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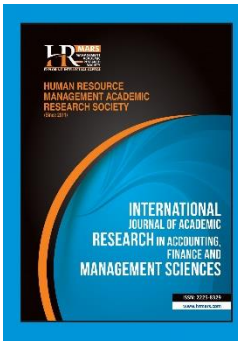
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The Impact of Capital Regulation on Bank Capital and Risk Decision Evidence for European Global Systemically Important Banks

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Abstract
Large banks were largely blamed for the recent financial crisis, due to their roles in the propagation of the crisis. Partly due to the unprecedented amount of public funds disbursed to rescue the fail banks to avert the total breakdown of the global financial system and the resultant moral hazard of their bailout. Policymakers and regulators have significantly increased bank regulations after the crisis to rein-in some of the "excesses" of the banks that cause to the financial crisis. Particularly, Basel III capital regulation came into existence largely to strengthening the capital framework for banks and increases the loss absorbency for the so-called too big to fail banks. This study investigates the impact of capital regulation on the capital and risk portfolio behaviour of European large and complex banks during the period 2009 – 2014. By using a modified version of the structural equation model developed by Shrieves and Dahl (1992) to estimate the effect of capital regulation on banks' capital and risk portfolios decisions.. The findings of our model estimation indicate that regulation has a significant impact on changes in bank capital. We, however, do not find any significant evidence of the impact of regulation on bank risk portfolio decisions. Model estimation results also show that there is a significant negative relationship between changes in bank capital level and changes in risk portfolio level and vice versa.
Keywords: Capital Requirements, Bank Regulation, Bank Capital, Risk Portfolio, Regulatory Pressure, Capital Ratio And Global Systemically Important Bank

Introduction

The concomitant impacts of the Great Depression on the economy of the United States and the global economy, in general, brought about the first major *big bang* reforms of the financial industry. These reforms saw a wave of regulations from many countries that were more legalistic and prescriptive in nature. Most notably among the banking regulations of the Depression era was the United States Banking Act of 1933 commonly known as *Glass-Steagall Act.*[1] The movement toward the deregulation of the financial markets gathers momentum in

[1]The Glass-Steagall Act brought about the separation of commercial and investment banking similar to post 2007 – 2009 financial crisis banking reform in the UK that called for Ring-fencing of the retail banking from the wholesale banking.

early 1980 and with the repeal of the *Glass-Steagall Act* in 1999 ushered in a period of loose or "soft-touch" regulation. Since the end of the Great Depression, there had been some banking crises on both sides of the Atlantic, each time the response of the policymakers has been to rewritten the rulebook. Conventionally, regulations have been the prevailing means of managing the overall risk inherent in the banking system (Spong, 2000). Regulation of the banks is necessary to: (i) Ensure the stability of the financial and the banking system (Goodhart, 2008; Pennachi, 2005). (ii) Protect taxpayers from the moral hazard ensuing from the public bailout of failed banks (see, for example, Tirole, 1997; Hellmann *et al.*, 2000; Tressel and Verdier, 2011). (iii) Safeguard bank depositors and the real economy from the domino effect of the collapse of the financial system (Spong, 2000).

Banking Regulations have increased significantly since the recent subprime bubble crisis and there is no sign of letting off the pressure on the sector, regulators are still churning out more reforms seven years after the crisis. It is possible, however, to separate the number of regulatory reforms into three major classes. Regulations intended to strengthen bank regulatory framework, to lessen the chance of another financial catastrophe. Those designed to limit the failure of large financial institutions (LFI) and those aimed to reduce the impact of failure on both the financial system and the macroeconomy.

One of the lessons learnt from the Great Financial Crisis was that the amount of high-quality capital held by many financial institutions was inadequate to absorb the losses incurred by banks during the crises. To address this deficiency, the Basel Committee on Banking Supervision (BCBS)[2] proposed a new regulatory capital framework-Basel III. Designed for improving the quantity and quality of capital in banking organisations, build additional capacity for losses into the banking system and withstand markets and economic shocks (BCBS). We cannot overemphasise the importance of capital to a banking organisation. The amount of capital held by a bank determine: (i) the level risk the bank can assume. (ii) Loss absorbency capacity. (III) The profitability level. (iv) The cost of funds. (v) Investors' confidence, and (vi) Going - concern of the bank. It is vital that banking organisations can maintain a balance between their capital risk portfolios. As a result, banks tend to adjust their balance sheet components to achieve an internally set capital target.

