) Market discipline through public disclosure of various financial and risk indicators.

Existing research has already produced some evidence on the impact of the credit risk management systems and particularly benefits and drawbacks of the Internal Ratings Based approaches (IRB); e.g. see Hakenes and Schnabel (2011), Heid (2007), Ruthenberg and Landskroner, (2008). In this paper we are interested to understand how Bank Holding Companies (BHC) adopt the risk measurement practices for their operational risk exposures and why some of them choose to invest in more sophisticated approaches. Several studies have already highlighted the importance of the operational risk management and the impact of operational losses on BHC market value (Cummins, Lewis, & Wei, 2006; Gillet, Hübner, & Plunus, 2010). Generally, capital markets punish BHC much more severely than operational losses themselves.

Formally, the operational risk is defined in Basel II New Capital Accord as:

"*…the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events…*" (BCBS, 2004, p. 149)

, and it is a subject of a compulsory capital charge. Three compliance methods to determine the capital charge are proposed: the Basic Indicator Approach (BIA), the Standardized Approach (SA), and the Advanced Measurement Approach (AMA). While the first two approaches define operational risk capital charge as a fraction of bank earnings, AMA requires banks to develop their own risk-sensitive models to determine the amount of needed capital to cover banks against the operational risk exposures within a time horizon of one year. Together with qualitative requirements banks that opt for this free-way approach should base their models on historical data of operational losses (internal, and, if necessary, external). Among possible methodologies, the Value-at-Risk techniques (VaR) have become the most popular. These advanced models are supposed to reflect better bank operational risk profile and should lead to considerable improvements in risk identification and management.

This right to choose gained a considerable interest among practitioners and scholars and raised many questions. The purpose of this study is to examine which factors lead BHC to invest in risk-sensitive operational risk measurement models (AMA) and to test empirically whether this approach allows banks to save capital as it is showed by BHC internal assessments (economic capital).

The remaining of this paper is organized as follows. In section 2 we develop our research propositions. Section 3 introduces our data, variables and descriptive statistics. In section 4, we present our empirical models and discuss the correlation among variables. Section 5 describes our empirical results. In section 6 we discuss our findings and conclude.

2. Literature review and research propositions

Today, the increase of BHC size is the result of geographical expansion and the entry in new business areas. The growing part of non-interest banking activities increases substantially bank operational risks (Edwards et al., 1995). To control these new risks, banks might need to implement sophisticated risk management systems and also are more likely to have necessary resources for that. Research in financial accounting shows, that large-size firms are more likely to implement costly accounting standards (Dumontier & Raffournier, 1998; Lang & Lundholm, 1993). Moreover, numerous studies in enterprise risk management (ERM) field suggest that the investment in ERM systems increases with the size of a firm (Beasley, Clune, & Hermanson, 2005; Colquitt, Hoyt, & Lee, 1999). Hakenes and Schnabel (2011) suggest that the adoption of internal ratings approaches (IRB) for credit risk requires substantial investments in risk measurement technologies. As IRB, AMA requires the use of advanced risk quantification tools and extensive expertise, thus the same "cost argument" should be relevant for operational risk. VanHoose (2007) estimated that an average cost of compliance with risk-sensitive approaches under Basel II is around $70 million. Only relatively large banks can afford such investment for risk measurement systems. Moreover, we suppose that other factors than size might influence the bank choice to adopt risk-sensitive risk measurement approaches for operational risks.

2.1. Prior knowledge

The prior experience in risk-sensitive measures of operational risk exposures might positively influence a BHC choice to adopt AMA. The theoretical ground of this proposition refers to the notion of a firm's absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002). Until the introduction of Basel II, there were no particular requirements for the operational risk assessment. Banks had been managing this type of risk in their own ways. Thus, by the time they had to choose one of three proposed approaches, banks had accumulated different experiences in this area of risk management. Hida II (2005) suggests that despite of intentions of risk managers to adopt AMA for BHC operational risk measurement only few banks are ready to implement it. AMA requires a comprehensive risk management framework with subjective assessments, key indicators, data collection, and controlling processes. By the end of 2007, some financial institutions had already adopted risk-sensitive measurement techniques, especially for an estimation of the economic capital (sometimes also called as risk-bearing capacity) associated with operational risks. Thus, banks that have been using internal models might dispose the necessary knowledge and resources to adopt the most sophisticated approaches under Basel II. Despite the argument that bank managers might be induced to adopt less sophisticated risk measurement approaches to avoid the information sharing with regulators and shareholders (Danielsson, Jorgensen, & de Vries, 2002), we propose the following hypothesis:

H.1: Banks that had experienced risk-sensitive practices in operational risk assessment prior to Basel II introduction are more likely to adopt AMA.

2.2. Level of equity

The bank level of equity might influence the choice of banks to adopt AMA for operational risks for the following reasons. First, regulatory bodies and rating agencies argue that risk-sensitive approaches for operational risks should lead to the lower capital requirements (BCBS, 2001a; Ramadurai, Beck, Olson, & Spring, 2004). Our preliminary analysis of BHC internal assessment of capital for operational risks revealed that banks need less capital than it is required by regulators. Despite the fact that the levels of economic and regulatory capitals depend on different factors (Elizalde & Repullo, 2007), the risk-sensitive approaches under Basel II necessitate the implementation of similar techniques that banks use for the economic capital determination. Thus, banks that determine the economic capital might validate their methodologies for AMA capital determination and, as a consequence, profit from lower levels of capital. Furthermore, after the recent financial crisis, BIS issued new capital rules commonly known as Basel III (BCBS, 2010a) that require banks to increase substantially their prudential indicators and consequently their equity. These new constraints might stringent the AMA quantitative argument.

Our second argument refers to the political considerations. As a bank leverage increases, depositors and other debtholders might have bigger concerns about bank risk-taking strategies and risk controls. The advanced approaches under Basel II are supposed to be more risk-sensitive and reveal better a particular bank operational risk exposures. These quantitative and political arguments drove us to the next hypothesis:

H.2: Banks with lower levels of equity are more likely to adopt AMA.

2.3. Institutional factors

While studying the reasons of management control systems' adoption for product development, Davila et al. (2009) suggest that the reason for adoption is often unrelated to a particular role that these systems are supposed to play. Among several adoption factors, they highlight the importance of contracts with external parties and the legitimization symbols. We believe that these two elements play a major role in the process of adoption of a particular approach for operational risk quantification in banks. When pay-offs of AMA adoption are uncertain banks might search in the first place legitimacy benefits that this approach could bring. Moreover, the propensity of a particular financial institution to invest in AMA might be directly related to the 'value' that domestic regulatory bodies attribute to this sophisticated approach for operational risk assessment. Existing literature on organizational innovations shows that isomorphic pressures influence considerably firms' decisions (Haveman, 1993).

Institutional isomorphism can be a result of coercive, mimetic, and normative processes (DiMaggio & Powell, 1983). Coercive isomorphism occurs when powerful authority imposes firms to adopt certain practices; mimetic isomorphism results from responses to uncertainty by adopting practices used by successful organizations; and normative isomorphism is associated with the adoption of practices that are considered as appropriate in the firm environment.

In terms of operational risk measurement practices, the institutional context might play a distinct role. First, the introduction of Basel II capital requirements for operational risks is itself an institutional pressure that intends to standardize BHC management practices and control systems. Together with the introduction of mandatory standards for operational risk capital charge calculation, BCBS leaves to banks a limited right to choose among three approaches. Therefore, the main question is: what approach is the best? One could naturally argue that approaches that cost more are better than those that cost less. However, this way of

thinking for the selection of management systems and practices is certainly questionable. Recommendations to adopt more sophisticated risk measurement approaches are often founded on myths and hypothetical evidence supported by agents that have a direct interest. Organizational sociology theories stress that myths might institutionalize the organizational behavior (Fennell, 1982; Meyer & Rowan, 1977). Origins of such myths could come from organizational practices as well from opinions and judgments of agents perceived as important players in the field. In case of high uncertainty about technologies, organizational goals and external factors these myths become more believable.

BCBS, like many of national regulators, support the adoption of risk-sensitive approaches. The primary argument for this posture is that these approaches will help banks to manage better operational risks and a capital buffer will adequately cover bank against the operational risk exposures. Wahlström (2006) drawing on the interviews of Swedish banks' senior managers, showed that these managers blindly believe in the success of Basel II rules for operational risks despite of their personal disaccord with these rules. The major argument explaining this behavior of Swedish managers is following:

"…The accord was so strongly supported by the managers in the banks…as a result of the process in which common agreements become socially produced. The Basel Committees' communication in the accord and its supporting documents is highly persuasive…" (p.512).

Having considered all these arguments, we propose that, in countries with stricter regulatory standards and more sophisticated business environment BHC will more likely invest in AMA.

H.3.a: BHC in countries with more stringent regulatory policies will more likely adopt AMA.

H.3.b: BHC in countries with more sophisticated business environment will more likely adopt AMA.

2.4. Listing status

In many countries, stock exchange rules require listed banks to improve their corporate governance and risk management reporting. Listed banks, by complying with stock exchange regulation, might have a higher propensity to adopt the most sophisticated risk measurement approaches for regulatory issues. Paape and Speklé (2012) report that listed firms have more formalized and developed Enterprise Risk Management systems compared to non-listed organizations. Kleffner et al. (2003) suggest that one of the main reasons to adopt ERM practices in Canadian firms is the compliance with Toronto Stock Exchange guidelines. Moreover, Gillet et al. (2010) report that in case of considerable operational losses, the decline of a market value is significantly higher than the operational loss amount announced. These market value losses are proportionally larger for BHC with a higher franchise value, implying that operational losses punish more severely banks with stronger profit-generation perspectives (Cummins et al 2006). Thus, listed banks might have a greater need to implement risk-sensitive approaches to manage better risk exposures and avoid the destruction of their market capitalisation.

Having considered these arguments we formulate a following hypothesis:

H.4: Listed BHCs are more likely to adopt AMA.

2.5. Quantitative considerations

In this section we intend to discuss the issues concerning the quantitative side of AMA adoption. While the regulators and rating agencies insist on the argument that banks will benefit from lower capital requirements if they adopt AMA, we could not identify any previous studies confirming this hypothesis. BCBS argues that the increasing sophistication in operational risk measurement will progressively lead to a lower need of capital and a better risk management (BCBS, 2001a). Rating agencies also insist that AMA gives a lower capital than those determined under less sophisticated approaches (Ramadurai et al., 2004). Dangl and Lehar (2004) comparing the capital requirements under Basel I capital accord and those computed under internal VaR-based approaches of well-capitalized banks, suggest that these banks might increase leverage or reduce equity without treating their solvency. Nevertheless, this study is based on the theoretical modelling and does not analyse any data. On the other hand, there are opposing arguments to the hypothesis that the sophistication in operational risk measurement will necessarily lead to lower capital requirements. Despite the fact that SA is positioned by BCBS as more advanced than BIA, Sundmacher (2007) illustrates that the operational risks capital charge determined under SA might be higher than that determined under BIA. Moreover, if bank has experienced significant operational losses in recent years (e.g. Société Générale Group and UBS Group) the capital charge under AMA might be higher than that computed under less sophisticated approaches especially in contraction periods when banks might have relatively low positive earnings.

These arguments lead us to the following research question:

R.Q: Does the determination of the operational risk capital charge under AMA save BHC capital?

3. Variables, data and descriptive statistics

3.1. Variables measurement

We measured the sophistication of BHC operational risk measurement approach by a dummy variable, *Approach*, which takes 1 if bank has adopted the Advanced Measurement Approach to determine its operational risk capital charge and 0 if it opted for earnings-based approaches (SA or BIA). The variable *ORWA* measures the bank operational risk-weighted assets. To eliminate the size effect we scaled it by BHC total assets. We approximated the bank experience in operational risk management by the categorical variable called *ORmgmt*. It is the score of two dummy variables. First variable, *ORmgmt_EC*, takes 1 if BHC was committed in the economic capital determination for operational risks in the year previous to Basel II introduction. Second, *ORS_SU* is equal 1 if BHC had already established central and independent unit for the operational risk management before Basel II introduction. For most of BHC in our sample, we took the information for these variables from 2007 risk management reports. Higher values indicate a higher BHC operational risk management experience. To measure size, several options exist: total assets, total revenue, number of employees and others. As the operational risk is primarily related to people and operations that they execute, we measured the BHC size as a total number of employees (*Size*). BHC level of equity, *Equity*, was measured as a ratio of common shareholders equity to total assets. The variable *Complex* approximates the BHC level of operational complexity and is measured as the ratio of BHC total assets to the number of employees. We measured bank performance with the pre-tax profit to total assets (*Performance*). BHC growth we measured as a difference in BHC total assets reported in 2007 and 2002 (*Asset_growth*). Listing is a dummy variable indicating whether the shares of BHC are listed on a public stock exchange.

To approximate the regulatory pressures we opted for the variable *Stingent*. This variable is an index constructed by Barth et al (2001; 2008) based on survey information. It measures the capital oversight stringency of national regulators, and is estimated with the following questions: a) whether national regulation has explicit requirements regarding the amount of capital that BHC must have relative to various guidelines (Basel rules, BHC inherent risks, unrealized losses); b) whether the source of funds counted as regulatory capital can include assets other than cash or government securities as well as whether the sources are verified by the national supervisors.

The normative pressures on BHC risk management practices adoption process is measured with the variable *BusSophis*. This variable is an index based on the executive opinion survey conducted by Browne et al (2009). It measures the sophistication of national business environments taking into account the following components: a) local supplier quality; b) state of cluster development; c) nature of competitive advantage; d) nature of value breadth; e) control of internal distribution; f) production process sophistication; g) extent of marketing; h) willingness to delegate authority. Table 1 presents all variables and their definitions.

Table 1

Variables definitions

Approach	Dummy variable that takes 1 if BHC adopted the Advanced Measurement Approach for its operational risk-weighted assets determination.
ORWA	Operational risk-weighted assets scaled by total assets as reported by BHC in annual risk reports. Time series observations for the period from 2008 to 2009.
ORWA_08/09/av	Operational risk-weighted assets scaled by total assets as reported by BHC in annual risk reports for corresponding years (2008, 2009). Subscript "av" denotes an average of 2008 and 2009 observations.
ORWA_AMA	Operational risk-weighted assets scaled by total assets of BHC having adopted the Advanced Measurement Approach.
ORWA_not_AMA	Operational risk-weighted assets scaled by total assets of BHC having adopted either the Basic Indicators Approach or the Standardized Approach.

ORmgmt	Score of two dummy variables. First dichotomy variable is taking 1if BHC reports that it determines an economic capital for operational risks in 2007. Second variable is equal to 1 if BHC reported that it had already established in 2007 a central unit for operational risk management. Higher value of this variable indicates a higher operational risk management experience.
Size_07/08/09_av	Natural logarithm of BHC total employees computed for corresponding years (2007, 2008, and 2009). Subscript "av" denotes an average of 2008 and 2009 observations.
Equity	Ratio of BHC common equity on total assets. Time series observations for the period from 2008 to 2009.
Equity_07/08/09/av	Ratio of BHC common equity on total assets for corresponding years (2007, 2008, 2009). Subscript "av" denotes an average of 2008 and 2009 observations.
Complex	Ratio of total assets to total employees. Time series observations for the period from 2008 to 2009.
Complex_08/09/av	Ratio of total assets to total employees computed for corresponding year (2008, 2009). Subscript "av" denotes an average of 2008 and 2009 observations.
Performance	Ratio of BHC pre-tax profit on total assets. Time series observations for the period from 2008 to 2009.
Performance_07/08/09/av	Ratio of BHC pre-tax profit on total assets computed for corresponding years (2007, 2008, and 2009). Subscript "av" denotes an average of 2008 and 2009 observations.
Asset_ghowth	BHC assets growth for the period from 2002 to 2007.
Listing	Dummy variable indicating if BHC shares are listed on public stock exchange.
Stringent	Index measuring the stringency of national regulatory oversight of BHC capital. This index is based on the following questions: a) Whether national regulation has explicit requirements regarding the amount of capital that BHC must have relative to various guidelines (Basel rules, BHC inherent risks, Unrealized losses); b) Whether the source of funds counted as regulatory capital can include assets other than cash or government securities as well as whether the sources are verified by the national supervisors (Source: Barth, Caprio, and Levine, 2001, 2008). This index is ranged between 0 and 5. Higher values of this index signify more stringent bank capital oversight policies.
BusSophis	Index measuring the sophistication of national business environments that is the average score of the following components: a) Local supplier quality; b) State of cluster development; c) Nature of competitive advantage; d) Nature of value breadth; e) Control of internal distribution; f) Production process sophistication; g) Extent of marketing; h) Willingness to delegate authority (Browne et al, 2008). This index is ranged between 1 and 7. Higher values of this index signify more sophisticated bank business environment.

3.2. Data and descriptive statistics

Knowing that Basel II Capital Accord is designed primarily for the large, internationally-active BHC, we built our sample using the Banker Top 1000 database. This database contains data on about 1000 world's largest commercial banks ranked according to their Tier 1 capital as defined by the Basel II Capital Accord. Banks from 90 countries are represented in this database. According to Pasiouras et al. (2009) near 120 countries adopted the Basel II capital accord. However, we intentionally restricted our sample to BHCs from the 54 countries members of BIS[1], assuming that regulators from these countries will more likely fully adopt the Basel II Capital Accord guidelines. This selection criterion reduced our sample to 835 potential observations. Moreover, we observed that by 2008 in some countries Basel II capital requirements had not been implemented. In such countries banks were not required to compute operational risk capital charge. Due to this lack of data we had to eliminate all banks from 18 countries among which USA, China and Russia. In some other countries, despite the adoption of the Basel II accord, the quality of risk management disclosures is still not appropriate for our analysis. For banks from these countries we were not able to determine which risk measurement approaches were adopted by BHCs. Mainly, it concerns banks headquartered in Eastern Europe. After these filtering operations, our final sub-sample to test our research hypotheses consists of 160 BHC from 23 countries where the Basel II accord was enforced from 2008. 31 banks declared that they received the approval from their domestic regulators to determine capital charge under AMA.

The second sample, is designed to answer our research question, and contains the data on 72 BHC that disclose their operational risk-weighted assets in 2008 and 2009 years. In total, we were able to collect 128 bank-year observations for this period for BHCs from 11 countries. In addition to financial data provided by the Banker Top 1000 database, the

[1] Information about nations BIS-members can be found on the site: www.bis.org

information on operational risk measurement approach was collected manually from the 2008-2009 risk reports. The data on business environment and capital stringency come from The Global Competitiveness Report (Browne et al., 2009) and the country regulations database constructed by Barth et al. (2001; 2008) respectively.

Panels A and B of Table 2 provide descriptive statistics for our variables. Skewness-Kurtosis normality test showed that all our variables, except *Size* are not normally distributed. Near 20% of banks in our sample adopted AMA. *AMA* banks are more likely to disclose their operational risk-weighted assets in risk management reports. Panel B.1 shows that the proportion of AMA-observations (0.291) is significantly higher than the proportion of AMA-banks reported in Panel A (0.194). On average, *ORmgm*t amounts for 1.056 while operational risk-weighted assets equal to 4% of BHC reported assets (*ORWA*). Average capital ratio in 2007 is at the level of 5.4% while it decreased to 4.5% in 2008-2009. Partially it could be explained by a growth of BHC average assets from 2007 to 2008-2009 and a decreased performance. Pre-tax return on BHC assets is almost 4 times higher in 2007 than in 2008. Near 70% of BHCs in our samples are listed on public stock exchanges. The country-level variables, *Stringent* and *BusSophis* exhibit similar characteristics in both samples.

Table 2

Descriptive statistics and Skewness-Kurtosis test

Panel A: Descriptive statistics of variables used in logistic regressions AMA adoption analysis. Data for 2007 reporting year except country-level variables.

	Nb of obs.	Mean	S.d.	Min	Max.	Skewness	Kurtosis	Skewness - Kurtosis test Prob < chi2
BHC level								
Approach	160	0.194	0.396	0.000	1.000	1.550	3.402	n.a.
Performance_07	160	0.011	0.018	-0.010	0.224	10.303	122.007	0.000***
Size_07	160	9.020	1.703	3.466	12.654	-0.221	2.736	0.424
ORmgmt	160	1.056	0.856	0.000	2.000	-0.108	1.382	n.a.
Equity_07	160	0.054	0.030	0.014	0.328	4.859	42.898	0.000***
Listing	160	0.700	0.460	0.000	1.000	-0.873	1.762	n.a.
Country level								
Stringent	23	3.313	1.397	1.000	8.000	0.916	5.972	n.a.
BusSophis	23	5.181	0.520	4.000	5.900	-0.393	2.514	n.a.

Panel B.1: Descriptive statistics of variables used in operational risk-weighted assets ordinary least squares analysis. Time series data for the period from 2008 to 2009 except country-level variables.

	Nb of obs.	Mean	S.d.	Min	Max.	Skewness	Kurtosis	Skewness - Kurtosis test Prob < chi2
BHC level								
ORWA	126	0.040	0.026	0.005	0.249	3.956	29.363	0.000***
Approach	126	0.291	0.456	0.000	1.000	0.921	1.848	n.a.
Complex	126	38.938	165.051	3.277	1936.821	9.774	108.683	0.000***
Performance	126	0.003	0.014	-0.151	0.022	-7.866	84.430	0.000***
Equity	126	0.045	0.019	0.005	0.127	0.891	4.893	0.001***
Listing	126	0.733	0.444	0.000	1.000	-1.055	2.114	n.a.
Country level								
Stringent	11	3.182	1.411	1.000	8.000	0.955	6.084	n.a.
BusSophis	11	5.188	0.493	4.000	5.800	-0.538	2.661	n.a.

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

Panel B.2: Descriptive statistics of variables used in operational risk-weighted assets two-stage least squares analysis.

	Nb of obs.	Mean	S.d.	Min	Max.	Skewness	Kurtosis	Skewness - Kurtosis test Prob < chi2
Asset_growth	159	1.511	1.159	-0.3	6.188	1.542	6.028	0.000***
ORWA_08	56	0.037	0.022	0.005	0.128	1.528	7.263	0.000***
ORWA_09	70	0.038	0.022	0.005	0.165	2.691	16.65	0.000***
ORWA_av	72	0.037	0.021	0.005	0.147	2.059	11.818	0.000***
Size_08	56	9.655	1.681	5.485	12.654	-0.44	2.516	0.275
Size_09	70	9.525	1.866	3.664	12.618	-0.538	2.937	0.146
Size_av	72	9.567	2.748	1.832	12.636	-0.475	2.077	0.016**
Complex_08	56	32.639	87.059	4.393	585.386	5.393	32.508	0.000***
Complex_09	70	59.656	240.328	4.071	1936.82	7.101	55.01	0.000***
Complex_av	72	41.693	131.753	2.917	968.41	5.85	38.549	0.000***
Performance_08	56	0.004	0.008	-0.017	0.022	-0.442	3.243	0.241
Performance_09	70	0.002	0.02	-0.151	0.015	-6.869	53.822	0.000***
Performance_av	72	0.003	0.011	-0.076	0.019	-4.729	34.161	0.000***
Equity_08	56	0.044	0.022	0.005	0.127	1.163	5.258	0.000***
Equity_09	70	0.046	0.016	0.019	0.091	0.403	2.924	0.324
Equity_av	72	0.045	0.014	0.02	0.083	0.689	3.234	0.075*

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

Panel A and B of Table 3 provide descriptive statistics of BHC classified by countries. The largest BHCs are headquartered in Belgium, France, and UK while the smallest come from Cyprus and Denmark. The most sophisticated banks in terms of operational risk

management experience are located in Germany, Australia, Canada, and Netherlands (Panel A, *ORmgmt* = 1.867, 1.625, 1.625, and 1.600) while BHCs from Finland, Austria, Italy, Denmark and Greece are the outsiders according to this criterion (Panel A, *ORmgmt* = 0, 0.375, 0.563, and 0.667). According to Barth et al. (2008), the most stringent capital regulation is in Denmark (Panel A, *Stringent* = 8) while the most relaxing is in Ireland, Germany, and Singapore (Panel A, *Stringent* = 1). Business environment is the most sophisticated in Japan, Germany, and Switzerland (Panel A, *BusSophis* = 5.9 and 5.8) in contrast to Greece and Portugal (Panel A, *BusSophis* = 4 and 4.3). Finally, we would like to mention that banks from South Africa in 2007 demonstrated an outstanding performance in terms of pre-tax return (*Performance_07*) of 6.1%. The sample average is 1.1%. More information could be found in table 3.

Table 3

Average figures grouped per country

Panel A: Variables used in logistic regressions AMA adoption analysis. Data for 2007 reporting year except country-level variables.

	Country	Nb of BHC	Approach	Performance_07	Size_07	ORmgmt	Equity_07	Stringent	BusSophis	Listing
1	Australia	8	0.625	0.014	9.650	1.625	0.051	3.000	4.800	1.000
2	Austria	8	0.000	0.006	8.336	0.375	0.052	5.000	5.500	0.250
3	Belgium	2	0.000	0.009	10.751	1.500	0.028	4.000	5.300	1.000
4	Canada	8	0.125	0.010	9.887	1.625	0.048	4.000	5.100	1.000
5	Cyprus	3	0.000	0.011	7.217	1.000	0.061	3.000	4.700	1.000
6	Denmark	6	0.000	0.011	7.673	0.667	0.059	8.000	5.500	0.500
7	Finland	2	0.000	0.012	8.180	0.000	0.063	4.000	5.400	1.000
8	France	7	0.429	0.006	10.826	1.429	0.050	2.000	5.300	0.429
9	Germany	15	0.400	0.002	9.025	1.867	0.027	1.000	5.800	0.533
10	Greece	9	0.000	0.011	8.452	0.667	0.063	3.000	4.000	0.778
11	Ireland	3	0.333	0.012	9.063	1.000	0.059	1.000	5.000	0.667
12	Italy	16	0.188	0.013	8.910	0.563	0.056	4.000	4.900	0.750
13	Japan	14	0.071	0.004	8.643	1.000	0.055	4.000	5.900	0.929
14	Korea (South)	11	0.182	0.013	8.789	0.727	0.057	3.000	4.900	0.545
15	Malaysia	4	0.000	0.012	8.380	0.750	0.071	3.000	4.800	0.500
16	Netherlands	5	0.400	0.005	7.862	1.600	0.043	3.000	5.500	0.200
17	Portugal	4	0.000	0.010	9.497	1.250	0.045	3.000	4.300	0.500
18	Singapore	3	0.000	0.015	9.800	1.333	0.069	1.000	5.200	0.667
19	South Africa	5	0.000	0.061	9.563	1.200	0.113	4.000	4.600	0.800
20	Spain	6	0.333	0.014	9.840	1.167	0.051	4.000	4.700	0.833
21	Sweden	5	0.200	0.007	9.051	1.000	0.036	3.000	5.700	0.800
22	Switzerland	8	0.250	0.012	8.099	0.500	0.059	3.000	5.800	1.000
23	UK	8	0.250	0.012	10.360	1.250	0.059	3.000	5.200	0.625
	Total	160	0.194	0.011	9.020	1.056	0.054	3.313	5.181	0.700

Panel B: Variables used in operational risk-weighted assets analysis. Time series data for the period from 2008 to 2009 except country-level variables.

	Country	Nb of obs.	ORWA	Approach	Complex	Performance	Equity	Stringent	BusSophis	Listing
1	Australia	8	0.036	1.000	11.175	0.010	0.045	1.000	3.000	4.800
2	Canada	15	0.047	0.133	7.588	0.007	0.049	1.000	4.000	5.100
3	France	5	0.033	1.000	14.320	0.002	0.032	0.800	2.000	5.300
4	Germany	23	0.017	0.478	70.246	-0.004	0.028	0.478	1.000	5.800
5	Ireland	4	0.039	0.250	27.690	-0.040	0.056	0.750	1.000	5.000
6	Italy	18	0.049	0.333	8.978	0.005	0.051	0.778	4.000	4.900
7	Netherlands	8	0.020	0.333	352.719	0.001	0.023	0.222	3.000	5.500
8	Spain	9	0.048	0.300	11.242	0.009	0.054	0.900	4.000	4.700
9	Sweden	10	0.021	0.200	25.851	0.004	0.044	0.800	3.000	5.700
10	Switzerland	10	0.052	0.300	16.983	0.007	0.057	1.000	3.000	5.800
11	UK	16	0.050	0.250	10.910	0.006	0.052	0.625	3.000	5.200
	Total	126	0.040	0.291	38.938	0.003	0.045	0.733	3.182	5.188

4. Models and correlation matrix

4.1. Empirical models

To test our research hypotheses we built the following logistic model:

$$P\,[Y = AMA|\,X] = \beta_0 + \beta_1 * ORmgmt_i + \beta_2 * Equity_i + \beta_3 * Stringent_i + \beta_4 * BusSophis_i + \beta_5 * Listing_i + \beta_6 * Performance_i + \beta_7 * Size_i + \sum Country_i + e_i \quad \textbf{(Model 1)}$$

, P [Y = AMA| X] is the probability that BHC adopts AMA, and Φ is the CDF of the standard normal distribution. To answer our research question, R.Q., regarding the impact of operational risk approach on risk-weighted assets, we opted for the following OLS model:

$$ORWA = \beta_0 + \beta_1 * Approach_{it} + \beta_2 * Complex_{it} + \beta_3 * Performance_{it} + \beta_4 * Equity_{it} + \beta_5 * Listing_{it} + \beta_6 * Stringent_i + \beta_7 * BusSophis_i + \sum Country_i + \sum Year_t + e_{it} \quad \textbf{(Model 2)}$$

To avoid the potential bias arising from the correlation between BHC choice to adopt AMA (Approach) and the error term when we use reported values to predict operational risk-weighted assets, we apply a two-stage least squares (2SLS) model. It allows us to study the impact of the sophistication of risk measurement models on capital charge incorporating the effects of bank size and growth on the choice to adopt such approach. In the first stage, the BHC choice to adopt AMA is defined as a function of bank size and size-growth characteristics and of other unit and country specific variables.

$$P\,[Y = AMA|\,X] = \beta_0 + \beta_1 * Asset\_growth_{it} + \beta_2 * Size_{it} + \beta_3 * Complex_{it} + \beta_4 * Performance_{it} + \beta_5 * Equity_{it} + \beta_6 * Listing_{it} + \beta_7 * Stringent_i + \beta_8 * BusSophis_i + \sum Country_i + e_{it} \quad \textbf{(Model 3 -1S)}$$

In the second stage, we use the predicted values of BHC choice (*Approach_predicted*) by the first stage as a variable of main interest together with other control variables.

$$ORWA = \beta_0 + \beta_1 * Approach\_predicted_{it} + \beta_2 * Complex_{it} + \beta_3 * Performance_{it} + \beta_4 * Equity_{it} + \beta_5 * Listing_{it} + \beta_6 * Stringent_i + \beta_7 * BusSophis_i + \sum Country_i + e_{it} \quad \textbf{(Model 3 -2S)}$$

Subscripts denote individual BHC (i = 1, 2…, 160), and time period (t = 2008, 2009).

4.2. Correlation among variables

Table 4 presents the correlation coefficients of our variables. Variables in both samples exhibit quasi-identical correlation coefficients. From these tables, we can observe some multicollinearity among variables. Particularly, *Size* is negatively and significantly correlated with *Equity* (Panel A, -0.325). This confirms findings of Rime (2001) that large BHCs are less capitalized. Large banks are also more likely to be listed on public stock exchange (Panel A, 0.322) and have a higher experience in voluntary operational risk-sensitive management (Panel A, 0.5). Publicly listed BHC are also more likely to invest in operational risk management systems, i.e. the correlation coefficient between *Listing* and *ORmgmt* is positive and significant (Panel A, 0.219). Banks with lower leverage exhibited a higher return on assets in 2007, i.e. correlation coefficient between *Equity* and *Performance* is 0.784 (Panel A) while in 2008-2009 the correlation between these variables remain positive, but is much less significant and is at the level of 0.139 (Panel B). Concerning country-level variables (*Stringent* and *BusSophis*), it is interesting to note that *Stringent* is negatively correlated with *ORmgmt* (Panel A, - 0.288). In the same time, the correlation coefficients between *Stringent* and *Equity* (Panel A, 0.162; Panel B, 0.067) are not significant. Among other results it is worth to note a high correlation between BHC capital ratios and BHC assets per employee (Panel B, 0.701). Other correlation coefficients could be observed in table 4.

Table 4

Correlation among variables

Panel A: Correlation matrix of variables used in logistic regressions AMA adoption analysis. Data for 2007 reporting year except country-level variables. The significance levels are indicated below correlation coefficients.

	Approach	Performance_07	Size_07	ORmgmt	Equity_07	Stringent	BusSophis
Performance_07	-0.067						
	0.399						
Size_07	0.397	-0.036					
	0.000	0.649					
ORmgmt	0.487	-0.124	0.500				
	0.000	0.119	0.000				
Equity_07	-0.278	0.784	-0.325	-0.360			
	0.000	0.000	0.000	0.000			
Stringent	-0.224	0.097	-0.158	-0.288	0.162		
	0.005	0.223	0.046	0.000	0.041		
BusSophis	0.082	-0.241	-0.070	0.097	-0.220	-0.034	
	0.300	0.002	0.377	0.222	0.005	0.669	
Listing	0.148	0.101	0.322	0.219	-0.064	0.029	-0.043
	0.061	0.202	0.000	0.005	0.424	0.712	0.590

Panel B.1: Correlation matrix of variables used in operational risk-weighted assets analysis. Time series data for the period from 2008 to 2009 except country-level variables. The significance levels are indicated below correlation coefficients.

	ORWA	Approach	Complex	Performance	Equity	Listing	Stringent
Approach	-0.205						
	0.008						
Complex	-0.217	-0.066					
	0.005	0.397					
Performance	0.202	-0.006	-0.069				
	0.009	0.936	0.378				
Equity	0.005	-0.091	0.701	0.139			
	0.951	0.246	0.000	0.076			
Listing	0.001	0.115	-0.200	0.196	-0.124		
	0.992	0.143	0.010	0.012	0.112		
Stringent	0.309	-0.254	-0.096	0.218	0.067	0.136	
	0.000	0.001	0.223	0.005	0.391	0.081	
BusSophis	-0.278	0.121	0.149	-0.175	0.199	-0.159	-0.221
	0.000	0.122	0.056	0.025	0.010	0.041	0.004

5. Empirical results

5.1. Adoption of risk-sensitive approaches for operational risk measurement

The first set of regressions tests our hypotheses related to factors leading to the adoption of AMA for the operational risk-weighted assets determination (Table 5). As we already mentioned, in all models we control for country fixed effects. The coefficients of a variable *Size* are significant at 1% level in all five models. These results support previous findings suggesting that the propensity to adopt a sophisticated risk management system increases with the size of a bank. The investments for AMA implementation are important, thus only banks with a certain size seem to be able to afford such a sophisticated system. No significance was found for bank performance in 2007.

The coefficients of the variable measuring the BHC prior experience in the operational risk management, *ORmgmt*, are significant at 1% and positive (Models 5-1 and 5-5). This is consistent with our first hypothesis stating that BHC with more formalized operational risk management structure and experience in risk-sensitive measurements are more likely to turn their attention to AMA.

Moreover, we found an empirical support for our second hypothesis. Coefficients of *Equity_07* are significant at 1% level and negative. The level of bank equity does influence the decision of banks to invest in AMA.

The stringency of national regulatory oversight, *Stringent*, seems to influence positively the propensity of banks to adopt AMA. Nevertheless, the coefficients are not significant at usual levels (Models 5-3 and 5-5). Thus, we cannot conclude that stronger pressures on BHC capital from national regulators encourage banks to adopt the most sophisticated measurement system for operational risks. Similar results were found for bank business environment. The coefficients of the variable *BusSophis* in models 5-3 and 5-5 are not significant, but are

positive as we predicted. More demanding environment in terms of supplier quality, cluster development, competitive advantage, and production process seems to have no influence on the sophistication of BHC risk management.