This study focuses mainly on large banks classified as the global systemically important banks (GSIBs). The classification of these banks is according to their size, complexity, organisation, business activities, as well as their importance to the global financial system. The aim of this study is to provide an empirical analysis of the impact of bank regulation on the capital and risk-taking behaviour of European global systemically important banks (G-SIBs). The paper seeks to provide answers to three important questions. (i) Does regulatory pressure force large banks to increase their capital target level? (ii) What is the impact of an increase in the capital requirement on the level of bank's portfolio risk? (iii) Does the sub-prime crisis induce banks to: (a) increase their capital level? (b) Reduce their portfolio riskiness? We address the above questions by building on the structural equation model developed by (Shrives & Dahl, 1992). And later used by, Jacques & Nigro (1994); Rime (2001) and in other literature. Simultaneous equation model include endogenous variables, which implies that a regressor may correlate with the error terms and therefore OLS estimation may lead to biased and inconsistent estimates. We, therefore, opted for the method of two-staged least square (2SLS) regression to estimate the model. 2SLS estimator takes into consideration

[2] The Basel Committee on Banking Supervision provides a forum for regular cooperation on banking supervisory matters. Its objective is to enhance understanding of key supervisory issues and improve the quality of banking supervision worldwide (see, http://www.bis.org/bcbs/index.htm)

the endogeneity of variables and thus produces a more consistent result than the Ordinary Least Square (OLS) estimator.

Literature Review

Capital Regulation and Bank Behaviour

Since the advent of Basel I capital adequacy requirements by the Basel Committee on Banking Supervision (BCBS) in 1988, the relationship between capital regulation and bank behaviour has received extensive coverage of the literature. One of the Pioneering studies that also motivated researchers to delve into the subject of bank capital regulation and risk is the seminal work of (Shrieves & Dahl, 1992). In their paper titled *"The relationship between risk and capital in commercial banks"*. Based on data acquired from a large sample of commercial banks in the United States, they investigate the relationship between changes risk and capital. Their findings reveal a positive association between changes in risk and capital for banks with capital in excess of the minimum regulatory requirements. They find evidence to suggest that the changes in the target level of bank capital over the period examined is based on changes in risk level. Jacques & Nigro (1994) used three staged least square model to evaluate the implication of Basel I standard on both capital and risk portfolio of banks. They find that risk-based capital requirement had a significant effect on capital and risk target level of adequately capitalised banks. But find a small impact on poorly capitalised banks.

Aggarwal and Jacques (1998) investigate the effect of the prompt corrective action (PCA)[3] standards on bank capital ratios and portfolio risk levels. They find evidence to suggest that adequately capitalised banks and undercapitalised banks respond to the PCA announcement by increasing their capital ratios. Their findings also indicate that the PCA cause both adequately capitalised and undercapitalised banks to reduce their risk portfolios, with no significant difference in the level of reduction between the two categories of banks. In contrast to the findings of Shrieves & Dahl (1992); Jacques & Nigro (1994), they do not find any empirical evidence to suggest that bank capital level is strictly determined by their portfolio risk level.

By building on the work of Shrieves & Dahl (1992); Rime (2001) studied the capital and risk behaviour of Swiss banks; he finds that regulatory pressure forced banks to increase their capital. He, however, did not find evidence to suggest any significant impact of capital regulation on banks' risk portfolio. Rime (2001) confirms the findings of Ediz *et al* (1998) in their study of the impact of bank capital requirement on the capital ratio using data from U.K. banks from 1989-1995. They find evidence to conclude that capital requirement do have an impact on the level of bank capital behaviour. They also find that adjustment in the bank's capital level is directly attributable to increase in their capital rather than through systematic adjustment of the components of their balance sheet.