Our results do not support the hypothesis concerning the listing status of a bank. Coefficients of variable, *Listing*, in models 5-4 and 5-5 are not even close to be significant. This might imply that stock exchange rules have no distinct effect on BHC choice to adopt risk measurement approach.

Table 5

Factors that influence BHC choice to adopt the Advanced Measurement Approach for operational risks

This table reports the results of logistic regressions AMA adoption analysis. Sample consists of 114 bank holding companies from 11 countries. In models 1-4 we test each of our 4 hypotheses separately. In model 5 we include all variables of interest and control variables. In each model we control for BHC performance and BHC size as well as for country fixed effects.

		Expected sign	**Probit models**				
			Model 5-1	Model 5-2	Model 5-3	Model 5-4	Model 5-5
	Control variables						
	Performance_07		-23.541	46.108	-18.513	-20.942	50.379
			(49.039)	(44.356)	(35.598)	(37.747)	(51.410)
	Size_07		0.410***	0.451***	0.570***	0.544***	0.288**
			(0.136)	(0.119)	(0.112)	(0.119)	(0.141)
	Variables of interest						
H.1	ORmgmt	+	1.448***				1.432***
			(0.323)				(0.366)
H.2	Equity_07	-		-48.791***			-49.701***
				(14.901)			(16.328)
H.3.a	Stringent	+			2.130		2.292
					(1.449)		(1.420)
H.3.b	BusSophis	+			2.377*		1.964
					(1.295)		(1.202)
H.4	Listing	+				0.400	-0.231
						(0.478)	(0.532)
	Country FE		yes	yes	yes	yes	yes
	Constant		-7.123***	-4.263**	-25.581**	-6.897***	-21.319**
			(1.587)	(1.674)	(11.717)	-1.473	(10.662)
	Wald chi2		48.133	46.341	46.523	48.197	58.011
	Pseudo R-squared		0.456	0.371	0.303	0.308	0.516
	Observations		114	114	114	114	114

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2. Operational risk capital charge univariate analysis

Table 6 presents the results of the univariate analysis. In this analysis, we compare operational risk-weighted assets (*ORWA*) determined under AMA to those computed under less sophisticated approaches (*SA* or *BIA*). On average, the operational risk-weighted assets computed under AMA (*ORWA_AMA*) represent 3.2% of BHC total assets, while operational risk-weighted assets determined under other approaches (*ORWA_non_AMA*) amounts for 4.1% (Model 6-1). The difference of 0.9% of BHC total assets is significant at 5% level. In models 6-2 and 6-3 we compare the operational risk-weighted assets reported by banks in 2008 and in 2009 correspondingly. The results do not differ significantly from the previous analysis. Only in 2008, the difference between ORWA of *AMA* banks and *non_AMA* banks is slightly lower but still significant at 10% and represents 0.8 % of BHC average assets. As we suspect that figures reported by banks in 2008 could be seriously impacted by the recent financial crisis, we performed an additional test where we compare the average *ORWA* of 2008 and 2009 observations for both types of BHC. This test showed a difference in *ORWA* between *AMA* banks and *non_AMA* banks of 0.7% of total assets confirming our previous results. These findings confirm that AMA adoption leads to lower capital requirements. By adopting *AMA* for the operational risk-weighted assets assessment, banks might save capital and create a competitive advantage compared to BHC, *non-AMA* adopters.

Table 6

Comparison of operational risk-weighted assets determined under different approaches

This table presents results of the univariate test of the operational risk-weighted assets determined under different approaches proposed by Basel II. In model 6-1 we compare the average operational risk-weighted assets computed under AMA to those determined under two other approaches (BIA and SA) for the time series period from 2008 to 2009. In models 6-2 and 6-3 we decompose our sample on two sub-samples according to the reporting year. In model 6-4 we compare the average figures of the operational risk-weighted assets reported in 2008 and 2009.

T-test: diff. = mean (ORWA_AMA) - mean (ORWA_not_AMA)

		Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf. Interval		t-Stat.
Model 6-1	Time series 2008 - 2009	ORWA_AMA	47	0.032	0.002	0.014	0.028	0.036	t = -2.253**
		ORWA_non_AMA	79	0.041	0.003	0.025	0.035	0.046	
Model 6-2	2008	ORWA_AMA	20	0.032	0.004	0.016	0.024	0.039	t = -1.455*
		ORWA_non_AMA	36	0.040	0.004	0.025	0.032	0.049	
Model 6-3	2009	ORWA_AMA	27	0.032	0.003	0.013	0.027	0.037	t = -1.71**
		ORWA_non_AMA	43	0.041	0.004	0.026	0.033	0.049	
Model 6-4	Average 2008 - 2009	ORWA_AMA	27	0.032	0.003	0.014	0.026	0.037	t = -1.517*
		ORWA_non_AMA	45	0.039	0.004	0.024	0.032	0.047	

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

5.3. Operational risk capital charge multivariate analysis

To check the robustness of our univariate results, we performed multivariate analysis which results are reported in table 7. In all six models we controlled for business complexity (*Complex*), accounting performance (*Performance*), bank level of equity (*Equity*), listing status (*Listing*), regulatory pressures (*Stringent*) and normative pressures (*BusSophis*). Models 7-1, 7-2, and 7-3 report OLS regression results where our variable of interest is dichotomous and takes the observed values (*Approach*). Overall, this OLS analysis confirmed our univariate findings. The coefficients of Approach are negative and significant at usual levels. In addition, to limit a potential problem of the correlation of our variable of interest *Approach* with the error term, we performed the two-stage least squares analysis

Table 7

Multivariate analysis of operational risk-weighted assets

This table reports the results of multivariate analysis of the operational risk-weighted assets scaled by total assets. Models 7-1, 7-2, and 7-3 present the OLS regressions results while models 7-4, 7-5, and 7-6 report the results of 2SLS analysis. In model 7-1 we use the time series data for the period from 2008 to 2009. In models 7-2, 7-3, 7-4, 7-5, and 7-6 the sample is reduced only to observations corresponding to focal year.

	OLS			**2SLS**					
	2008 - 2009	2008	2009	2008		2009		Average 2008-2009	
				First-stage	Second-stage	First-stage	Second-stage	First-stage	Second-stage
	Model 7-1	Model 7-2	Model 7-.3	Model 7-4		Model 7-.5		Model 7-6	
Approach	-0.007***	-0.004	-0.007*						
	(0.002)	(0.004)	(0.004)						
Approach_predicted					-0.004		-0.004		-0.004
					(0.003)		(0.003)		(0.005)
Instruments									
Asset_growth				-0.242		0.169		-0.048	
				(0.246)		(0.174)		(0.174)	
Size (08/09/av)				0.691***		0.442***		0.164**	
				(0.256)		(0.139)		(0.079)	
Control variables									
Complex (08/09/av)	-0.001***	-0.001***	-0.001***	0.001	-0.001***	-0.001	-0.001**	-0.003	-0.001**
	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)
Performance (08/09/av)	0.102	0.627	0.052	-54.961	0.612	33.838	0.223	-18.347	0.441
	(0.118)	(0.470)	(0.112)	(36.329)	(0.584)	(35.691)	(0.194)	(22.507)	(0.321)
Equity (08/09/av)	0.255***	0.358**	0.199**	7.064	0.005	-12.981**	0.115	-1.720	0.048
	(0.080)	(0.167)	(0.089)	(7.322)	(0.021)	(5.830)	(0.131)	(5.153)	(0.078)
Listing	-0.003	-0.003	-0.001	-0.810	-0.009	0.779	0.003	0.992*	-0.003
	(0.005)	(0.006)	(0.008)	(0.810)	(0.008)	(0.720)	(0.006)	(0.557)	(0.006)
Stringent	-0.001	0.001	-0.001	2.029	0.009***	-8.336**	-0.001	0.556	-0.002
	(0.002)	(0.002)	(0.003)	(1.486)	(0.003)	(4.004)	(0.004)	(2.427)	(0.005)
BusSophis	-0.014*	-0.012	-0.013	2.496*	0.003	-7.056*	0.001	0.484	0.003
	(0.007)	(0.012)	(0.009)	(1.506)	(0.009)	(3.652)	(0.009)	(2.214)	(0.010)
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Constant	0.102**	0.074	0.097**	-26.341**	0.016**	60.921*	0.029	-6.780	0.036
	(0.039)	(0.060)	(0.047)	(13.25)	(0.007)	(33.001)	(0.052)	(20.091)	(0.056)
Observations	126	56	70	56	56	70	70	72	72
Wald chi2				24.731		26.649		19.881	
Pseudo R-squared				0.299		0.329		0.204	
R-squared	0.533	0.685	0.471		0.644		0.503		0.541

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(González, 2005; Laeven et al., 2009; Larcker & Rusticus, 2010). As instrumental variables, we selected BHC size (*Size*) and BHC asset growth (*Asset-growth*). The results are reported in table 7, models 7-4, 7-5, and 7-6. The predicted values of AMA (*AMA_predicted*) exhibit negative signs, but they are not significant at usual levels.

6. Discussion and conclusion

The evolution of banking industry has made this sector much more risky. As the financial crisis of 2007-2008 showed, the problems that are primary related to an excessive risk-taking behavior by banks might spill over the banking sector and affect considerably the world economic stability. To prevent the "moral hazard" situation faced by bank owners and managers, the regulators introduced new minimum requirements for credit, market and operational risk with the objective of having banks gaining control of their risk factors and improve the governance of the entire industry. One of such regulatory instruments is the Basel II New Capital Accord structured on three pillars. According to Pillar 1, banks should have enough capital to absorb their credit, market, and operational risk exposures. However, the intention of the international regulator is to offer several approaches to banks and let them decide which one to adopt. Therefore, banks must decide whether to invest in risk-sensitive risk management practices or to satisfy to elementary compliance standards by implementing relatively inexpensive, standard measurement methods. Little is known about why some financial institutions prefer to implement the most sophisticated methods for their risk management. Today, when the financial crisis impacted the behavior of almost all large banks across the world, supplementary discretionary expenses had to be weighted several times against potential benefits. Risk-sensitive measurement approaches proposed by Basel II are costly (Hakenes et al., 2011; VanHoose, 2007). In contrast, the standardized approaches are

not expensive and their introduction allows banks to make immediate savings. But, whether these savings are worth potential benefits and what kind of benefits can be derived remains unclear.

Despite of an increased interest of the academic community to this issue, there is limited evidence on banks' choice of risk assessment approaches. The aim of this paper is to identify factors that influence BHC decision to adopt in sophisticated risk measurement systems. We limited our interest to operational risks and particularly to the adoption of the risk-sensitive approach (AMA) for the capital charge determination. We chose the operational risk for two reasons. First, this is a new requirement that banks did not face before. Second, there is a common opinion that this risk is highly idiosyncratic to institutions and measurement policies cannot be standardized.

Our main findings show that the adoption of AMA is motivated by potential technical and managerial advantages in the operational risk management and the level of equity that banks had in years previous to Basel II adoption.

We also predicted that certain institutional factors might influence the banks' decision to adopt AMA. As regulators and rating agencies favor the adoption of risk-sensitive approaches like AMA we predicted that the degree of regulatory pressure might influence positively the propensity of banks to invest in AMA, even if pure economic outputs of such approach remain highly uncertain. Moreover, we predicted that BHC institutional environment might influence the decision to adopt the sophisticated risk management practices. Higher business standards in a particular country might lead to a higher sophistication in bank risk management practices. Nevertheless, our empirical findings did not robustly confirm these hypotheses. Moreover, our empirical results suggest that the listing status does not influence the bank decision to adopt AMA.

The second question we raised in this study is whether AMA leads to lower capital requirements as it is suggested by different agents (BCBS, 2001a; Ramadurai et al., 2004). Banks that adopt AMA can save capital and gain a competitive advantage compared to those that adopt income-based approaches. The empirical results of our analysis generally support this view, but are not robust enough.

Our research is a subject of several limitations. First, due to the information availability, our sample is restricted. Some banks do not disclose information on operational risk management as it is requested by Pillar III of Basel II. However, we are confident that our findings could be generalized to all large, internationally-active banks. Second, our measures of regulatory and normative pressures could be debatable. These two variables are constructed only on the country-level. We might expect that even in a formally homogenous regulatory environment, different banks might be subject to different pressures, especially if this concerns regulatory pressures. Banks that positioned as "to big to fall" could be encouraged by national regulators to invest in their risk management practices. Third, we recognize that endogeneity issues might arise in our analysis. Specifically, the sophistication in the operational risk management might be a cause of a bank intention to adopt risk-sensitive approaches proposed by Basel II. With 2SLS analysis we tried to solve partially this problem, but further analysis is needed, especially concerning the choice of instrumental variables.

At this stage, additional research is needed to explore if the adoption of sophisticated risk-sensitive approaches brings any financial, managerial and technical benefits to financial institutions. It is also interesting to understand the real cost of the operational risk assessment under different measurement techniques and how these measurement practices impact the bank overall risk management process and, more importantly, risk-taking strategies. This will facilitate the evolution of the regulatory framework and hopefully reduce the probability of systemic crises in the banking sector.

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Essay 2:

Internal Risk Controls and their Impact on Bank Solvency

1. Introduction

In the past decade, the importance of a healthy banking system for the development and stability of the world economy has been outlined in many academic and practitioner studies (Caprio, Laeven, & Levine, 2007; Kimball, 2000) and accompanied with calls for more research on the role that control systems can play to prevent financial crises (Hopwood, 2009). The recent financial crisis spilled over the financial sector and heavily impacted the real economy stressing the dependence on this sector. It also raised a large number of questions such as: Why did financial institutions with sophisticated risk systems suffer from the financial crisis (leading to the bankruptcy of several of them) and record massive losses during 2007 – 2009? What organizational, managerial and regulatory measures can be taken to prevent such situations?

These questions are of great interest to improve the risk management of financial institutions and scholars have started to examine the effectiveness of internal and external governance and risk management systems to control risk taking in banks and, by that, to lower the risk of systemic financial crisis. Kimball (2000) suggests that banks could minimize errors in risk management as well as potential exposures of these errors by building the strong and formalized risk management mechanisms sensitive to bank business strategies. Scholes (2000) stresses that actual risk quantitative modeling is not efficient to prevent financial crisis and to some extent could provoke it. Greater quality of risk management and measurement models reduce bank losses and banks might respond to this by proposing new, riskier products that, in their turn, require better internal risk controls.

Nocco and Stulz (2006) say that the role of risk management in organizations changed dramatically during the past decade. Today, the risk management function plays an important role in a day-to-day management by providing bank managers the crucial information about potential risk and returns of different business strategies they might implement to carry out

the overall strategic plan set by firm shareholders. In bank holding companies, enterprise risk management has another important role to balance the overall risk of default among different group legal entities (Gatzert et al., 2008). However, despite the importance of the topic, few studies examine the impact of risk management systems (RMS) on bank performance and risk. With a sample of 74 US Bank Holding Companies (BHC), Ellul and Yerramilli (2010) investigate the link between risk controls and bank risk. Through the construction of a Risk Management Index (RMI), they find that BHCs with a high RMI have lower enterprise-wide risk. Aebi et al (2011) performing an empirical analysis with a sample of North American banks provide mixed evidence about BHC risk management governance mechanisms and bank performance. While the reporting status of the Chief Risk Officer (CRO) exhibits a positive and empirically significant relation with bank performance, the presence of a dedicated risk committee on the bank board and the executive status of the CRO do not seem to influence bank stock and equity returns.

Our paper extends these studies on various aspects. First, our measure of risk control intensity combines three types of risk control mechanisms: the existence of a risk committee (RC) composed of board members, the appointment of a Chief Risk Officer (CRO) in the management executive board, and the use of risk-sensitive measurement models (Value-at-Risk modeling) to assess risk exposure. Second, we measure bank solvency using two internal risk measures, Tier 1 ratio and Z-score, and not stock market prices. Our two dependent variables aim to capture BHC risk taking and risk exposure associated to internal factors and not factors from the outside environment. Third we examine the relationship between risk controls and BHC solvency through the prism of various interaction factors that might influence this relationship. Fourth, our sample is made of international banks excluding US banks. With a sample of 465 Bank Holding Companies (BHC)-Year observations collected over the period of 2004 - 2010, we analyze under which circumstances internal risk controls

influences banks' solvency. We find a positive effect of internal risk controls on BHC solvency, which is positively moderated by ownership concentration and the comparative power of national bank regulators. However, we find that the relationship between risk control and solvency is negatively affected (hence internal risk control become less efficient) when banks follow a growth strategy. Overall, the study is one of the first of its kind contributing to an enhanced understanding of the effectiveness of internal risk controls in the banking sector.

The remaining of this paper is organized as follows. Section 2 discusses the previous literature on the various aspects of bank risk taking and performance. Section 3 discusses our data and our methodology. In section 4, we provide descriptive statistics of the sample. Section 5 and 6 present results and discuss their robustness. Section 7 concludes.

2. Literature review and hypotheses development

Previous studies examined determinants of Enterprise Risk Management (ERM) and its impact on firm performance (Barton, Shenker, & Walker, 2002; Lam, 2003). With a sample of US insurers, Hoyt and Liebenberg (2011) find a positive relation between the use of ERM and firm value. Beasley et al. (2005) document that the stage of ERM implementation is positively associated to the presence of a chief risk officer (CRO), board independence, CEO and CFO apparent support for ERM, the presence of a Big Four auditor, entity size in the banking, education, and insurance industries. Another stream of research is aimed to study different types of ERM (Mikes, 2009) and the roles of CRO in managing and communicating firm risks (Mikes, 2008).