Contemporary literature on the subject of capital regulation and bank behaviour are motivated by the recent financial crisis. Many researchers are interested in studying the subject with respect to the effects of the sub-prime crisis and the Basel III capital requirements on banks' ability to adjust capital and risk level. For example, Cohen (2013) contends that strong regulatory requirements have enabled banks to increase their capital ratios consistently since the advent of the financial crisis. From a study of over 82 banks from

[3] Section 38 of the United States Federal Deposit Insurance Act (1991) requires insured depository institutions and federal banking regulators to take "prompt corrective action" to resolve capital deficiencies at insured depository institutions. The Act categorized financial institutions capital into: well-capitalized, adequately capitalized, undercapitalized, significantly undercapitalized and critically undercapitalized. (see, https://www.fdic.gov/regulations/laws/rules/1000-4000.html)

different economies, He finds evidence to suggest that many banks have achieved most of their capital and risk adjustment through the accumulation of retained earnings. While Athanasoglou (2011) using a simultaneous equation model to estimate an unbalanced panel of banks from the South Eastern European region. The findings of his study show that there is a weak but significant relationship between capital adequacy ratio and risk taking.

Some researchers have investigated the relationship of capital regulation and other areas of bank behaviour. For example, Fawwaz and Alrgaibat (2015) on their study of capital adequacy of the Jordanian banking system from the period of 2000–2013, they find that there is a statistical significant relationship between capital adequacy and the capital risk. Demirguc-Kunt *et al* (2010) in their paper titled "Bank Capital: Lessons from the Financial Crisis", study whether well-capitalised banks do have higher stock returns during the subprime crises. In their study, they differentiated among different types of capital ratios. They find that differences in the capital did not have any significant effect on stock returns before the outbreak of the crisis. But find evidence to indicate that the impact of capital position was significant during the crisis, particularly for larger banks. Their findings also reveal that the relationship between stock returns and capital is more significant when capital is measured by the leverage ratio compared to risk-adjusted capital ratio. Lee & Hsieh (2013) study the impacts of bank capital on profitability and risk. The result of their research shows that commercial bank exhibit the largest reverse capital effect on Risk with banks from low-income countries have a higher capital impact on profitability.

Basel III Capital Requirements

Capital requirement has been the fundamental pillar of the Basel Committee on Banking Supervision reforms since it came to force as Basel 1 in 1988. Basel Committee has improved the current standard (Basel III) significantly make it fit for purpose. According to the Basel Committee on Banking Supervision, *"Basel III is a comprehensive set of reform measures, to strengthen the regulation, supervision and risk management of the banking sector*". The current standards, Basel III, have required banks to comply with a set of new minimum capital requirements. (i) A ratio of common equity Tier 1 capital to risk-weighted assets (common equity tier 1 capital ratio) is now 4.5 percent. (ii) a ratio of Tier 1 capital to risk-weighted assets (Tier 1 capital ratio) is now 6 percent, this represents an increase of 50 percent over that of the previous standard; (iii) A ratio of total capital to risk-weighted assets (total capital ratio) of 8 percent; (iv) a ratio of Tier 1 capital to average total consolidated assets (leverage ratio) of 4 percent. (v) For banks implementing the advanced approaches only, an additional requirement which set the ratio of Tier 1 capital to total leverage exposure (supplementary leverage ratio) at least 3 percent (BCBS). Detail of the phase-in implantation of the new capital rule is provided in Table 1.

Table 1

Basel III phase-in arrangements (All dates are as of 1 January)

Phases	**2013**	2014	2015	2016	2017	2018	**2019**
Leverage Ratio		Parallel run Jan 2013- 1 Jan 2017 Disclosure starts 1 Jan 2015				Migration to Pillar 1	
Minimum Common Equity Capital Ratio	3.5%	4.0%	4.50%				**4.5%**
Capital Conservation Buffer				0.625%	1.25%	1.875%	**2.5%**
Minimum Common Equity plus Capital Conservation Buffer	3.5%	4.0%	4.5%	5.125%	5.75%	6.375%	**7.0%**
Phase-in of deduction from CET1		20%	4.0%	60%	80%	100%	**100%**
Minimum Tier 1 Capital	4.5%	5.5%	6.0%				**8.0%**
Minimum Total Capital							
Minimum Total Capital plus Conservation Buffer		8.0%		8.625%	9.25%	9.875%	**10.5%**
Capital Instruments that no longer qualify as non-core Tier 1 capital orTier 2 capital		Phased out over 10 year horizon beginning 2013					

Source: Basel Committee on Banking Supervision, BIS

The standard also proposed a capital conservation buffer at 2.5 percent of risk-weighted assets above the minimum risk-based capital ratio requirements. That could increase by a countercyclical capital buffer for banks implementing the advanced approaches under certain conditions. Where a bank failed to hold capital above the prescribed minimum capital ratios and proposed capital conservation buffer, such banks would face some restrictions on capital distributions and discretionary bonus payments. The newly proposed countercyclical capital buffer was intended to take into account the macro-financial environment in which the banks operate. As proposed by the standard, the countercyclical capital buffer would initially be set at zero percent, and could increase to 2.5 percent of risk-weighted assets. Effectively, the new capital requirement rule for banks would hit 10.5 per cent by 2019

In addition to the above requirements, regulators prescribed further capital requirement for banks classified as too-big-to-fail. The additional capital charge is imposed as a direct consequence of (i) The role played by the large banks in the propagation of the global financial crisis. (ii) The inherent systemic risks associated with the failure of large banks. (iii) The effects of the crisis on the financial system. Global systemic important financial institutions (G-SIFIs) are mandated to have higher loss absorbency capacity to reflect the greater risks they pose to both the financial system and the real economy[4].

Methodology of Research

A Simultaneous Equation Model with Partial Adjustment for Capital and Risk

From the empirical literature reviewed in section 2 above, it has been broadly established that banks capital and risk decisions are simultaneously determined. In this study, we use simultaneous equation model to test the relationship between capital and risk decisions of Europe's' G-SIFIs., We modelled our specification on the approach developed by Shrieves & Dahl (1992), who estimates observed changes in banks capital and risk target levels as a function of two components (i) A discretionary adjustment by bank managers as well as (ii) A change caused by an exogenous random shock to the bank.

[4] The additional loss absorbency requirements are to be met with a progressive Common Equity Tier 1 (CET1) capital requirement ranging from 1% to 2.5%.

$$\Delta CAP_{j,t} = \Delta^{d} CAP_{j,t} + \varepsilon_{j,t;} \quad (1)$$

$$\Delta RISK_{j,t} = \Delta^{d} RISK_{j,t,t} + \mu_{j,t;} \quad (2)$$

where $\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ are the total observed changes and $\Delta^{d} CAP_{j,t}$ and $\Delta^{d} RISK_{j,t}$ are the endogenously determined adjustments, and $\varepsilon_{j,t}$ and $\mu_{j,t}$ are the exogenous random variables in capital and risk levels respectively for bank *j* in period *t*. Banks may be constrained to have a full adjustment to their desired capital and risk target levels in any given period *t,* due to pressures exerted by exogenous shocks. Banks will therefore, have to partially adjust both risk and capital to their target levels. To acknowledge this constraint, the model used in this paper therefore, assumes partial, rather than complete adjustment in each period *t.* The partial adjustment framework assumes that the adjustment is proportional to the difference between the desired target level and the bank's level in period t-1. The internally managed adjustment components can therefore be expressed as:

$$\Delta^{d} CAP_{j,t} = \alpha(CAP^{*}_{j,t} - CAP_{j,t-1}) \quad (3)$$

$$\Delta^{d} RISK_{j,t} = \beta\,(RISK^{*}_{j,t} - RISK_{j,t-1}) \quad (4)$$

Where $CAP^{*}_{j,t}$ and $RISK^{*}_{j,t}$ are the optimum or desire target capital and risk levels respectively and α and β are proportionality parameters. Substituting equations (3) and (4) into equations (1) and (2), the observed changes in capital and risk can be expressed as:

$$\Delta CAP_{j,t} = \alpha(CAP^{*}_{j,t} - CAP_{j,t-1}) + \varepsilon_{j,t.} \quad (5)$$

$$\Delta RISK_{j,t} = \beta\,(RISK^{*}_{j,t} - RISK_{j,t-1}) + \mu_{j,t.} \quad (6)$$

Therefore, the observed changes in capital and risk in period *t* are a function of the target levels and the lagged levels of capital and risk respectively and exogenous shocks[5].