2.1. Risk controls and BHC solvency

According to Fama and Jensen (1983) internal risk controls are corporate governance mechanisms designed to reduce information asymmetry and align interests between investors and managers. Stulz (2008) stresses, that in banks, the primary role of internal risk controls is to identify and to evaluate the risks faced by the firm, to communicate these risks to management (and possibly to the board of directors), and to monitor and manage those risks in a way that ensures the firm bears only the risks its management and shareholders want exposure to. The determination of company's risk taking is an important duty of the bank board of directors as the main representative of its shareholders. Incurring a large loss might not just be a problem of poor risk management, but also a cause of unsuccessful business strategies and unfavorable external factors. However, risk control and risk management failures indisputably might affect firm performance. In the banking sector, the recent large losses of Société Générale in 2008 and UBS in 2011 are well-known examples. Stulz (2008) identified five potential risk management failures: 1) use of inappropriate risk metrics; 2) erroneous measurement of known risk; 3) ignoring of certain risks; 4) incorrect communication of identified risks to business managers; 5) inappropriate monitoring and managing of day-to-day risks. Frequently, these failures occur as consequences of political games driven by different bank stakeholders such as manager-regulator games, owner-manager games and others. Nevertheless, risk control systems create value by enabling senior management to quantify and manage the risk-return tradeoff faced by firms. In the financial sector, effective risk controls should ensure bank solvency by reducing risk of default. The aim of risk controls is also to ensure that all material risks are "owned", and risk-return relation carefully evaluated (Nocco et al., 2006). Considering these arguments, we propose the following hypothesis:

Hypothesis 1: The intensive use of risk controls is positively associated with bank solvency.

2.2. The interaction of risk controls with structure, strategy and regulatory factors

In the management accounting field studies have analyzed effects of interactions between management control systems and context factors on performance (Chenhall, 2003). With regard to governance systems, Aguilera et al. (2008) recently call for extending agency theoretical work on the link between corporate governance systems and performance by studying how these relations depend not only on context factors but also on complementarities, i.e. other management practices in place. This conceptual approach has become increasingly popular in studies on bank risk taking (Laeven et al., 2009; Shehzad, de Haan, & Scholtens, 2010). Gordon et al (2009) found that the relation between ERM and firm performance is contingent on environment stability, intensity of industry competition, firm size, complexity of firm assets, and board of directors' strength. These theoretical arguments as well as the empirical results indicate that efficiency of risk management systems in banks might also be dependent on contextual variables. Therefore, we argue in this paper that the relation between internal risk controls and bank solvency depends on a) ownership structure, b) growth strategy, and c) banking sector regulation issues.

Ownership structure

Traditional agency theory suggests that diversified owners have incentives to take higher risks in business strategies, while a higher proportion of personal wealth invested in a firm equity decreases the motivation to take excessive risk (Jensen & Meckling, 1976). Moreover, owners with large shareholdings have greater possibilities to control business strategies, and consequently the BHC risk control system should be more intensively used and more aligned with their interests. Supporting this idea, Caprio et al., (2007) find that ownership concentration represents a moderating factor for the relation between the

shareholder protection laws and bank valuations. The ownership structure of firms hence plays an important role to reduce agency costs and align managers-shareholders interest. With a sample of property-liability insurance companies, Cole et al. (2011) find that each ownership structure has an influence on bank risk-taking. Denis et al. (1999) suggest that ownership structure affects the magnitude of agency problems and, as a consequence, influences corporate strategy, organizational structure and management systems. However, the existing research on the ownership structure in banks demonstrates mixed results. Laeven and Levine (2009) report that bank risk-taking strategies are positively associated to the comparative power of shareholders, while the studies of Iannotta et al. (2007) and Shehzad et al. (2010) find that the ownership concentration lowers bank risk of default by increasing the quality of assets and capital adequacy ratios. Demsetz et al. (1997) suggest that the relation between the bank shareholding structure and its risk-taking is contingent on the charter value of a bank. Only in low-capitalized banks a higher ownership concentration leads to a higher risk-taking, while in banks with relatively high franchise value this relationship is not empirically significant. These findings imply that ownership concentration matters for bank risk-taking.

Taking into consideration the fact that major shareholders have greater possibilities to control the behavior of bank managers, we propose that ownership concentration will moderate positively the effectiveness of risk management control systems.

Hypothesis 2a: Increase in ownership concentration will strengthen the relationship between internal risk controls and BHC solvency.

BHC growth strategy

The question how internal control systems and business strategies interact was raised in many academic studies (Baysinger & Hoskisson, 1990; Denis et al., 1999; Peek, Rosengren,

& Kasirye, 1999; Spira & Page, 2003). Kober et al. (2007) find the existence of a two-way relationship between management control systems and strategy. The simultaneous influence of enterprise risk management systems and firm business strategy is also underlined by Gordon et al. 2009 that consider strategy as a critical element to manage risk. Previous research in strategic management field suggests that firm growth strategies lead to a lower efficiency in day-to-day operations, and negatively affect financial performance, while downsizing strategies improve efficiency (Hopkins & Hopkins, 1997; Morris, Cascio, & Young, 1999).

As a result, internal risk controls in banks pursuing growth strategies are likely to lose their effectiveness at assessing and monitoring risks. Hence, we propose the following hypothesis:

Hypothesis 2b: Growth strategies will make weaker the relationship between internal risk controls and BHC solvency.

Banking regulation

The introduction of new banking reforms and the financial crises have boosted research on banking regulation rules (Caprio et al., 2007; González, 2005; Pasiouras et al., 2009). Preliminary findings suggest that identical rules for all banks operating within one particular country are not efficient and might have adverse effect. While stringent capital requirements are associated with fewer non-performing loans, Barth et al. (2004) stress that capital stringency is not robustly linked with the banking sector stability and bank performance. Moreover, González (2005) report that under certain conditions, regulatory restrictions might even increase bank risk-taking incentives. Pasiouras et al. (2009) in their turn, report controversial results: stricter capital requirements have positive effect on cost efficiency but decrease bank profitability, while restrictions on bank activities impact bank cost and profit

exactly in the opposite way. Several studies consider banking regulations as important context factors impacting the relation between ownership structure and bank performance and risk (Laeven et al., 2009; Shehzad et al., 2010). Danielsson et al. (2002) infer that the presence of external regulation may induce banks to decrease the quality of its risk management system.

Based on this theoretical argumentation and empirical findings, we predict that higher external requirements might reinforce the effectiveness of internal risk controls. To comply with rules imposed by strong regulatory bodies, BHC managers will implement and use more intensive internal risk control mechanisms leading to a positive impact on risk taking and solvency. For example, if regulators force banks to adopt advanced approaches under Basel II Capital Accord (BCBS, 2004a) banks should considerably improve their qualitative side of risk management. As a result, we formulate the following hypothesis:

Hypothesis 2c: More stringent regulatory environment will strengthen the relationship between internal risk controls and BHC solvency.

3. Data, variables and methodology

3.1. Sample and data

To test our hypotheses we use a sample of 465 Bank Holding Companies (BHC)-Year observations covering the period from 2004 to 2010. We built it using BHC annual risk and corporate governance reports, as well as The Banker and Worldscope databases. We first chose Bank Holding Companies from country-members of Basel Committee on Banking Supervision[2]. Then, we excluded countries in which, Basel II New Capital Accord had not been enforced before 2008 to avoid discrepancies in BHC risk-taking measurement. For the

[2] The Committee's members come from Argentina, Australia, Belgium, Brazil, Canada, China, France, Germany, Hong Kong SAR, India, Indonesia, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. Source: http://www.bis.org/bcbs/about.htm

remaining countries, we extracted data on BHC from The Banker Database Top 1000 Rankings. To balance our sample and avoid an overweighting from banks of countries such as Italy and Japan, we decided to limit our sample to a maximum of 10 publicly listed BHC per country and taking the largest ones (Caprio et al., 2007; Laeven et al., 2009). When a country had only one BHC, we decided not to include it in the sample. For each BHC-Year observation we manually collected data on the risk management systems and structure, risk measurement approaches, and ownership structure from the annual reports. Information on bank solvency and risk of default were obtained from the Banker database while financial data was collected from the Worldscope database. Data for our country-level control variables came from the Financial Development Report 2010 Executive Opinion Survey (Bilodeau, 2010) and Barth et al. (2001; 2008). As a result, our final sample consists of 88 banks and 465 BHC-year observations from 16 countries. Because of data availability for country-level variables, *Corgov* and *Bsstab*, we use 446 bank-year observations in models where the dependent variable is *Tier 1 Ratio* and 287 bank-year observations in models where the dependent variable is *Z-score*.

3.2. The dependent variable - measuring bank solvency and risk of default

Existing literature identify different proxies for bank riskiness. For example, the fraction of non-performing or impaired loans is often used as a measure of bank riskiness (Podpiera, 2004; Shehzad et al., 2010) and/or an indicator of asset quality (Cihák et al., 2010). However, Demirgüç-Kunt and Detragiache (2010) suggest that in different countries the accounting reporting rules vary to a large extent making it difficult to compare non-performing loans (NPL) in cross-country study. In addition, this indicator is mainly associated with bank credit risk and does not take into account other important factors such as market risk, operational risk, and the level of a bank's capital. For example, NPL is not an

appropriate indicator of BHC riskiness whose strategies are oriented more towards other businesses than traditional lending.

Measures based on capital market valuations such as stock return volatility are also commonly used to reflect bank riskiness (Anderson & Fraser, 2000; Demsetz et al., 1997; Ellul et al., 2010). Nevertheless, from a risk point of view, these measures tend to reflect too much the financial market conditions and not the specific risk associated to a bank.

Finally, the measures used by regulatory bodies to assess capital adequacy like Tier 1, Tier 2, Tier 3, and Overall Capital ratios are the third type of proxies to reflect bank riskiness (Rime, 2001; Shehzad et al., 2010; Stolz & Wedow, 2011). These proxies proposed by the Bank for International Settlement (BIS) and common to the associated countries combine BHC risk taking with the safeguard measures, i.e. a level of capital to absorb potential losses.

Based on these arguments, we decided to use *Tier 1* ratio as a measure of bank solvency. To control that our results are not influenced by the proxy selection, we selected also *Z-score* as an alternative measure (Demirgüç-Kunt et al., 2010; Iannotta et al., 2007; Laeven et al., 2009). *Z-score* is often called as "a distance to insolvency" (Boyd et al., 1998; Roy, 1952). It is defined as the average return on assets plus equity/assets divided by the standard deviation of the return on assets over the period [t-7 to t]. To overcome the problem of a high skewness of *Z-score*, we use its natural logarithm as applied by Laeven and Levine (2009).

3.3. Measuring the intensity of internal risk control use

Bank board of directors takes an ultimate responsibility for the whole process of risk management (Dickinson, 2001). The Chief Risk Officer (CRO), as the head of this function, must report directly to the board of directors, even though in most BHC, he is formally accountable to the CEO. Liebenberg and Hoyt (2003) studying a sample of industrial firms

found that it is rather the intention of firm debt holders to appoint CRO with the purpose to reduce the information asymmetry about firm risks. In banks, where the equity part seldom accounts for 5% of total assets this argument might present a greater interest.

According to Basel Committee on Banking Supervision (2010a), banks should have a) a risk management function including a chief risk officer, a compliance function and an internal audit function, each with sufficient authority, stature, independence, resources and access to the board; b) risks should be identified, assessed and monitored on an ongoing firm-wide and individual entity basis; c) an effective internal controls system which should be in place; d) the sophistication of a bank's risk management, compliance and internal control infrastructures should keep pace with any changes to its risk profile (including its growth) and to the external risk landscape; and e) effective risk management requires frank and timely internal communication within the bank about risk, both across the organization and through reporting to the board and senior management.

Two fundamental elements of the bank corporate governance play a special role in the risk management process. First, the board of directors, often represented by a risk committee, should set the overall bank risk strategy and policies. Second, to implement risk management principles set by the board, bank directors should delegate these responsibilities to a particular executive. This executive is commonly referred to as the Chief Risk Officer (CRO).

To estimate the intensity of internal risk controls use, we first explored a short sample of bank risk management and corporate governance reports. This preliminary research revealed that the risk management function is typically exercised at the following levels of BHC: 1) shareholders level, represented by the board of directors, 2) senior management level, and 3) operational level, represented by risk management day-to-day functions exercised within different departments of a bank. If the first two mainly relate to risk

management governance, the third one reflects the importance of the risk management activities in the bank daily business.

The example of Credit Suisse Group 2010 Risk Management Report presented in Table 1 illustrates these different levels.

“”…Our risk management organization reflects the specific nature of the various risks in order to ensure that risks are managed within limits set in a transparent and timely manner. At the level of the Board, this includes the following responsibilities:

- *Group/Bank Board: responsible to shareholders for the strategic direction, supervision and control of the Group and for defining our overall tolerance for risk;*
- *Risk Committee: responsible for assisting the Board in fulfilling their oversight responsibilities by providing guidance regarding risk governance and the development of the risk profile and capital adequacy, including the regular review of major risk exposures and the approval of overall risk limits;*

Risk management function reports to the CRO, who is independent of the business and is a member of the Executive Board.

We use an economic capital limit structure to manage overall risk taking. The overall risk limits for the Group are set by the Board and its Risk Committee and are binding. Any excess of these limits will result in immediate notification to the Chairman of the Board’s Risk Committee and the CEO of the Group, and written notification to the full Board at its next meeting. Following notification, the CRO can approve positions that exceed the Board limits by no more than an approved

percentage with any such approval being reported to the full Board…" (Credit Suisse Group 2010 Annual report, p. 120).

Table 1

Credit Suisse Group key risk management bodies and committees

Group level		
Board of Directors / Risk Committee		
Executive Committee / Chief Risk Officer		
Capital Allocation & Risk Management Committee (CARMC)		
ALM / Capital / Funding / Liquidity	Position Risks	OpRisk / LCD / BCM
Risk Processes & Standards Committee	Credit Portfolio & Provisions Review Committee	Reputational Risk & Sustainability Committee
Division level		
Private Banking	Investment Banking	Asset Management
Risk Management Committee	Risk Management Committee	Risk Management Committee

Source: Credit Suisse Annual Report 2010, Risk management section, p. 120.

The main problem we faced in the data collection on the use of internal risk controls is the multiplicity of definitions that BHCs use in their reports. On that matter, there is no common standard for risk management reporting. Nevertheless, we identified three internal risk controls that prevail within banks. Based on them, we constructed our internal risk control index (IRCI) reflecting the sum of three dummy variables – risk committee, chief risk officer and economic capital VaR model. Risk Committee variable takes the value of 1 if the BHC board of directors has appointed an independent risk management committee meeting at least once a year. BHCs use different names for such board committee, but prevailing names are: a) risk committee, b) risk and capital committee and c) credit and market risks committee. The Chief Risk Officer variable takes the value 1 if the BHC reports that the risk management function is headed by a Chief Risk Officer member of the executive board. The Economic Capital VaR Model variable takes the value of 1 if BHC reports the use of internal risk-sensitive measurement models to calibrate its potential loss exposures. The output of such models is often called – economic capital. Elizalde and Repullo (2007) define economic

capital as follow: "*the capital level that bank shareholders would choose in absence of capital regulation*" (p.1). Some BHCs disclose in their reports the use of internal risk-sensitive models, but do not clearly disclose techniques they apply. In this case, we check if the BHC had adopted advanced risk-measurement approaches under Basel II New Capital Accord in 2008 (or other year of a first reporting).

3.4. Ownership concentration, business strategy, and national bank regulations

A large variety of measures has been used for bank ownership structure. For example, Barth et al. (2001) classify banks as widely held if they do not have shareholders with 10% and more voting rights while Laeven and Levine (2009) use a cutoff of 20% of direct and indirect shareholdings to define a large shareholder. Following Shehzad et al. (2010) and Caprio et al. (2007), we measure ownership concentration with a dummy variable (*Largeshd*) that equals 1 if the BHC has at least one owner with direct shareholdings higher than 10% and 0 otherwise.

To estimate if the BHC pursues an aggressive business strategy, we use two variables expressing the growth in total assets and securities investments. *Strart_1* is defined as the growth of BHC assets compared to previous year while *Strat_2* is the growth of BHC securities investments including items such as: treasury securities, federal agency securities, state and municipal securities, trading account securities, securities purchased under resale agreements, mortgage backed securities, federal funds, other securities, and other investments.

To test our hypothesis that bank regulations moderate the relationship between internal risk controls and bank solvency we use two measures proposed by Barth et al. (2001). The variable *Cstring* is an index of regulatory oversight of BHC capital. This index is based on following questions: 1) Is the minimum capital asset ratio requirement risk weighted in line

with Basel guidelines? 2) Does the minimum ratio vary as a function of market risk? 3) Are market values of loan losses not realized in accounting books deducted from capital? 4) Are unrealized losses in securities portfolios deducted? 5) Are unrealized foreign exchange losses deducted? 6) What fraction of revaluation gains is allowed as part of capital? 7) Are the sources of funds to be used as capital verified by the regulatory or supervisory authorities? 8) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? 9) Can the initial disbursement of capital be done with borrowed funds? The variable *Restrict* is an index of regulatory restrictions on BHC activities. It concerns regulatory impediment to banks engaged in: 1) securities market activities, 2) insurance activities, 3) real estate activities, and 4) ownership of nonfinancial firms.

3.5. Control variables

In our study we use two sets of control variables. The first set includes variables controlling for different factors specific to the BHC characteristics and is made of Tobin's Q (*Tobin*), equity to assets (*Equity*), revenue to assets (*Revenue*), loan to assets (*Loan*), deposits to assets (*Deposit*), the natural logarithm of assets (*Size*), and one dummy variable indicating if prudential ratios are reported under Basel II New Capital Accord (*Basel*).

The second set of variables controls for country characteristics and consists of a variable for the corporate governance development (*Corgov*) and a variable for the national banking system stability (*Bsstab*) (The Financial Development Report, 2010). *Corgov* is an index measuring the efficiency of country corporate governance standards. It is based on the following items: 1) extent of incentive-based compensation, 2) efficacy of corporate boards, 3) reliance on professional management, 4) willingness to delegate, 5) strength of auditing and reporting standards, 6) ethical behaviour of firms, and 7) protection of minority shareholders' interests. *Bsstab* is an index measuring the national banking system stability. It

is based on the following items: 1) frequency of banking crises, 2) financial strength indicator, 3) measures of real estate bubbles, 4) financial stress measures, 5) Tier 1 capital ratio, and 6) output loss during banking crisis. All variables are described in Table 2.