Definitions of Capital and Risk

The commonest definitions of capital used in previous studies are (i) the ratio of capital to total assets (RCTA) and (ii) the ratio of capital to risk-weighted assets (RCWA). Shrieves and Dahl (1992) used the first definition. The wide adoption of the Basel accord standards has made the second definition more popular as banks are now required to meet capital requirements in terms of risk-weighted assets (RWAs).[6] This definition has been employed by Jacques & Nigro (1997) while Rime (2001); Aggarwal & Jacques (2001) use both definitions. We employ the ratio of capital to the risk-weighted asset (RCWA) as this measure is consistent with the Basel III measure of Capital Adequacy Ratio (CAR) used to gauge bank's health and loss absorbency. This definition, unlike the ratio of capital to total assets takes into account the risk profiles of assets into account.

[5] Exogenous factors that could exert pressure on banks' capital and risk include changes in regulatory capital requirements, macroeconomic factors, bank credit rating and wholesale funding and adjustment cost.

[6] For example, the Basel III capital standards require banks to meet the following minimum capital requirements: 3.5% Common Equity Tier 1/RWAs, 4.5% Tier 1 capital/RWAs and 8.0% total capital/RWAs.

In line with Basel III, CAR is defined as:

$$\text{Capital Adequacy Ratio (CAR)}^{7} = \frac{\text{Capital}}{\text{Risk}} = \frac{\text{Tier 1 capital + Tier 2 capital}}{\text{Risk Weighted Assets * 8\%}} \quad (7)$$

The definition and measurement of risk is both diverse and difficult, and has continued to generate debate in many quarters. Consistent with Shrieves and Dahl (1992), Jacques & Nigro (1997), Aggarwal & Jacques (1998) and Rime (2001), we chose the ratio of risk-weighted asset to total assets. Our preference for this measure is due to its ability to adjust banks assets for risk and its consistency with the Basel III risk calculation requirements.

Variables Affecting Changes in Banks' Capital and Risk

The partial adjustment model assumed that each bank will aim to establish their optimum target capital and risk levels (equations 5 and 6). Bank's target levels of capital and risk are not readily observable and are dependent on a number of variables. Here, we provide detail explanation for the different independent variables and their potential impact on banks' capital and risk level. These variables have been used in previous standard work in this area (Shrieves & Dahl, 1992; Aggarwal & Jacques, 1998; Rime, 2001).

Size: Size may impact capital and target levels of a bank due to its relationship to economies of scale, diversification and the bank capacity to access funding in the capital market. The impact of size on the level of capital, stability of funding, and the share of market-based activities cannot be dismissed. We include the natural logarithm of total assets (measured as SIZE) is included in the model equation to account for the impact of size on the capital and risk target levels in a bank.

Current profits: Profits are a vital component of capital and current profits are expected to have a positive impact on bank's capital level. Current profits in the form of retained earnings may serve as a credible way of increasing the capital level of a bank particularly, when it is difficult or too expensive for banks to raise other forms of capital in the markets. We include the bank's return on assets (ROA) in the capital equation as a measure of profits with an expected positive impact on the capital level.

Current loan losses: A bank's current loan losses would have a negative effect on the regulatory capital charges calculation as it decreases the denominator (the risk-weighted assets) in the capital calculation. We estimate these losses (LLOSS) with the ratio of new provisions to total assets, are included in the risk equation with an expected negative effect on risk.

Regulatory pressure: Growing regulatory pressure on banks to increase capital level in order to guard against future financial shocks may have a negative effect on the ability of banks to raise their capital and risk to desired target level. Under Basel III, regulators expect banks to achieve 7 per cent core tier 1 ratio plus additional 1 to 2.5 percent for systemic important financial institutions (SIFIs). We expect regulatory pressure to have a substantial impact on large banks capital and risk decisions due to stringent capital requirements imposed by the regulators. Two main methods have been adopted in previous literature to measure regulatory pressure. (i) The prompt corrective action (PCA), this approach was

[7] Tier I comprises of Ordinary share capital, audited revenue reserves, future tax benefits, and intangible assets.
Tier II comprises of Unaudited retained earnings, general provisions for bad debts; revaluation reserves, perpetual subordinated debt, perpetual cumulative preference shares, and subordinated debt.

introduced by Aggarwal & Jacques (1998) (ii) The probabilistic approach introduced by Ediz *et al* (1998) and subsequently used by Rime (2001). The probabilistic approach is based on the assumption that risk and capital decisions are impacted by regulatory pressure once a bank capital drops close to the minimum regulatory capital requirement.

In this paper, the category of banks under investigation is the large and complex banks classified as the global systemically important banks (GSIBs), we, therefore, expect all banks in our sample to have capital ratio above the minimum 8% capital requirement. As a result, we have not use the probabilistic approach and the prompt corrective action (PCA) method as all banks in our sample are adequately capitalised. We, therefore, computed regulatory pressure (REG) as the difference between the bank's capital ratio and the minimum (8%).

Simultaneous changes in risk and capital: The empirical model discussed above is based on the assumption that the level of capital and risk in banks are simultaneously determined. This joint determination of risk and capital level requires the inclusion of both endogenous variables to the model equation. Following Shrieves & Dahl (1992), $\Delta RISK$ and ΔCAP are added to the right-hand side of equation 7 and equation 8 respectively to enable us determine whether there is a relationship or no relationship between the two variables, and also the type of relationship - positive or negative.

Macroeconomics shocks: Macroeconomic shocks can have a significant impact on bank's capital and risk level (see, Meeks, 2014). (Gizycki) 2001 examines the ability if macroeconomic variables to explain changes in banks risk. He finds that macroeconomic variables exert a strong impact on bank risks and profitability. We account for the impact of changes in macroeconomic shocks on banks' capital and risk level by introducing dummy variables to the regression model for each year under consideration except one; this is in line with (Shrieves & Dahl, 1992; Rime, 2001).

Model Specification

From the analysis provided in Section 3.1 above, equations (5) and (6) can be specified as follows:

Capital Equation

$$\Delta CAP_{j,t} = \lambda_0 + \lambda_1 . REG_{j,t-1} + \lambda_2 . ROA_{j,t} + \lambda_3 . SIZE_{j,t} + \lambda_4 . \Delta RISK_{j,t} - \lambda_5 . CAP_{j,t-1} + dummy2009 + dummy2010 + \ldots + dummy2014 + \varepsilon_{j,t} \quad (7)$$

Risk Equation

$$\Delta RISK_{j,t} = \lambda_0 + \lambda_1 . REG_{j,t-1} + \lambda_2 . LLOSS_{j,t} + \lambda_3 . SIZE_{j,t} + \lambda_4 . \Delta CAP_{j,t} - \lambda_5 . RISK_{j,t-1} + dummy2009 + dummy2010 + \ldots + dummy2014 + \mu j, t \quad (8)$$

Where:

REG denotes regulatory pressure;

$\varepsilon_{j,t}$ and $\mu_{j,t}$ are error terms.

Data, Empirical Estimation and Results

The data used consists of 202 samples from 17 banks classified as Global Systemically Important Banks (G-SIBs) in Europe from 2005–2014 (see Table 2).

Table 2
Sample Distribution, 2009 – 2014

Number	Year	Samples
1	2009	17
2	2010	17
3	2011	17
4	2012	17
5	2013	17
6	2014	17
	Total	**102**

Data is collected from the bank's balance sheet, income statement obtained from Reuters and individual bank websites (see, Table 3, 4 and 5 for Mean Variables in Years, Descriptive Statistics and Correlation Matrix respectively)and . The dependent and independent variables are as discussed in Section 3.4 above.

Table 3
Mean of Variables in Years

	2009	2010	**2011**	2012	**2013**	2014
REG_{t-1}	7.0092	6.6865	6.8251	5.8900	5.9684	6.3089
ROE_t	0.4979	0.0821	-0.0079	0.0000	0.0288	0.0492
$LLOSS_t$	0.1808	2.6019	0.8450	0.9710	1.3056	0.7548
$SIZE_t$	13.8615	13.9036	13.9088	13.8801	13.7482	13.7949
ΔCAP	1.2623	0.9640	-0.4529	0.9049	0.8561	1.0080
ΔRISK	1.0475	1.0129	1.6944	1.0241	0.9121	1.0138
CAP_{t-1}	0.0488	0.0425	0.0447	0.0422	0.0448	0.0516
$RISK_{t-1}$	0.3020	0.3291	0.3235	0.3015	0.2900	0.3145