3.6. Empirical models

To test our hypotheses we built the following base model:

$$\textbf{\textit{Solvency}} = \beta_0 + \beta_1 * IRCI_{it} + \beta_2 * Largeshd_{it} + \beta_3 * Strat\_1_{it} + \beta_4 * Strat\_2_{it} + \beta_5 * Cstring_{it} + \beta_6 * Restrict_{it} + \sum \beta_x * X_{it} + \sum \beta_y * Y_{it} + e_{it}$$

where subscripts i denotes individual BHC (i = 1,2…, 334), t time period (t = 2004,…, 2010) while X is a set of BHC-level control variables and Y is a set of variables controlling for country characteristics. To control for potential self-selection bias we apply Heckman two-step correction models. The first stage of these models is used to predict the likelihood that a BHC will disclose characteristics of its internal risk controls. We attributed 0 to BHC-Year observations for which we were not able to collect information on IRCI and 1 for those for which the information was available. Independent variables for this first-stage estimation were chosen by applying stepwise procedure of selection only for variables that significantly impact this choice at usual levels: market-to-book value, equity to assets ratio (*Equity*), loans to assets ratio (*Loan*), deposit to assets ratio (*Deposit*), the natural logarithm of total assets (Size), the index of corporate governance (*Corgov*), and the index of banking system stability (*Bsstab*).

4. Descriptive statistics

Table 3 provides descriptive statistics for the whole sample. On average *Tier 1* ratio amounts to 10.3%, and 3.002 for the *Z-score*. Regarding this latter variable it means that profits would have to fall by 20 times their standard deviation to outstand BHC equity. The index of internal risk controls (*IRCI*) amounts on average to 1.6. In terms of ownership concentration, 58% of our BHC have a large shareholder with shareholdings greater than 10%. Table 4 provides descriptive statistics on banks classified by countries. Banks from Switzerland also exhibit an outstanding average of *Tier 1* ratio (14.4%). It is important to note that for the whole sample and in each country the average *Tier 1* ratio is higher than the level required by regulatory bodies. Banks from Germany, France, and Belgium have the lowest ratios of common equity to assets (*Equity*) with 2.7%, 3.1% and 3.5% respectively, but the level of *IRCI* is above the average of the sample. *Z-score* does not vary much across countries. Asian countries show the highest values with Singapore (3.698), Hong Kong (3.600), and Japan (3.360). The internal risk controls index (*IRCI*) of Saudi Arabia is one of the weakest (*IRCI* = 0.324) despite the highest average ratio *Tier 1* (15.6%). However, it is worth noting the amount of equity buffer that Arabian banks hold (*Equity* = 12.3%).

Table 2

Definitions of variables

Tier 1 Ratio	Tier 1 ratio as reported at the end of a reporting year
Z-Score	Natural logarithm of Z-score computed according to the formula (ROA+CAR)/ STDV (ROA) using data over 1998-2010. 7 years historical data used to compute Z-score for each BHC-Year observations. For example, to compute Z-score for one BHC observation in 2007 we use data on ROA over 2001-2007.
Largeshd	Dummy variable that takes 1 if there is at least one owner with shareholdings greater than 10% and 0 otherwise.
Strat_1	BHC total assets growth comparing to previous year $((Assets_t / Assets_{t-1}) - 1)$.
Strat_2	BHC investments growth comparing to previous year $((Investments_t / Investments_{t-1}) - 1)$. Investment includes: treasury securities, federal agency securities, state and municipal securities, trading account securities, securities purchased under resale agreements, mortgage backed securities, federal funds, other securities, and other investments.
Tobin	Tobin's Q that equals to Market value of equity plus the Book value of liabilities divided by the Book value of assets.
Equity	BHC total common equity.
Revenue	BHC revenue (interest income plus non-interest income) divided by total assets.
Loan	Total loans divided by total assets.
Deposit	Total deposits divided by total assets.
Size	Natural logarithm of BHC total assets.
Basel	Dummy variable that takes 1 if Tier 1 Ratio is reported under Basel II New Capital Accord.
Cstring	Index of regulatory oversight of BHC capital. This index is based on following questions: 1) Is the minimum capital asset ratio requirement risk weighted in line with Basel guidelines? 2) Does the minimum ratio vary as a function of market risk? 3) Are market values of loan losses not realized in accounting books deducted from capital? 4) Are unrealized losses in securities portfolios deducted? 5) Are unrealized foreign exchange losses deducted? 6) What fraction of revaluation gains is allowed as part of capital? 7) Are the sources of funds to be used as capital verified by the regulatory or supervisory authorities? 8) Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? 9) Can the initial disbursement of capital be done with borrowed funds?
Restrict	Index of regulatory restrictions on the activities. It concerns regulatory impediment to banks engaging in: 1) securities market activities, 2) insurance activities, 3) real estate activities, and 4) ownership of nonfinancial firms.
Corgov	Index measuring the efficiency of country corporate governance standards. It is formed from following measures: 1) extent of incentive-based compensation, 2) efficacy of corporate boards, 3) reliance on professional management, 4) willingness to delegate, 5) strength of auditing and reporting standards, 6) ethical behaviour of firms, and 7) protection of minority shareholders' interests.
Bsstab	Index measuring the national banking system stability. It is formed from the following measures: 1) frequency of banking crises, 2) financial strength indicator, 3) measures of real estate bubbles, 4) financial stress measures, 5) Tier 1 capital ratio, and 6) output loss during banking crisis.

Table 3

Variables definitions

	Nb of obs.	Mean	S. D.	Minimum	Maximum	Median
Tier 1 ratio	465	0.103	0.038	0.039	0.340	0.094
Z-score	299	3.002	0.711	-0.631	4.730	3.045
IRCI	465	1.589	1.128	0.000	3.000	2.000
Largeshd	465	0.583	0.494	0.000	1.000	1.000
Strat_1	465	0.119	0.208	-0.336	1.954	0.083
Strat_2	465	0.220	0.583	-0.994	9.003	0.145
Cstring	446	4.265	1.379	1.000	6.000	4.000
Restrict	446	2.058	0.619	1.250	3.250	2.000
Tobin	465	1.292	0.205	0.926	2.685	1.274
Equity	465	0.062	0.040	-0.043	0.411	0.055
Revenue	465	0.060	0.039	0.020	0.420	0.050
Loan	465	0.622	0.167	0.024	1.086	0.643
Deposit	465	0.523	0.200	0.011	0.904	0.508
Size	465	18.925	1.597	14.345	22.052	18.942
Basel	465	0.344	0.476	0.000	1.000	0.000
Corgov	465	5.084	0.654	3.600	6.100	5.300
Bsstab	465	4.853	0.901	3.300	6.400	5.100

From the internal risk controls point of view, BHCs from South Africa, Australia, and Canada are the most advanced with an index reaching a level of 2.714, 2.622 and 2.936 respectively. The *IRCI* for European countries amounts to 1.713 and varies within a range of 0.882 for Italy and 2.524 for France. The proportion of traditional lending activities (*Loan*) is more or less identical across countries. Only BHCs from France demonstrate relatively low proportion of loans to total assets (36.6%). Deposit financing is more popular in Hong Kong (*Deposit* = 80.7%) and Japan (*Deposit* = 75.5%) in contrast to European countries which mainly rely on long term borrowings to finance their business activities (average *Deposit* in European countries ≈ 38 % and average *Equity* ≈ 4.65 %).

Table 4

Average figures grouped per country

	Tier 1 Ratio	Z-score	IRCI	Strat_1	Strat_2	Tobin	Equity	Revenue	Loan	Deposit	Size
Australia	0.082	3.018	2.622	0.189	0.366	1.230	0.062	0.080	0.719	0.565	18.688
Belgium	0.104	2.279	2.071	0.056	0.091	1.393	0.035	0.092	0.562	0.385	20.150
Canada	0.107	2.936	2.265	0.102	0.177	1.146	0.045	0.055	0.561	0.693	18.956
France	0.090	2.894	2.524	0.106	0.167	1.195	0.031	0.052	0.366	0.321	21.243
Germany	0.096	1.472	1.962	0.065	0.168	1.492	0.027	0.049	0.526	0.278	19.275
Hong Kong	0.099	3.600	0.263	0.116	0.156	1.079	0.082	0.043	0.680	0.807	17.151
India	0.091	2.114	1.250	0.250	0.277	1.280	0.077	0.108	0.568	0.575	18.044
Italy	0.074	3.351	0.882	0.120	0.199	1.379	0.073	0.062	0.690	0.407	18.686
Japan	0.092	3.360	1.156	0.340	0.102	1.085	0.039	0.026	0.616	0.755	19.488
Saudi Arabia	0.156	2.846	0.324	0.147	0.462	1.469	0.123	0.064	0.657	0.733	17.014
Singapore	0.124	3.698	1.810	0.114	0.186	1.129	0.090	0.040	0.568	0.592	18.639
South Africa	0.135	2.550	2.714	0.210	0.148	1.310	0.108	0.155	0.691	0.469	17.725
Spain	0.081	2.935	1.903	0.108	0.283	1.460	0.054	0.060	0.730	0.416	19.222
Sweden	0.084	2.690	1.880	0.088	0.135	1.455	0.042	0.043	0.699	0.321	19.557
Switzerland	0.144	2.707	1.000	0.026	0.093	1.318	0.060	0.043	0.604	0.498	18.372
United Kingdom	0.105	3.277	1.486	0.250	0.356	1.264	0.050	0.055	0.525	0.413	20.434
Nb of Obs.	465	299	465	465	465	465	465	465	465	465	465

Table 5 presents the pair-wise correlation matrix. Variables *IRCI, Strat_1, Strat_2, Tobin, Equity, Revenue, Loan, Deposit,* and *Size* are mean-centered. Correlation coefficients between our variables of interest (*IRCI, Largeshd, Strat_1, Strat_2, Cstring, Restrict*) do not present special risk of multicollinearity.

5. Regression results

The first set of empirical analyses investigates the impact of internal risk controls on bank solvency and risk of default. We report the results of our regressions in Table 6. To ensure a rigorous evaluation, we conduct various tests. First, we test Hypothesis 1 with two dependent variables, our base variable *Tier 1* ratio and *Z-score* as an alternative variable. We apply Heckman two-step model to adjust for potential problems of sample self-selection bias. We control for BHC and year fixed effects. All models are well-fitted with R-squared values ranging from 0.845 to 0.918.

In model 6-1 and 6-2 we regress *Tier1* ratio against our company-level and country-level independent variables. The coefficients of *IRCI* are significant at 1% level (β=0.00533, $p<0.01$). A one standard deviation change of *IRCI* is associated with a change in *Tier 1* ratio of 0.7%. These results are consistent with Hypothesis 1 and in line with findings of Ellul and Yerramilli (2010). Strong internal risk controls are effective in lowering risk in banking institutions. As reported in models 6-3 and 6-4, our results are similar when *Z-score* is used as the dependent variable for bank solvency and risk of default. The coefficients of *IRCI* are positive and significant (β=0.13311, $p<0.05$).

Regarding the coefficients of our control variables, it is worth to note some interesting elements. Coefficients of *Tobin* are positive and significant in all models suggesting that high BHC franchise value has a positive impact of bank solvency and risk of default. This result is consistent with previous findings that bank franchise value is a significant force in mitigating risk taking (Keeley, 1990). The coefficients of *Equity* are positive and significant as expected since common equity is a large part of Tier 1 capital and is used directly in Z-score formula. The deposit financing of BHC (*Deposit*) has also the predicted sign and impacts positively on BHC solvency and risk of default. Higher percentage of deposit financing induces banks to practice low-risk activities and consequently the overall bank solvency is higher.

Our second set of empirical analyses investigates the moderating effects of ownership concentration, growth strategies, and banking regulations on the relation between internal risk controls and BHC solvency and risk of default (Hypotheses 2a, 2b and 2c). We report our results in Table 7. We enter each interaction term separately to reduce multicollinearity. Like before, we include variables controlling for BHC and country characteristics and adjust for BHC and Year fixed effects. In models 7-6 to 7-10 we apply Heckman two-step sample selection bias correction. Our findings are in line with our hypotheses. In Model 7-1, the relation between *IRCI* and *Tier 1* ratio is positively moderated by the ownership concentration

(β =0.00517, p<0.05). It confirms that the presence of a large shareholder strengthens the impact of internal risk controls on bank solvency and risk of default (Hypothesis 2a). The coefficients of the two interaction terms *IRCI*Strat_1* and *IRCI*Strat_2* in models 7-2 and 7-3 are negative and statistically significant at 5% (β = -0.00007, p<0.05; β = -0.00253, p<0.05) and support the hypothesis that high growth strategies impact negatively the effectiveness of BHC internal risk controls (Hypothesis 2b). It reflects that changes in bank size and structure of assets bring new challenges to risk management systems. With Model 7-4, we examine the impact of supervisory oversight on the relation between internal risk controls and bank solvency. As predicted, the coefficient of *Cstring* has a positive and significant effect at 1% level (β =0.00315, p<0.01) suggesting that high levels of regulatory requirements for bank capital (in size and quality) strengthen the effectiveness of BHC internal risk controls (Hypothesis 2c).

However, our second measure of regulatory requirements, *Restrict*, enters negatively in the relation between *IRCI* and BHC solvency (β =-0.00639, p<0.01), meaning that in highly restricted regulatory environments, the impact of internal risk controls on bank solvency and risk of default is lower. These results are unexpected and might reflect that in environments where banking activities are restricted and separated, the impact of voluntary internal risk controls is reduced to a large extent. In models 7-6 to 7-10, the results of our two-step Heckman regressions are consistent with results of OLS regressions.

Table 6

BHC solvency and internal risk controls

This table reports results of the multivariate analysis where the dependent variables measure bank solvency (*Tier 1 Ratio* and *Z-score*). In OLS models, 6-1 and 6-3, we regress our dependent variables on the index measuring the strength of bank internal risk controls (*IRCI*). Models 6-2 and 6-4 report results of the two-step Heckman analysis.

	OLS	Heckman two-step	OLS	Heckman two-step
	(6-1)	(6-2)	(6-3)	(6-4)
	Tier 1 Ratio	Tier 1 Ratio	Z-score	Z-score
IRCI (+)	0.005***	0.005***	0.133**	0.152***
	(0.001)	(0.001)	(0.062)	(0.055)
Largeshd	-0.004	-0.005*	-0.261**	-0.203*
	(0.003)	(0.003)	(0.127)	(0.113)
Strat_1	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Strat_2	-0.003***	-0.003***	0.139*	0.134*
	(0.001)	(0.001)	(0.081)	(0.071)
Cstring	0.004*	-0.004	-0.401**	0.503**
	(0.002)	(0.006)	(0.184)	(0.215)
Restrict	-0.001	0.016	0.213	0.475
	(0.011)	(0.013)	(0.489)	(0.442)
Tobin	0.067***	0.067***	1.904***	1.720***
	(0.008)	(0.008)	(0.583)	(0.517)
Equity	0.552***	0.556***	12.865***	11.576***
	(0.063)	(0.057)	(2.583)	(2.293)
Revenue	-0.048	-0.038	(3.791)*	(4.851)**
	(0.065)	(0.059)	(2.095)	(2.159)
Loan	-0.079***	-0.075***	-1.008	-0.989*
	(0.011)	(0.010)	(0.624)	(0.578)
Deposit	0.053***	0.060***	2.960***	2.928***
	(0.018)	(0.018)	(0.758)	(0.697)
Size	-0.019***	-0.019***	-0.158	-0.149
	(0.004)	(0.004)	(0.152)	(0.136)
Basel	0.004	0.002	-0.173	-0.251**
	(0.003)	(0.003)	(0.133)	(0.123)
Corgov	0.014*	-0.003	-0.671*	0.231
	(0.009)	(0.007)	(0.374)	(0.235)
Bsstab	-0.015*	0.005	-0.533	-0.271
	(0.008)	(0.011)	(0.340)	(0.353)
BHC fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Constant	0.121	0.094	9.472***	1.299
	(0.096)	(0.059)	(3.330)	(2.404)
Mills Lambda		0.002		-0.070
		(0.003)		(0.098)
Wald chi2		4486.961***		1388.960***
		0.000		0.000
Observations	446	459	287	303
R-squared	0.918		0.845	

Standard errors in parenthese; *** p<0.01, ** p<0.05, * p<0.1

6. Robustness tests

Additionally, we performed several robustness tests. To validate, the construction of our Internal Risk Controls Index (*IRCI*) made of three categorical variables - risk committee, chief risk officer (CRO), and use of economic capital VaR model - we split our IRCI into three parts and regressed Tier 1 ratio and Z-score on each of them. Our results remained significant for risk committee and economic capital VaR Model at 1% and 5% levels respectively.

We also used some alternate measures to check the stability of our results. For the measurement of ownership concentration (*Largeshd*), we applied the thresholds of 20% and 50% instead of 10% (Laeven et al., 2009; Shehzad et al., 2010). We also used an alternative measure and regress our dependent variables on the percentage owned by the largest BHC shareholder instead of the presence of a large shareholder. For our growth strategy measures, we replaced growth of assets by growth of revenue. In all these different cases, our results remained similar to our original results.

Concerning our moderator variables we executed the following tests. We included in each corresponding model the quadratic terms of *IRCI*, *Largeshd*, *Strat_1*, *Strat_2*, *Cstring*, and *Restrict* to test for nonlinearity concerns. All these terms entered non-significantly and confirmed the robustness of our moderation effects.

Finally, we replaced our dependent variable Tier 1 ratio by the Tier 1 capital buffer (Stolz et al., 2011) computed as a difference between actual BHC Tier 1 ratio and the minimum level required by national regulators. The significance and signs of our variables of interest in all models did not change.

Table 7

BHC risk, ownership structure, bank strategies, regulation, and internal risk controls

This table reports results of the multivariate analysis where the dependent variable measures bank solvency (Tier 1 Ratio). In OLS models, 7-1to 7-5, we regress our dependent variable on the index measuring the strength of bank internal risk controls (IRCI) intercepted with moderation and complimentary factors (Largeshd, Strat_1, Strat_2, Cstring, and Restrict). Models 7-6 to 7-10 report results of the two-step Heckman analysis.