Table 4
Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
REG_{t-1}	102	0.069	10.989	6.448	0.197	1.992	3.968
ROE_t	102	-0.900	7.500	0.108	0.074	0.751	0.564
$LLOSS_t$	102	-7.808	23.395	1.110	0.255	2.579	6.649
$SIZE_t$	102	12.300	14.600	13.846	0.045	0.455	0.207
ΔCAP	102	-24.400	2.400	0.753	0.251	2.535	6.424
ΔRISK	102	0.000	12.300	1.112	0.114	1.156	1.337
CAP_{t-1}	102	0.000	0.100	0.033	0.005	0.047	0.002
$RISK_{t-1}$	102	0.000	0.500	0.314	0.011	0.111	0.012

Table 5
Correlation Matrix

	REG_{t-1}	ROE_t	$LLOSS_t$	$SIZE_t$	ΔCAP_t	$\Delta RISK_t$	CAP_{t-1}	$RISK_{t-1}$
REG_{t-1}	1.000							
ROE_t	0.050	1.000						
$LLOSS_t$	-0.019	-0.038	1.000					
$SIZE_t$	0.157	0.111	-0.004	1.000				
ΔCAP	-0.131	0.130	0.019	0.215	1.000			
ΔRISK	0.199	-0.137	-0.037	-0.162	-0.939	1.000		
CAP_{t-1}	0.076	-0.002	-0.097	0.159	0.244	-0.098	1.000	
$RISK_{t-1}$	0.125	-0.059	-0.086	0.085	0.112	0.067	0.777	1.000

Variables in our regression equations can be endogenous due to measurement error, simultaneity and omitted variable biased. We test the endogeneity of our dependent variables using the Hausman Test. We find that the residual capital equation (Redsid_CAP) is significant at 1% with a coefficient of 1.489 with SE 0.335 and t-value of 4.53. The result of the test shows that Ordinary Least Square (OLS) estimation would not be appropriate. The problem using OLS estimation in this type of situation is that the error term $\varepsilon_{j,t}$ and the explanatory variables become correlated due to the unobserved element or omitted variable present in the error term. As a result, we estimate the equations using the Two-Staged Least Square (2SLS) for more consistent estimation of the regression equations.

Table 6
Capital Equation Model Regression (2SLS) Results

	Capital Equation (ΔCAP)	
	Coeff.	**t-value**
REG_{t-1}	2.327*	0.005
ROE_t	0.034	0..89
$LLOSS_t$	------	
$SIZE_t$	-1.315*	0.489
ΔCAP_t	------	
$\Delta RISK_t$	-1.972*	-13.435
CAP_{t-1}	-0.156**	0.043
Dummy2009	0.416*	1.210
Dummy2010	0.381**	1.240
Dummy2011	0.316	0.710
Dummy2012	0.276**	1.520
Dummy2013	0.742	0.005
Dummy2014	0.245	1.002
Adj. R^2	0.026	

*, ** indicates significance at the 5% and 10% level respectively

Table 7

Risk Equation Model Regression (2SLS) Results

	Risk Equation (ΔRISK)	
	Coeff.	**t-value**
REG_{t-1}	1.578	-0.114
ROE_t	-----	
$LLOSS_t$	-0.024	0.136
$SIZE_t$	0.416*	0.333
ΔCAP_t	-0.439**	-20.239
$\Delta RISK_t$		
$\Delta RISK_{t-1}$	-0.241	-1.261
CAP_{t-1}	0.430*	0.053
Dummy2009	0.024	0.456
Dummy2010	0.325*	0.315
Dummy2011	-0.015**	-0.124
Dummy2012	-0.007	-3.125
Dummy2013	-0.046	-0.573
Dummy2014	-0.028	0.606
Adj. R^2	0.046	

*, ** indicates significance at the 5% and 10% level respectively

The results of estimating the regression model for equation (7) and (8) using the various capital and risk variables defined in Section 3.2 above are presented in Table 6 and Table 7 for the capital equation and the Risk equation respectively. In the capital equation, although the coefficient of ROE is positive 0.034, which indicate that bank tends to raise capital through retained earnings as capital accumulation via capital market is more costly particularly after a deep recession. We, however, could not find evidence to suggest that the amount of capital raised through retained earnings have a significant impact on changes in the target capital buffer. This result is contrary to the findings in Rime (2001) who finds a significant positive impact of ROA on changes in capital. Plausible explanations for this difference are that the banks in our sample are just emerging from a deep financial crisis that has contributed to the depletion of their profit. Secondly, the costs of meeting the post-crisis financial regulations and in particular increase in capital requirements for the GSIBS have impacted the ability of the banks to plough back their profit to increase their capital position.