	OLS	OLS	OLS	OLS	OLS	Heckman two-step	Heckman two-step	Heckman two-step	Heckman two-step	Heckman two-step
	7-1 Tier 1 Ratio	7-2 Tier 1 Ratio	7-3 Tier 1 Ratio	7-4 Tier 1 Ratio	7-5 Tier 1 Ratio	7-6 Tier 1 Ratio	7-7 Tier 1 Ratio	7-8 Tier 1 Ratio	7-9 Tier 1 Ratio	7-10 Tier 1 Ratio
IRCI (+)	0.003	0.005***	0.005***	-0.008*	0.018***	0.003	0.005***	0.005***	-0.009**	0.0184***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
Largeshd	-0.007**	-0.004	-0.004	-0.007**	-0.005	-0.008**	-0.005*	-0.005*	-0.008***	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Strat_1	0.001	0.001*	0.001*	0.001	0.001	0.001	0.001*	0.001*	0.001	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Strat_2	-0.003***	-0.004***	-0.006***	-0.003**	-0.003**	-0.003***	-0.004***	-0.006***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Cstring	0.005**	0.005**	0.005**	0.002	0.003	-0.003	-0.003	-0.003	-0.010	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Restrict	0.006	0.001	0.001	-0.005	-0.009	0.023*	0.016	0.014	0.021	0.008
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Tobin	0.067***	0.065***	0.069***	0.068***	0.068***	0.068***	0.066***	0.069***	0.069***	0.068***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Equity	0.555***	0.553***	0.549***	0.566***	0.574***	0.559***	0.558***	0.555***	0.567***	0.574***
	(0.063)	(0.063)	(0.063)	(0.062)	(0.063)	(0.057)	(0.057)	(0.057)	(0.056)	(0.057)
Revenue	-0.061	-0.032	-0.047	-0.064	-0.028	-0.049	-0.024	-0.036	-0.062	-0.019
	(0.065)	(0.066)	(0.065)	(0.065)	(0.065)	(0.060)	(0.060)	(0.060)	(0.059)	(0.059)
Loan	-0.078***	-0.081***	-0.083***	-0.079***	-0.075***	-0.074***	-0.076***	-0.078***	-0.076***	-0.071***
	(0.011)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Deposit	0.049***	0.054***	0.054***	0.061***	0.052***	0.058***	0.061***	0.061***	0.069***	0.058***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)
Size	-0.018***	-0.019***	-0.018***	-0.019***	-0.018***	-0.019***	-0.020***	-0.019***	-0.019***	-0.019***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Basel	0.004	0.003	0.003	0.004	0.004	0.003	0.002	0.002	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Corgov	0.016*	0.015*	0.015*	0.015*	0.014*	0.000	-0.002	-0.002	-0.005	-0.004
	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Bsstab	-0.016**	-0.014*	-0.014*	-0.016**	-0.013*	0.007	0.004	0.004	0.012	0.001
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
IRCI * Largeshd (+)	0.005**					0.004*				
	(0.003)					(0.002)				
IRCI * Strat_1 (-)		-0.001**					-0.001**			
		(0.000)					(0.000)			
IRCI * Strat_2 (-)			-0.003**					-0.002**		
			(0.001)					(0.001)		
IRCI * Cstring (+)				0.003***					0.003***	
				(0.001)					(0.001)	
IRCI * Restrict (+)					-0.006***					-0.007***
					(0.002)					(0.002)
BHC FE	yes	yes	yes	yes	yes	Yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	Yes	yes	yes	yes	yes
Constant	0.100	0.110	0.100	0.150	0.135	0.053	0.097*	0.098*	0.080	0.132**
	(0.096)	(0.096)	(0.096)	(0.095)	(0.095)	(0.064)	(0.059)	(0.059)	(0.058)	(0.059)
Mills Lambda						0.002	0.002	0.002	0.001	0.002
						-0.003	-0.003	-0.003	-0.003	-0.003
Wald chi2						4521.88***	4522.58***	4526.19***	4622.02***	4633.93***
						0.000	0.000	0.000	0.000	0.000
Observations	446	446	446	446	446	459	459	459	459	459
R-squared	0.919	0.919	0.919	0.921	0.920					

Standard errors in parenthese; *** p<0.01, ** p<0.05, * p<0.1

7. Discussion and conclusion

Previous research and actual problems in the financial sector show a growing importance of risk management systems for enterprise risk taking and profitability. In this paper, we investigate the impact of bank internal risk controls on bank solvency. We find that more formal risk control mechanisms such as a setting of the risk committee within the board of directors, an appointment of the chief risk officer and an use of the sophisticated risk measurement models such as VaR impact positively BHC solvency and reduce the risk of default. This is consistent with theory suggesting that enterprise risk management systems create value for a firm by ensuring that all material risks are assessed and managed. In addition, from a contingency perspective, ownership concentration and strict oversight by regulatory bodies over BHC capital moderates positively the relation between internal risk controls and BHC solvency. In contrast, bank growth strategies and regulatory restrictions on BHC activities influence negatively the importance of internal risk control mechanisms.

These findings are relevant for banking regulators and practitioners. Banking supervisory bodies need to understand how banks manage risks and how much attention is paid to the risk management process by its corporate governance bodies. The monitoring and management of risks occur through a large set of mechanisms whose interdependency and effectiveness are not very well known. It appears that higher involvement and higher expertise of internal (board of directors) and external (bank regulator) supervisory bodies increase the solvency of banks and reduce their risks of default.

The following limitations of our study provide opportunities for future research in this important area. First, our sample includes only publicly-listed banks. Second, BHCs in our sample are from countries – members of Basel Committee on Banking Supervision and are supposed to strictly comply with its guidelines. Thus, banks from other countries might apply different approaches to measure and manage their risks. Third, we use a global measure for

BHC solvency, and additional tests should be conducted with alternative measures like profit and cost efficiency to evaluate the impact of internal risk controls. Finally, additional contingent factors could also moderate the relationship between internal risk controls and bank solvency.

Despite these limitations the paper deserves some merits for having contributed to an enhanced understanding under which circumstances internal risk controls are effective to increase banks' solvency and decrease risk of default.

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Essay 3:

The Impact of the Sophistication of Risk Measurement Approaches under Basel II on Bank Holding Companies Value

1. Introduction

Banking system is a crucial element for the development and stability of the world economy (Caprio et al., 2007; Estrella, Park, & Peristiani, 2002). Kimball (2001) suggests that the quality of bank risk management and measurement systems to determine and to measure risk exposures as well as the level of equity to absorb potential losses due to risk-taking activities are fundamental factors to avoid financial crises. A number of academic studies investigate the behavior of financial institutions under different external regulations and constraints (Barth et al., 2004; Pasiouras et al., 2009; Shehzad et al., 2010). Some, in particular, examine the efficiency of capital standards to increase banks' solvency and to prevent a systemic crisis (Demirgüç-Kunt et al., 2010; Podpiera, 2004). In addition, several researches are dedicated to the question of how well prudential ratios predict bank riskiness and overall stability of national financial sectors (Beltratti & Stulz, 2009; Cihák et al., 2010). Our paper contributes to the literature on the efficiency of banking regulation by providing empirical evidence on the predictive power of bank prudential indicators. With a sample of 192 Bank Holding Companies-Year observations collected over the period from 2008 to 2010, we analyze under which circumstances the risk-weighted capital ratios predict the value of Bank-Holding Companies (BHC). We find a negative moderating effect of the sophistication of bank risk measurement techniques on the relation between bank solvency indicators and market valuation.

The remaining of this paper is organized as follows. Section 2 presents the capital regulation policies development. In section 3 we discuss previous literature on the various aspects of bank capital regulation and develop our working hypotheses. Section 4 introduces our data, variables and methodology. In section 5, we provide descriptive statistics about sample. Sections 6 and 7 present our results and discuss their robustness. Section 8 concludes.

2. Capital regulation review

By 1985, almost all developed countries had adopted Basel Committee regulation guidelines that place a higher emphasis on specific capital ratio calculations (Tarullo, 2008). In 1988, the Basel Committee on Banking Supervision (BCBS) decided to introduce a capital measurement system relying on risk-weighting of assets commonly referred to as Basel Capital Accord (Basel I). The baseline of this approach was to weight each bank asset with one of five risk categories, calculate the risk-adjusted value of each asset, and then add all these amounts to produce a total amount of credit risk-weighted assets. This number is used as a denominator to compute the risk-weighted capital ratios (Tier 1 and Tier 2) which should be at least 4% and 8% respectively. The numerator for Tier 1 ratio is composed from paid-up share capital/common stock and disclosed reserves. For Tier 2 ratio banks add the undisclosed reserves, revaluation reserves, general loan-losses reserves, hybrid capital instruments, and subordinated debts.

Following some amendments of Basel I, including the capital requirements for market risk, BCBS released in 2004 the Basel II New Capital Accord, formally called "International Convergence of Capital Measurement and Capital Standards: A Revised Framework" (BCBS, 2004a). Basel II proposed several approaches to compute the value of their risk-weighted assets for credit, market, and operational risks. According to the most sophisticated methods, Internal Rating Based approach for credit risk (IRB), and Advanced Measurement Approach for operational risk (AMA), banks should determine themselves the risk ratings to apply to different classes of assets based on their own estimates of the loss occurrence probability and its potential amounts. The benefits of the most sophisticated approaches under Basel II (IRB and AMA) are: 1) greater risk sensitivity of bank assets, 2) reliability of risk models, 3) more formalized and efficient risk management, and 4) potential decrease of required capital. Despite of these advantages, risk sensitive approaches of Basel II were criticized mainly for

two reasons: 1) the procyclical effects of capital regulation (Estrella, 2004; Pennacchi, 2005) and 2) the competitive inequality between adopters and non-adopters of most sophisticated approaches (Berger & Bonaccorsi di Patti, 2006; Flannery, 2006; Hakenes et al., 2011; Repullo & Suarez, 2007). These critics became more pronounced with the 2008 financial crisis. As a response, BCBS proposed a number of significant changes of all three pillars of Basel II (BCBS, 2010a, 2010b). Paragraph 6 of the Basel III a global regulatory framework for more resilient banks and banking systems illustrates the general lines of proposed changes:

> *"To address the market failures revealed by the crisis, the Committee is introducing a number of fundamental reforms to the international regulatory framework. The reforms strengthen bank-level, or microprudential, regulation, which will help raise the resilience of individual banking institutions to periods of stress. The reforms also have a macroprudential focus, addressing system-wide risks that can build up across the banking sector as well as the procyclical amplification of these risks over time. Clearly these micro and macroprudential approaches to supervision are interrelated, as greater resilience at the individual bank level reduces the risk of system-wide shocks."(p. 2)*

Concerning Pillar 1 of Basel II, new standards proposed the following amendments: a) greater capital requirements for certain products, b) more strengthened capital requirements for assets held in trading book, c) more strengthened capital treatment of liquidity, and d) supervision of capital requirements over the credit cycle (Tarullo, 2008). Capital ratios in their quantitative aspects were also a subject of significant changes under Basel III. Particularly, Tier 1 ratio is required to be at least 6% of risk-weighted assets from which at least 4.5% should be made of common equity. Moreover, new rules introduced two absolutely new concepts: the capital conservation buffer and the countercyclical buffer. The first one has a general purpose to ensure that banks build up additional capital outside periods of stress

which can be drawn as losses incur, while the former should be designed to ensure that banking sector capital requirements take into account the macro-financial environment in which banks operate. The capital conservation buffer should be 2.5% of risk-weighted assets and comprised of common equity Tier 1. The countercyclical buffer ranges between 0 and 2.5% of risk-weighted assets and depends on the macroeconomic situation of geographic regions in which a bank operates. Additionally, the Basel III regulation requires banks to present a simple non-risk based leverage ratio. Figure 1 illustrates these requirements.

Figure 1

Basel III capital framework

Calibration of the capital framework

Calibration of the Capital Framework

Capital requirements and buffers (all numbers in percent)

	Common Equity Tier 1	Tier 1 Capital	Total Capital
Minimum	4.5	6.0	8.0
Conservation buffer	2.5		
Minimum plus conservation buffer	7.0	8.5	10.5
Countercyclical buffer range*	0 – 2.5		

Source: Basel III: A global regulatory framework for more resilient banks and banking systems, BIS, 2010, p. 64.

3. Literature review and hypotheses development

The impact of a capital regulation on bank behavior was a subject of numerous academic studies (Barth et al., 2008; Stolz et al., 2011). The agency cost hypothesis suggests

that a high leverage or eventually a low capital-to-assets ratio reduces the agency costs of shareholders and aligns their interests with those of firm managers (Danielsson et al., 2002; Demsetz, Saidenberg, & Strahan, 1996). Traditional investment theory predicts that bank shareholders have a direct interest to increase bank leverage to maximize the bank value. However, the relationship between the bank leverage and bank value is not monotonic (Shrieves et al., 1992). When the leverage becomes excessively high, its further increases will lower bank value, because of higher expected costs of financial distress or bankruptcy.

Reasons why regulators require banks to hold capital at certain levels converge with those of bank depositors and other debt holders. By setting the minimum capital requirements, regulators intend to: a) protect national economies against the costs of financial distress, b) reduce the information asymmetry between bank shareholders and "uninsured" depositors, and c) preserve a certain market discipline that weakened, because of different safety measures taken by government such as deposit insurance, payment guarantees, and access to the different mark downs (Berger et al., 1995). Although the impact of capital requirements on bank behavior has been extensively studied (Kaplanski & Levy, 2007; Kim & Santomero, 1988; Rime, 2001), results remain controversial. Are these requirements efficient in shaping bank risk-taking and reducing moral hazard problems due to shareholder incentives to choose excessively risky business strategies? While stringent capital requirements are associated with less non-performing loans (Barth et al., 2004) and greater cost efficiency (Pasiouras et al., 2009), several studies suggest that they are not robustly linked with the stability of the banking system (Barth et al., 2008; González, 2005). Jacques et al. (1997) and Shrieves et al. (1992) stress that risk-sensitive capital standards are the efficient tools to increase capital ratios and to reduce an excessive risk-taking in commercial banks. In contrast, Rime (2001) infers that regulatory pressures are positively related with bank level of capital, but have no impact on its risk-taking strategies. Moreover, Acharya et al. (2011) evoke that banks during

the time of 2007-2009 financial crisis increased their prudential capital, but this augmentation was mainly due by the raise of debt-like hybrid capital, while the common equity was decreased by the distribution of dividends.

Several studies suggest that regulators together with setting quantitative standards for capital ratios and other requirements and restrictions on bank activities should also consider banks corporate governance aspects (Laeven et al., 2009; Shehzad et al., 2010). Particularly, banks with concentrated shareholdings might react differently to the existing regulation than widely-held financial institutions. Jeitschko and Jeung (2005) argue, that the relation between bank risk-taking and bank value is influenced by the incentives of three agents – the deposit insurer, the shareholder, and the manager. The degree at which the bank capitalization impacts its risk-taking behavior depends upon which influence prevail in setting bank business strategies. Contrarily to the conventional point of view, a bank in which management interests prevail may practice higher risk strategies as bank capitalization increases.

3.1. Risk-weighted capital ratios under Basel II and BHC market value

According to regulators, risk-weighted capital ratios should reveal a current state of bank solvency. So far, academic research has produced some empirical evidence on a predictive power of bank capital ratios. Kim and Santomero (1988) suggest that risk-related capital regulation standards are an effective tool in predicting bank default risk. Avery and Berger (1991) infer that banks with higher ratios of risk-weighted assets to un-weighted assets (higher risk-taking) have poorer predicted performance. Berger (1995) found that bank capital-asset ratio (CAR) and return on equity (ROE) are positively related, and this relationship is statistically and economically significant. Färe et al. (2004) show, that risk-based capital standards have a significant impact on bank business efficiency by optimizing the mix of outputs and inputs (allocative efficiency). Estrella et al. (2002) and Čihák et al.

(2010) found that capital ratios (Tier 1 ratio, Total Capital ratio, Leverage ratio) can be used as good predictors for banking crisis. Studying the bank performance during recent 2007-2009 financial crisis, Beltratti and Stulz (2009) found that banks with higher Tier 1 ratio exhibited a better performance, while Ellul and Yerramilli (2010) did not find a strong relationship between stock returns and the level of Tier 1 capital.

If the relation between bank performance and capital ratios is not robustly confirmed by existing empirical results, the BHC value – the present value of the potential future profits, might be stronger related to bank solvency. Demsetz et al. (1996) found that banks with higher market value have higher common equity capital and lower asset risk than banks with a lower franchise value. Barrios and Blanco (2003) studying a sample of Spanish banks, infer that there exists an optimal level of bank capital which maximizes the market value of a bank. However, if the optimal capital ratio goes below a legally required level, the bank should hold an excess of equity and operate with an inefficient financial structure.

As pointed out in Section 2, capital ratios under Basel regulation (Tier 1, Tier 2, and Total Capital Ratio) could be determined according to different approaches. Advanced approaches such as IRB for credit risks and AMA for operational risks are based on BHC own estimates of probabilities that losses occur and their potential amounts. Scholars and practitioners agree that the greater risk sensitivity in capital requirements is a major advancement in banking regulation. Advanced approaches allow banks to calibrate better capital requirements to the actual risk of a particular bank. Risk exposures are computed using the financial information specific to particular BHC assets and borrowers quality. Logically, capital ratios determined under the advanced approaches should give more accurate information concerning bank solvency. Nevertheless, there are some critics related to computation methodologies and disclosures that banks provide. Herring (2005), among other critical points of advanced approaches, suggests that the diversity of methods and rules given

to banks under Internal Ratings Based approach (IRB) makes capital ratios incomparable across banks even if they properly disclose underlying data and methods. Moreover, in many countries the supervisors are not ready to effectively monitor the application of advanced approaches. Other problem comes from the internationality of banks. It is still difficult to apply same monitoring rules for bank home and host supervisors, especially if it concerns BHC from emerging economies (Powell, 2004). Another problem is related to the Pillar 3 of Basel II, market disclosures. This pillar is seen by academicians as the weakest and the least developed (Barth et al., 2008; Tarullo, 2008). Today, the risk measurement disclosures are not comparable across banks. Our work on data collection revealed that more advanced approaches banks apply, higher is the divergence in risk measurement disclosures. According to Danielsson et al. (2002), even if BHC have adopted advanced approaches, it does not have any intention to disclose properly risk measurement procedures and critical parameters. To avoid completely the information sharing with regulators and other agents, banks might adopt a dual risk measurement system: standardized approaches for regulatory purposes and risk-sensitive for private ends. In contrast, capital ratios determined under standardized approaches are more comprehensive for investors and depositors. To compute these ratios, banks do not have a choice of tools and apply the relatively unified methodologies (Herring, 2005; Tarullo, 2008).

These arguments lead to the following testable predictions. First, stronger capital ratios should be associated with a higher BHC market value. Second, the sophistication of bank risk measurement approaches under Basel II will moderate negatively the predictive power of capital ratios, because of a high diversity of computation methodologies applied by banks and weak public disclosures.

4. Data, variables and methodology

4.1. Sample and data

To test our hypotheses we use a sample of 183 bank-year observations for 66 Bank Holding Companies including observations for 2008, 2009, and 2010. We built our sample using BHC annual risk and corporate governance reports, as well as The Banker and Worldscope databases. First, we chose BHC from country-members of Basel Committee on Banking Supervision[3]. Then, we excluded countries in which, Basel II New Capital Accord had not been enforced before 2008 to avoid discrepancy in BHC risk measurement approaches. For the remaining countries, we extracted data on BHC from The Banker Database Top 1000 Rankings. To build a balanced sample and exclude an overweighting of BHC from certain countries, we limited our sample to a maximum of 10 publicly listed BHC per country (Caprio et al., 2007; Laeven et al., 2009). When a country had only one BHC, we decided not to include it in the sample. For each bank-year observation we manually collected data on the Basel II risk measurement approaches from the risk management reports, often called Basel II Pillar 3 reports. Information on BHC annual return on assets, risk-weighted capital ratios, and non-performing loans was obtained from the Banker database, while other financial data was collected from the Worldscope database. Data for country-level control variables comes from the Financial Development Report 2010 Executive Opinion Survey.

4.2. BHC franchise value measure

Stock price data from publicly traded BHC is one of few available resilient sources to measure bank's valuation by independent parties. In this study we approximate the bank value

[3] The Committee's members come from Argentina, Australia, Belgium, Brazil, Canada, China, France, Germany, Hong Kong SAR, India, Indonesia, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. Source: http://www.bis.org/bcbs/about.htm

by Tobin's Q that is computed as the sum of bank market value of equity (MVE) and book value of liabilities (BVL) divided by book value of bank assets (BVA) excluding goodwill:

$$\text{Tobin's Q} = \frac{\text{MVE} + \text{BVL}}{\text{BVA} - \text{Goodwill}}$$

Tobin's Q is the most popular proxy of bank market value in academic research (Caprio et al., 2007; Demsetz et al., 1996; González, 2005). Tobin's Q combines the market valuation of the bank and the replacement value of bank's existing assets and is a function of two factors: 1) bank-specific variables which impact the bank future growth opportunities, and 2) country-specific variables which represent the generosity of the governmental safety net, financial market development, banking industry market structure, and others (Allen & Rai, 1996). Jones et al. (2011) infer that banks with higher Tobin's Q before the financial crisis of 2007-2008 experienced lower declines in equity during the time of the financial turbulence. Thus, the informational significance of Tobin's Q appears to persist even in times of economic contractions.

4.3. BHC risk-weighted capital ratios

In this paper we use two risk-weighted capital ratios required by Basel II and reported by BHCs: BIS Tier 1 Ratio and BIS Total Capital Ratio, hereafter Tier 1 and Capital ratios. Except national regulations of Canada, Hong Kong, Singapore, and South Africa, the required minimum levels of these ratios should be respectively 4% and 8% (Table 4). In the academic literature the risk-weighted capital ratios are mainly used to proxy bank soundness (Rime, 2001; Shehzad et al., 2010; Stolz et al., 2011). In our view, the risk-weighted capital ratios have a considerable advantage over other proxies of bank solvency, because they combine

two complementary factors: BHC risk-taking strategy, and the safeguard measures against risk-taking activities, e.g. a level of capital to absorb potential losses.

4.4. Sophistication of risk measurement under Basel II

To proxy the sophistication of BHC risk measurement approaches for its risks we constructed our internal index (*B2_score*) reflecting the magnitude of the adoption of advanced approaches under Basel II. This index is the sum of fractions of risk-weighted assets (RWA) for credit, market, and operational risks computed under the advanced approaches to total reported RWA:

$$B2\_score = \frac{\text{RWA under IRB for Credit Risk}}{\text{Total RWA}} + \frac{\text{RWA under VaR for Market Risk}}{\text{Total RWA}} + \frac{\text{RWA under AMA for Operational Risk}}{\text{Total RWA}}$$

According to Basel II rules, the IRB itself might be of different degrees of sophistication, e.g. Advanced Internal-Ratings Based approach and Foundation Internal-Ratings Based approach depending on the fact whether the bank is able to produce its own estimates of default exposures, loss if default occurred, and maturity of the exposure. Unfortunately, only few BHC report such detailed information, thus, we were not able to collect the information on this level. The majority of BHC in our sample applies different approaches to quantify their risks for different subsidiaries. Moreover, for different categories of assets, banks often apply the mix of allowed approaches. The example of UBS Group illustrates the partial application of different approaches for credit risk exposures:

> *"…The standardized approach is generally applied where it is not possible to use the advanced IRB approach and/or where an exemption from*

the advanced IRB approach has been granted by FINMA[4]. The standardized approach requires banks to use risk assessments prepared by External Credit Assessment Institutions (ECAI) or Export Credit Agencies to determine the risk weightings applied to rated counterparties. We use ECAI risk assessments

to determine the risk weightings for the following classes of exposure:

— central governments and central banks,

— regional governments and local authorities,

— multilateral development banks,

— institutions,

— corporates.

We selected three FINMA-recognized external credit assessment institutions for this purpose: Moody's Investors Service, Standard and Poor's Ratings Group and Fitch Group. The mapping of external ratings to the standardized approach risk weights is determined by FINMA and published on its website…" (UBS Group 2010 Annual Report, p. 121).

According to our sample, credit risk is the biggest risk that BHCs face, and the ratio of credit RWA to total RWA ranges from sixty to ninety percent. Thus, as an alternative measure of risk measurement sophistication, we chose a simple dummy variable indicating if BHC has adopted the internal-ratings based approach at least for a part of its credit RWA (*IRB*).

[4] FINMA is Swiss Finanical Market Supervisory Authority, note from authors

4.5. Control variables

In our study we use two sets of control variables. The first set includes variables controlling for different factors specific to banks and is made of loan to assets ratio (*Loan*) and the natural logarithm of assets (*Size*). The second set of variables controls for country characteristics and consists of a variable for the corporate governance standards development (*Governance*), a variable for the national banking system stability (*Stability*), and a variable for the national banking financial services development (*Sophistic*). All these variables are taken from the Financial Development Report 2010 Executive Opinion Survey (Bilodeau, 2010). *Governance* is an index measuring the efficiency of country corporate governance standards. It is based on the following items: 1) extent of incentive-based compensation, 2) efficacy of corporate boards, 3) reliance on professional management, 4) willingness to delegate, 5) strength of auditing and reporting standards, 6) ethical behaviour of firms, and 7) protection of minority shareholders' interests. *Stability* is an index measuring the national banking system stability. It is based on the following items: 1) frequency of banking crises, 2) financial strength indicator, 3) measures of real estate bubbles, 4) financial stress measures, 5) Tier 1 capital ratio, and 6) output loss during banking crisis. *Sophistic* is an index measuring the national banking financial services development. It is formed from the following components: 1) financial system size, 2) index of the efficiency of national financial system, and 3) quality of financial information disclosures. All variables are described in Table 1.

Table 1

Variables definitions

Tobin's Q	Tobin's Q that equals to Market value of equity plus the Book value of liabilities divided by the Book value of assets.
Tier	Tier 1 ratio as reported at the end of reporting year.
BIS_Ratio	Total capital ratio as reported at the end of reporting year (Tier 3 ratio).
IRB	Dummy variable that takes 1 if BHC adopted the Internal Rating Based (IRB) approach for at least a part of its credit risk-weighted assets.
B2_Score	Index of risk measurement approaches sophistication under Basel II. This index is the sum of fractions of risk-weighted assets (RWA) for credit, market, and operational risks computed under the advanced approaches to total reported RWA.
Loan	Ratio of bank total loans to total assets.
Size	Natural logarithm of BHC total assets.
Governance	Index measuring the efficiency of country corporate governance standards. It is formed from following measures: 1) extent of incentive-based compensation, 2) efficacy of corporate boards, 3) reliance on professional management, 4) willingness to delegate, 5) strength of auditing and reporting standards, 6) ethical behaviour of firms, and 7) protection of minority shareholders' interests. This index is ranged between 1 and 7. Higher values indicate a higher development of corporate governance practices in a country.
Stability	Index measuring the national banking system stability. It is formed from the following components: 1) frequency of banking crises, 2) financial strength indicator, 3) measures of real estate bubbles, 4) financial stress measures, 5) Tier 1 capital ratio, and 6) output loss during banking crisis. This index is ranged between 1 and 7. Higher values indicate a higher stability of a banking system.
Sophistic	Index measuring the national banking financial services development. It is formed from the following components: 1) financial system size measures, 2) efficiency of national financial systems measures, and 3) quality of financial information disclosures. This index is ranged between 1 and 7. Higher values indicate a higher sophistication of financial services in a country.

4.6. Empirical models

To test our hypotheses we built the following base model:

$$Q = \beta_0 + \beta_1 * BIS\_Ratio_{it}\ (Tier_{it}) + \beta_2 * B2\_Score_{it}\ (IRB_{it}) + \sum \beta_x * X_{it} + \sum \beta_y * Y_{it} + e_{it}$$

, where subscripts i denotes individual BHC (i = 1,2…, 66), t time period (t = 2008,…, 2010) while X is a set of bank-level control variables and Y is a set of variables controlling for country characteristics. As we work with longitudinal, cross-country data, we controlled for country and BHC fixed effects.

5. Descriptive statistics

Table 2 provides descriptive statistics for the sample. On average, *Tobin's Q* amounts to 1.242 with a minimum of 0.926 and maximum of 2.022. Tier 1 and Capital ratios, on average, are significantly higher than required minimum levels and equal to 11.1% and 14.1% respectively. No prudential ratio of bank-year observations of our sample is below the required level. The average of *B2_Score* is lower than 0.5 with the highest value of 0.966. It means that no financial institution of our sample fully applied the advanced approaches for its risk exposures. The minimum level of *B2_Score* is 0 meaning that several BHC apply only standard approaches to determine their risk-weighted assets. Particularly, no bank from India and Saudi Arabia adopted advanced approaches.

Table 2

Descriptive statistics and Skewness-Kurtosis test

	Nb of obs.	Mean	S.d.	Min.	Max	Skewness	Kurtosis	Skewness - Kurtosis Test
Tobin's Q	183	1.242	0.167	0.926	2.022	1.054	5.567	0.00***
Tier	183	0.111	0.035	0.051	0.331	2.066	11.727	0.00***
BIS_Ratio	183	0.141	0.037	0.086	0.339	2.211	11.456	0.00***
IRB	183	0.678	0.469	0.000	1.000	-0.760	1.578	n.a.
B2_Score	183	0.454	0.356	0.000	0.966	-0.264	1.429	0.00***
Loan	183	0.623	0.164	0.153	0.916	-0.620	3.095	0.00***
Size	183	19.088	1.651	14.959	21.960	-0.194	2.234	0.00***
Governance	183	4.994	0.721	3.600	6.100	-0.773	2.643	n.a.
Stability	183	4.928	0.910	3.300	6.400	-0.183	1.881	n.a.
Sophistic	183	4.584	0.620	3.100	5.400	-0.535	2.167	n.a.

In Table 3 we present the descriptive statistics by countries. The highest values of *Tobin's Q* is exhibited by banks from South Africa, Sweden, and Spain (1.437, 1.426, and 1.412), while the Tobin's Q of BHCs from Asian countries is close to 1. Nevertheless, Asian banks, except those from Hong Kong, show relatively high risk measurement sophistication. According to our index *B2_Score*, the most sophisticated banks in risk measurement have their headquarters in Germany (0.841), Sweden (0.799), Belgium (0.734), and Australia (0.731). Banking groups from South Africa exhibit the highest values of prudential ratios (*Tier* = 18.3%, *BIS_Ratio* = 22.1%). The lowest levels of capital ratios are reported by BHCs from Italy and Spain, which also exhibit the sophistication of risk measurement below the sample average.

The proportion of traditional lending activities (*Loan*) is more or less identical across countries of our sample. Only BHCs from Germany and France demonstrate relatively low proportion of loans to total assets (20.8% and 36.9%). The biggest BHCs in term of total assets are from Germany and France, while the smallest are from Saudi Arabia and South Africa.

Variable, *Governance*, indicates that the highest corporate governance standards are in Sweden (6.1) and Canada (5.7) while the poorest are in Italy with its outstanding value of 3.6.

The most stable banking systems are in Saudi Arabia (*Stability* = 6.4), Switzerland, Hong Kong, and Canada (*Stability* = 5.6). More risky environment is showed in United Kingdom (3.3), India (3.5), Spain (3.8), and Sweden (3.9). In general, the banking financial services are well developed in countries of our sample. Only India and South Africa have remarkably low values of *Sophistic* index, 3.1 and 3.7 correspondingly.

Table 3

Average figures grouped per country

	Nb. of Obs.	Tobin's Q	Tier	BIS_Ratio	IRB	B2_Score	Loan	Size	Governance	Stability	Sophistic
Australia	10	1.217	0.089	0.120	1.000	0.731	0.703	19.453	5.500	5.500	5.100
Belgium	6	1.362	0.116	0.141	1.000	0.734	0.619	20.238	5.100	4.500	4.900
Italy	3	1.328	0.075	0.099	0.000	0.000	0.649	17.718	3.600	5.100	4.100
Canada	18	1.139	0.117	0.146	0.722	0.601	0.544	19.208	5.700	5.600	4.800
France	7	1.186	0.098	0.123	1.000	0.568	0.369	21.464	4.900	4.600	4.100
Germany	3	1.181	0.117	0.134	1.000	0.841	0.208	21.660	5.400	4.200	4.300
Hong Kong	9	1.024	0.104	0.157	0.333	0.240	0.655	16.945	5.100	5.600	5.300
India	3	1.267	0.113	0.158	0.000	0.000	0.542	18.457	4.400	3.500	3.100
Italy	24	1.345	0.079	0.113	0.500	0.205	0.722	18.991	3.600	5.100	4.100
Japan	17	1.063	0.100	0.129	1.000	0.629	0.599	19.987	5.100	4.000	5.200
Saudi Arabia	18	1.210	0.138	0.160	0.000	0.000	0.715	17.128	5.000	6.400	3.500
Singapore	9	1.074	0.140	0.169	1.000	0.643	0.564	18.881	5.600	5.800	4.600
South Africa	7	1.437	0.183	0.221	0.571	0.418	0.683	17.283	5.300	5.200	3.700
Spain	16	1.412	0.088	0.116	0.750	0.382	0.731	19.215	4.300	3.800	5.200
Sweden	11	1.426	0.098	0.139	1.000	0.799	0.660	19.741	6.100	3.900	4.800
Switzerland	12	1.286	0.142	0.161	0.583	0.482	0.607	18.679	5.400	5.600	4.500
United Kingdom	10	1.196	0.121	0.153	1.000	0.688	0.434	21.159	5.400	3.300	5.400
Total	183	1.242	0.111	0.141	0.678	0.454	0.623	19.088	4.994	4.928	4.584

Table 4 presents the pair-wise correlation matrix. Correlation coefficients between our variables of interest (B2_Score, IRB, BIS_Ratio, and Tier) do not present special risk of multicollinearity.

Table 4

Correlation among variables

	Tobin	Tier	BIS_Ratio	IRB	B2_Score	Loan	Size	Governance	Stability
Tier	0.050								
	0.502								
BIS_Ratio	0.187	0.811							
	0.011	0.000							
IRB	-0.138	-0.168	-0.143						
	0.062	0.023	0.053						
B2_Score	-0.092	-0.087	-0.036	0.834					
	0.218	0.239	0.627	0.000					
Loan	0.306	-0.035	-0.050	-0.445	-0.543				
	0.000	0.636	0.499	0.000	0.000				
Size	-0.045	-0.316	-0.257	0.724	0.703	-0.672			
	0.545	0.000	0.000	0.000	0.000	0.000			
Governance	-0.270	0.389	0.369	0.297	0.470	-0.278	0.107		
	0.000	0.000	0.000	0.000	0.000	0.000	0.151		
Stability	-0.195	0.290	0.227	-0.410	-0.316	0.184	-0.511	0.065	
	0.008	0.000	0.002	0.000	0.000	0.013	0.000	0.385	
Sophistic	-0.196	-0.248	-0.185	0.500	0.472	-0.113	0.351	0.307	-0.512
	0.008	0.001	0.012	0.000	0.000	0.127	0.000	0.000	0.000

6. Regression results

The first part of our empirical analysis investigates the impact of risk-weighted capital ratios on BHC value measured by Tobin's Q. We report these results in models 5-1 and 5-2 of Table 5. To ensure a rigorous evaluation, we conduct several tests with alternative measures of the bank solvency: Tier 1 Ratio (*Tier*) and Total Capital ratio (*BIS_Ratio*). Moreover, we included in all these models the variables quantifying the sophistication of BHC risk measurement approaches under Basel II (*B2_Score* and *IRB*). Both models are well-fitted with a high R-squared values (0.672, 0.761). These high values of R-squared are partially explained by the fact that we control for country and year fixed effects.