The capital equation model result shows that the impact of SIZE on Bank capital position is both negative and significant (-1.315 in Table 5). This evidence the fact that large banks are slower at increasing the ratio of their capital to risk-weighted assets compared to smaller banks. It is not a surprise that bank SIZE (measured as natural logarithm of total assets) has a significant positive impact on the risk portfolio (0.416, in Table 7); this effect can be attributed to the degree of risk aversion by large bank during and post the Global Financial Crisis. Bank tightened loan rates during and after the financial crisis by cutting back loans to both private and commercial sectors. Secondly, Europe, particularly the Eurozone remained in recession long after the crisis. Coupled with the high level of uncertainty in the European economies brought about the situation and handling of the Sovereign debts of some EU countries for example, Greece, Spain, Italy and Portugal. The size versus risk result agrees with Kwan (2010) who finds that during the financial crisis, large and medium-sized banks reduced the amount of loan disbursed more than the smaller banks.

The estimated parameters in capital equation show that changes in risk ($\Delta RISK_t$) have a negative significant impact on capital (-1.972, in Table 6). This may suggest that the implementation of the Basel III capital requirements has induced bank to reduce their risk portfolios (Furlong and Keeley, 1989). The financial crisis may also have a part to play in this, one of the backlashes against public bail-out of the too-big-to-fail banks is the resultant moral hazard, a situation where banks tend to take more risk with the expectation that the public would pay for their losses. Banks may want to deliberately refrain from amassing excessive risk to avoid further criticism from the public and penalties from their regulators. Similarly, in the risk equation, changes in capital (ΔCAP_t) have a significant negative effect on risk (- 0.439, in Table 7).

One of the main goals of this study is to provide plausible answers the question – *what is the impact of capital regulation on bank capital and portfolio risk?* In the capital equation in Table 6, the parameter estimate for regulatory pressure (REG) has a positive and significant impact on the capital. This finding indicates that capital requirements were effective in inducing banks to increase their capital level. The chief aim of the Basel III capital measures is to increase the ability of banks to absorb shocks due to financial and economic stress by inducing banks particularly the large banks to hold more and quality capital (BCBS)[8]. We, however, did not find any evidence in the risk equation to suggest that regulatory pressure has any impact on bank risk portfolio.

Conclusions

Large and complex banks were at the centre of the recent financial crisis, partly due to the parts played by these banks in the events leading to the crisis. And also due to the unprecedented public intervention to rescue the banks to avert global systemic collapse and the resultant moral hazard of their bail-out. Policymakers and regulators have significantly increased bank regulations after the crisis to rein-in some of the "excesses" of the banks that cause to the financial crisis. Basel III capital regulation was largely proposed to strengthening the global capital framework for banks and increasing the quality of bank capital base.

This study investigates the effect of capital regulation on the capital and risk portfolio behaviour of European large and complex banks during the period 2009–2014. By using a modified version of the structural equation model developed by Shrieves & Dahl (1992) to estimates the impact of capital regulation on banks' capital and risk portfolio. The findings of our empirical estimation indicate that that regulation has a significant impact on changes in bank capital, indicating that bank increases capital position significantly as a result of capital requirement. We, however, did not find any evidence to suggest that capital regulation has a significant impact on bank risk portfolio decisions. The results of our model estimation also indicate that changes in the capital have a negative impact on risk. Similarly, changes in risk have a negative effect on bank capital.

Although the focus of this paper is on the "big banks" classified as the global systemically important banks, our results fundamentally agree with the empirical findings from previous research on the subject; for example, Shrieves & Dahl (1992); Jacques & Nigro (1997); Aggarwal & Jacques (1998) as well as (Rime, 2001). The results confirm the relevance and effectiveness of bank capital regulation in improving the capital position of banks.

[8] In addition to meeting the Basel III requirements, global systemically important financial institutions (SIFIs) must have higher loss absorbency capacity to reflect the greater risks that they pose to the financial system - (BCBS) http://www.bis.org/bcbs/basel3/

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