The results confirm our prediction that higher capital ratios are associated with higher BHC market valuation. The coefficients of variables *Tier* and *BIS_Ratio* are empirically

significant at 1% level and positive. These findings are consistent with the evidence showed by Estrella et al. (2002), Čihák et al. (2010), and Beltratti and Stulz (2009). Despite of arguments that capital levels required by Basel II are not efficient from pure economic point of view (Barrios et al., 2003), our empirical analysis showed that BHC market capitalization is a direct function of bank equity level and hybrid instruments.

The interesting results were found for our variables measuring BHC risk measurement sophistication (*B2_Score* and *IRB*). While the sophistication in credit risk measurement (*IRB*) is negatively related to bank charter value, the overall sophistication in measurement (*B2_Score*) is positive and significant at usual levels. This could mean that the advanced approaches for market and operational risks are not well valuated by capital markets.

Regarding the coefficients of the unit-level control variables, it is worth to note some interesting findings. All coefficients of *Loan* are significant at 1% level implying that banks focusing on traditional banking lending business are better valued by markets. Size seems to be also positively and significantly related to bank market valuation.

On the side of country-level, it is worth to note that coefficients for our measure of the strength of corporate governance standards, *Governance*, are negative and significant implying that BHC from countries with more advanced corporate governance practices are poorer valuated by capital markets.

In our second set of models reported in Table 5 (from 5-3 to 5-6), we test whether the sophistication of risk measurement approaches proposed by Basel II has moderating effects on the relation between risk-weighted capital ratios and BHC value. To reduce the multicollinearity problem, we enter each interaction term separately. The main finding of this analysis is that our second proposition is empirically confirmed. The coefficients of all four interaction terms are significant at 1% level and have predicted (negative) signs. Despite the fact that coefficients of moderating variables (*IRB* and *B2_Score*) alone exhibit different and

significant signs, the negative moderation effects are observed for both our variables of interest. The adoption of sophisticated, risk-sensitive measurement approaches decreases significantly the predictive power of bank risk-weighted capital ratios for bank market value.

7. Robustness tests

Additionally, we performed several robustness tests. First, we replaced Tobin's Q by the accounting measure of BHC profitability, the return on assets (ROA). The coefficients of our variable of interest (Tier and BIS_Ratio) remain positive and significant at 1% level. Moreover, when we control for BHC risks measured by non-performing loans (*NPL*) the results do not change.

Second, following Stolz and Wedow (2011), instead of regressing BHC value on risk-weighted capital ratios, we used the capital buffers, i.e. excesses of Capital and Tier 1 ratios over the minimum required levels:

$$BUF_{CR} = \textit{Actual Capital Ratio Reported} - \textit{Minimum required level}$$

$$BUF_{Tier1} = \textit{Actual Tier 1 Ratio Reported} - \textit{Minimum required level}$$

Our results remain absolutely similar to those reported in Table 5.

Third, considering a potential undermining of our analysis by recent financial crisis, we performed distinct analysis for observations corresponding to each year, i.e. 2008, 2009, and 2010. Results are reported in Table 6. With a few exceptions, the coefficients of our variables of interest remain significant and have predicted signs. This time-comparison allows us to generalize our findings across different stages of a business cycle.

Table 5

Capital ratios, sophistication of risk measurement approaches and BHC market valuation

This table reports the results of OLS regressions. Sample consists of 183 bank-year observations from 17 countries for the period from 2008 to 2010. The dependent variable is Tobin's Q adopted to financial institutions. In models 5-1 and 5-2 we regress BHC market valuation on capital ratios (Tier 1 and Total Capital Ratio). Models 5-3, 5-4, 5-5, and 5-6 report the results of the moderation of BHC risk measurement approaches on the relation between bank market valuation and capital ratios.

	Model 5-1	Model 5-2	Model 5-3	Model 5-4	Model 5-5	Model 5-6
Tier	1.563***		2.532***	2.376***		
	(0.356)		(0.378)	(0.385)		
BIS_Ratio		2.356***			3.089***	2.902***
		(0.254)			(0.278)	(0.290)
IRB	-0.133***	-0.108***	0.156**	-0.133***	0.188***	-0.108***
	(0.0351)	(0.0300)	(0.0640)	(0.0332)	(0.0652)	(0.0290)
B2_Score	0.131***	0.116***	0.127***	0.508***	0.129***	0.426***
	(0.0498)	(0.0425)	(0.0461)	(0.0984)	(0.0397)	(0.0972)
Loan	0.281***	0.271***	0.216**	0.194**	0.230***	0.211***
	(0.0905)	(0.0769)	(0.0848)	(0.0881)	(0.0721)	(0.0762)
Size	0.0274**	0.0207**	0.0273**	0.0253**	0.0232**	0.0196**
	(0.0117)	(0.00970)	(0.0108)	(0.0111)	(0.00905)	(0.00938)
Governance	-0.136***	-0.171***	-0.163***	-0.161***	-0.193***	-0.189***
	(0.0447)	(0.0375)	(0.0417)	(0.0427)	(0.0352)	(0.0366)
Stability	-0.0118	0.000807	-0.0146	-0.0122	0.00482	0.00474
	(0.0203)	(0.0174)	(0.0188)	(0.0192)	(0.0162)	(0.0168)
Sophistic	0.0210	0.0481	0.0477	0.0406	0.0735**	0.0653**
	(0.0368)	(0.0316)	(0.0344)	(0.0351)	(0.0298)	(0.0309)
Tier * IRB			-2.756***			
			(0.527)			
Tier * B2_Score				-3.468***		
				(0.794)		
BIS_Ratio * IRB					-2.270***	
					(0.452)	
BIS_Ratio * B2_Score						-2.232***
						(0.635)
Country FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Constant	1.022***	0.990***	0.977***	1.049***	0.843***	0.959***
	(0.332)	(0.282)	(0.307)	(0.314)	(0.264)	(0.273)
Observations	183	183	183	183	183	183
R-squared	0.672	0.761	0.720	0.707	0.794	0.778

Standard errors in parentheses

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

Concerning our moderator variables we executed following tests. We included in each corresponding model the quadratic terms of *Tier*, *BIS_Ratio*, *IRB* and *B2_Score*, to test for nonlinearity concerns. All these terms entered non-significantly and confirmed the robustness of our moderation effects.

8. Discussion and conclusion

Recent crisis in the financial sector showed a growing importance of risk measurement and management systems for banks' solvency and overall economic stability. Banking sector supervisory bodies responded to these turbulences by strengthening the actual capital regulation standards. Nevertheless, the adoption of risk-sensitive rules under Basel II perfectly coincided with the beginning of the financial crisis that jeopardized their introduction in practice. The efficiency or eventually inefficiency of Basel II standards was not rigorously assessed by existing studies.

In this paper, we investigate the impact of risk-weighted capital ratios on BHC value – the profit-generation capacity. We found that the prudential ratios reported under Basel II rules might predict bank market valuation. Similar results were reported by Estrella et al. (2002), Čihák et al. (2010), and Beltratti and Stulz (2009). However, from the contingency perspective, the sophistication in risk measurement seems to significantly decrease a predictive power of risk-weighted capital ratios for BHC value. The prudential indicators of banks that apply standardized approaches to measure their risk exposures reveal better the actual risk-taking and are considered by financial markets. If the capital ratios are determined using sophisticated approaches, higher values of them are not necessarily translated to a higher market valuation of bank equities.

Table 6

Capital ratios, sophistication of risk measurement approaches and BHC market valuation

This table reports the results of OLS regressions for different years. The dependent variable is Tobin's Q adopted to financial institutions. In models 6-1, 6-2, 6-7, 6-8, 6-13, and 6-14 we regress BHC market valuation on capital ratios (Tier 1 and Total Capital Ratio). Other models report the results of the moderation of BHC risk measurement approaches on the relation between bank market valuation and capital ratios.

	2008						2009						2010					
	M. 6-1	M. 6-2	M. 6-3	M. 6-4	M. 6-5	M. 6-6	M. 6-7	M. 6-8	M. 6-9	M. 6-10	M. 6-11	M. 6-12	M. 6-13	M. 6-14	M. 6-15	M. 6-16	M. 6-17	M. 6-18
Tier	1.998***		2.222***	2.269***			1.335*		3.125***	2.785***			2.566**		4.402***	3.840***		
	(0.524)		(0.517)	(0.525)			(0.749)		(0.825)	(0.856)			(0.981)		(1.036)	(1.033)		
BIS_Ratio		2.170***			2.578***	2.501***		2.488***			3.136***	2.891***		2.688***			4.100***	3.795***
		(0.442)			(0.502)	(0.525)		(0.450)			(0.480)	(0.506)		(0.569)			(0.616)	(0.652)
IRB	-0.011	-0.006	0.149	-0.038	0.162	-0.017	-0.129*	-0.109**	0.281**	-0.121**	0.233*	-0.101*	-0.213***	-0.175***	0.307*	-0.190***	0.331**	-0.168***
	(0.065)	(0.059)	(0.104)	(0.065)	(0.120)	(0.061)	(0.064)	(0.051)	(0.126)	(0.059)	(0.132)	(0.050)	(0.071)	(0.062)	(0.169)	(0.067)	(0.143)	(0.057)
B2_Score	(0.057)	0.043	0.053	0.404*	0.045	0.262	0.099	0.094	0.075	0.587***	0.096	0.362*	0.240**	0.214**	0.216**	0.790***	0.239***	0.759***
	(0.094)	(0.086)	(0.091)	(0.207)	(0.084)	(0.207)	(0.093)	(0.074)	(0.083)	(0.190)	(0.068)	(0.180)	(0.104)	(0.089)	(0.093)	(0.229)	(0.078)	(0.208)
Loan	0.259*	0.188	0.148	0.152	0.109	0.127	0.319*	0.325**	0.266	0.230	0.265*	0.260*	0.447**	0.417**	0.274	0.206	0.349**	0.287
	(0.145)	(0.133)	(0.151)	(0.151)	(0.139)	(0.142)	(0.180)	(0.142)	(0.160)	(0.169)	(0.134)	(0.145)	(0.210)	(0.178)	(0.195)	(0.216)	(0.155)	(0.170)
Size	0.026	0.008	0.021	0.017	0.007	0.006	0.029	0.028	0.037*	0.033	0.033**	0.028*	0.028	0.021	0.023	0.018	0.022	0.015
	(0.019)	(0.016)	(0.018)	(0.018)	(0.016)	(0.016)	(0.022)	(0.017)	(0.019)	(0.021)	(0.016)	(0.016)	(0.025)	(0.021)	(0.022)	(0.023)	(0.018)	(0.019)
Governance	-0.049	-0.047	-0.051	-0.061	-0.049	-0.053	-0.112	-0.164**	-0.156*	-0.150*	-0.176***	-0.172**	-0.224**	-0.244***	-0.300***	-0.275***	-0.309***	-0.295***
	(0.051)	(0.046)	(0.049)	(0.049)	(0.045)	(0.046)	(0.089)	(0.069)	(0.080)	(0.084)	(0.064)	(0.068)	(0.101)	(0.082)	(0.093)	(0.096)	(0.073)	(0.078)
Stability	-0.034	-0.035	-0.032	-0.029	-0.034	-0.033	-0.006	0.007	-0.022	-0.017	0.008	0.008	-0.035	-0.005	-0.033	-0.029	0.011	0.008
	(0.027)	(0.025)	(0.026)	(0.026)	(0.024)	(0.025)	(0.039)	(0.032)	(0.035)	(0.037)	(0.029)	(0.031)	(0.043)	0.037)	(0.038)	(0.039)	(0.033)	(0.035)
Sophistic	0.110	0.115*	0.122*	0.108	0.133*	0.123*	0.038	0.059	0.083	0.069	0.085	0.073	0.043	0.089	0.113	0.099	0.163**	0.150**
	(0.073)	(0.066)	(0.071)	(0.071)	(0.066)	(0.066)	(0.072)	(0.057)	(0.065)	(0.067)	(0.054)	(0.057)	(0.079)	(0.069)	(0.074)	(0.077)	(0.063)	(0.067)
Tier * IRB			-1.905*						-3.92***						-4.432***			
			(0.994)						(1.079)						(1.332)			
Tier * B2_Score				-3.096*						-4.70***						-5.149**		
				(1.658)						(1.631)						(1.940)		
BIS_Ratio * IRB					-1.503						-2.58***						-3.60***	
					(0.940)						(0.935)						(0.948)	
BIS_Ratio * B2_Score						-1.585						-2.048						-3.792***
						(1.367)						(1.257)						(1.328)
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	0.440	0.698	0.542	0.664	0.651	0.727	0.749	0.651	0.549	0.688	0.460	0.609	1.211*	1.011	1.270**	1.379**	0.750	0.971*
	(0.533)	(0.472)	(0.516)	(0.528)	(0.462)	(0.470)	(0.639)	(0.508)	(0.568)	(0.592)	(0.479)	(0.500)	(0.702)	(0.611)	(0.627)	(0.657)	(0.533)	(0.563)
Observations	55	55	55	55	55	55	66	66	66	66	66	66	62	62	62	62	62	62
R-squared	0.806	0.838	0.826	0.825	0.850	0.844	0.672	0.793	0.750	0.726	0.824	0.805	0.701	0.775	0.767	0.747	0.836	0.814

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

These findings are relevant for regulators and other interested parties, and question the effectiveness of risk-sensitive measurement approaches. Especially in the light, that the adoption of IRB and AMA require considerable investments in bank risk management.

The following limitations of our study provide opportunities for future research in this area. First, our sample includes only publicly-listed banks and the situation could be different for privately held financial institutions. Second, BHCs in our sample are from countries – members of Basel Committee on Banking Supervision and are supposed to strictly comply with its guidelines. Thus, banks from other countries might apply different approaches to measure their risks. Third, we use a global measure for BHC value, and additional tests should be conducted with alternative measures like stock returns, profit and cost efficiency to evaluate the impact of BHC risk-weighted capital ratios. Finally, alternative proxies for BHC risk measurement (management) sophistication could be applied.

Despite these limitations the paper deserves some merits for having contributed to an enhanced understanding under which circumstances prudential ratios under Basel II are effective in predicting BHC market valuation.

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Thesis Conclusions

In this dissertation we aimed to study relevant questions related to bank regulation and risk management practices in financial institutions. As re-distributors of society savings, banks play an essential role for the prosperity of the world economy (Barth, Caprio Jr, & Levine, 2008) and recent financial crisis very clearly illustrated that. Thus, bank regulation and risk management practices matter.

This thesis consists of three essays that study the questions how banking regulation affects bank behavior and how bank risk management practices impact bank risk of default and market valuation.

The first essay entitled "*The choice to adopt risk-sensitive measurement approaches for operational risks: the case of Advanced Measurement Approach under Basel II New Capital Accord*" is designed to study how financial institutions respond to regulation requirements to measure operational risks. This study was partly motivated by the lack of previous research on the question why financial institutions decide to invest in sophisticated risk management systems (Beasley, Clune, & Hermanson, 2005; VanHoose, 2007). Moreover, there is a myth that advanced measurement approaches (AMA) lead to lower capital requirements and banks that opt for these approaches could gain a competitive advantage compared to competitors that adopt standardized methods (BCBS, 2001; Ramadurai, Beck, Olson, & Spring, 2004). First, we formulated several hypotheses to determine factors that might influence the banks' choice to adopt advanced approaches for operational risks (Cohen & Levinthal, 1990; Davila, Foster, & Li, 2009; Elizalde & Repullo, 2007; Paape & Spekle, 2012). Second, we performed an empirical analysis to examine whether advanced approaches lead to lower capital requirements. Our findings revealed that the adoption of sophisticated approaches to measure operational risks is motivated by technical and managerial knowledge that banks accumulated and the level of equity that banks have before the adoption of advanced measurement

methodologies. The size also seemed to impact positively the bank propensity to adopt AMA. Furthermore, our analysis revealed that AMA leads to lower capital requirements compared to other less sophisticated operational risk measurement approaches.

In the second essay, entitled "*Internal Risk Controls and their Impact on Bank Solvency*", we studied how bank risk management systems are designed and how they impact bank solvency. To do that, we constructed the Internal Risk Controls Index (IRCI) composed of three elements: a) the presence of independent risk management committee on bank board; b) executive status of bank chief risk officer; and c) use of risk-sensitive measurement techniques (Aebi, Sabato, & Schmid, 2011; Nocco & Stulz, 2006; Stulz, 2008). Results of our empirical analysis suggest that more formalized risk controls impact positively bank solvency by reducing risk of default. In addition, ownership concentration (Laeven & Levine, 2009; Shehzad, de Haan, & Scholtens, 2010) and strict regulatory oversight (Barth et al., 2008) over bank capital moderates positively the relation between bank risk management sophistication and solvency. Contrarily to that, limitations on activities that bank could practice (Caprio, Laeven, & Levine, 2007) and bank growth (Hopkins & Hopkins, 1997) make the internal risk controls less efficient.

Our third essay, "*The Impact of the Sophistication of Risk Measurement Approaches under Basel II on Bank Holding Companies Value*" aims to study whether bank prudential indicators determined under Basel II New Capital Accord (Tier 1 ratio and Total capital ratio) have an impact on bank market valuation. According to previous research ((Berger, Herring, & Szegö, 1995; Cihák & Schaeck, 2010; Kim & Santomero, 1988), bank capital ratios could predict banking crisis. Nevertheless, no study considered the fact that these capital ratios could be computed according to different risk-sensitivity degree approaches. We designed our study to fill this lack of knowledge. We provide evidence that higher bank capital ratios lead to a higher bank market valuation. Nevertheless, the increasing sophistication in measurement

approaches to determine these ratios moderates negatively their predictive power. Thus, capital ratios computed under standardized approaches predict better bank market valuation.

Bank regulators and supervisors need to understand better how financial institutions manage their risks and how much attention is paid to the risk governance process. The monitoring and management of risks occur through a large set of mechanisms whose interdependency and effectiveness are not very well known. It appears that higher involvement and higher expertise of internal (board of directors) and external (bank regulator) supervisory bodies increase the solvency of banks and reduce their risks of default. We hope that our findings will make a valuable contribution in the current stream of research on bank behavior and the regulation that affects it.

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