Performance, Risk and Capital Buffer under Business Cycles and Banking Regulations: Evidence from the Canadian Banking Sector*

Alaa Guidara
Department of Finance, Insurance and Real Estate
Faculty of Business Administration
Laval University, Quebec, Canada
Email: alaa.guidara.1@ulaval.ca

Van Son Lai
Department of Finance, Insurance and Real Estate
Faculty of Business Administration
Laval University, Quebec, Canada
Email: vanson.lai@fas.ulaval.ca

and

Issouf Soumaré
Department of Finance, Insurance and Real Estate
Faculty of Business Administration
Laval University, Quebec, Canada
Email: issouf.soumare@fsa.ulaval.ca

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Abstract

Using quarterly financial statements and stock market data of the six Canadian big chartered banks from 1982 to 2009, this paper documents the countercyclical behaviour of Canadian banks capital buffer, with this feature more pronounced over subsequent rounds of amendments to the Basle I Accords and the Basle II period. Thus, the introduction of Basle Accords and the balance sheet leverage cap imposed by the Canadian banking regulator were somewhat effective in rendering Canadian banks' capital countercyclical to business cycles. We find that Canadian banks are well capitalized, and hold bigger capital buffer in recession than in expansion, which explains in part why they weather well the recent financial crisis. All these are evidence that Canadian banks ride the business and regulation cycles, which underscore the appropriateness of both a micro and macro-prudential "through-the-cycle" approach to capital adequacy advocated in current consultative proposals to strengthen the banking sector resilience.

Keywords: Capital Buffer, Risk, Performance, Basle Accords, Regulation, Business Cycles, Canadian Banks

JEL Codes: G21, G28

I. Introduction

The recent 2007 subprime turmoil has underscored the imperative for both a sound micro and macro prudential framework for banking regulation and supervision to build resilience against severe crises and to insure stability of the whole financial system.[1] During this crisis, the Canadian banking system has behaved much better than any other industrialized country banking sector. As a matter of fact, amid collapses, bailouts, or imposed take-overs of high profile banks in Europe, US and other parts of the world (e.g., Fortis, Citigroup, UBS, Royal Bank of Scotland, etc.), no Canadian bank has failed or been openly bailed-out. So what makes Canadian banking sector to withstand the financial crisis? And what lessons can we draw from the resilience of the Canadian banking sector?

In this paper, we examine the cyclical relationship between capital buffer and business cycles in the Canadian banking sector. We first examine the cyclicality of Canadian banks capital buffer (capital buffer is the capital cushion above the regulatory capital requirement fixed by the Bank of Canada), and next analyse the impact of capital buffer on banks' risk and performance through the business cycles and different capital regulatory environments, namely the pre-Basle Accords period, the Basle I and subsequent amendments to the Basle I and Basle II regimes. Specifically, we address the following research questions: (1) Are Canadian banks capital buffer counter to business cycles? (2) Are Canadian banks capital buffer sensitive to changes in capital regulation? (3) How sensitive are Canadian banks' risk to changes in capital buffer? (4) What is the impact of induced changes in capital buffer on Canadian banks' performance?

Several works have pointed to the procyclicality of Basle regulatory environment (e.g., Carpenter et al. (2002), Krainer (2002), Heid (2007), among many others). Procyclicality refers to the positive co-movement between business cycles, bank capital and its lending and non credit activities (e.g., Illing and Paulin (2004), Koopman et al. (2005), Stolz (2007)).[2] Nevertheless, few researches have examined issues related specifically to capital buffer.

[1] Micro pertains to bank level specific management actions, while macro refers to country level monetary and other macroeconomic policy channels.

[2] For instance, in economic downturns, deteriorating portfolio quality will lead to an increase in default risk, through the effect of asset repricing. Hence, to meet regulatory capital requirements, in general, banks have two options. Either they increase their capital level by raising funds on the market, or they reshuffle their portfolio to decrease their portfolio risk. The first option can be unpractical given that their reserve and/or retained earnings are low or inexistent; and scarcity of funds in stressed-capital market renders these expensive. More likely, in the second option, banks will decrease asset with high capital risk charge to decrease the level of their risk-weighted assets, therefore, banks can, among other things, squeeze credit to meet the capital requirement. This squeeze can jeopardize the economic recovery and even amplify the downturns.

While Ayoso et al. (2004), Lindquist (2004), Stolz and Wedow (2009), among others, found a countercyclicality of capital buffer in Spain, Norway, and Germany, respectively, others, such as Jokippi and Milne (2008) and Fonseca and Gonzalez (2009) documented procyclical behaviour of capital buffer. Besides the cyclical behavior of capital buffer studied in the above works, others have investigated the determinants of capital buffer and/or the relationship between capital and risk, capital and performance or risk and performance, e.g., Lindquist (2004), Repullo and Suarez (2004), Nier and Baumann (2006), Marcucci and Quagliariello (2008), Albertazzi and Gambacorta (2009), Fonseca and Gonzalez (2009).

Our work departs from the previous literature on capital buffer in many ways. First, this is the first study on Canadian banking sector to use a comprehensive quarterly database between 1982 and 2009. Second, unlike previous researches, our study period covers at least three regulatory environments. Third, we study simultaneously the relationship between capital buffer, risk and performance. Thus, we develop a system of three simultaneous equations linking capital buffer, risk and performance, within several business cycles and multiple changes in regulation. As far as we know, this is the first paper to address, comprehensively, these issues related to capital buffer in the Canadian context.

To address our research questions, we use quarterly available financial statements data and daily stock return data of the six big Canadian chartered banks from 1982 to 2009. The business cycles have been constructed using the troughs and peaks data from the US National Bureau of Economic Research (NBER), e.g., Amato (2004), Powell et al. (2009).[3] Over the sample period (from 1982 to 2009), we can distinguish three regulatory regimes: (1) the pre-Basle I Accord regulatory regime before 1988, (2) the period from 1988 to 1997 corresponding to the first Basle I regulatory environment, which introduces the risk-weighted assets (RWA) based on credit risk, and (3) the 1998-2009 period with the 1996 amendment to the Basle I Accord, which introduces market risk as a distinct risk category, and the 2000's with the spirit of Basle II Accord.

Note that, before Basle I in 1988, there was no explicit capital requirements, only in 1988 Basle I introduces the risk-weighted assets (RWA) approach with a 8% minimum capital

[3] We use the NBER data for two main reasons. First, no Canadian governmental institution publishes the business cycles as done by the NBER. Only Statistics Canada gives some information on the level of production per period, but not enough information on the behaviour of the business cycles. Second, there is a very strong correlation between the two countries business cycles, because of the high interconnection between their economies. In fact, we find a correlation of 99.43% between the variations of the outputs in the two countries for our period of study.

requirement. In Canada, the minimum regulatory capital to RWA required was 8% since 1988, and changes to 10% in 2000. Besides the minimum regulatory capital to RWA requirement, Basle imposes a maximum balance sheet leverage ratio, measured by the ratio of assets to shareholders' total equity. From 1982 to 1991, a cap leverage ratio of 30 was in effect in Canada for large banks. In 1991, the limit was decreased to 20, and this limit remains until 2000, when it was increased to 23 under certain conditions.[4] This leverage ratio requirement has been shown to contain asymmetric information and agency problems (e.g., Blum (2008)), and has been claimed to have contributed to Canadian banking sector resilience to the recent credit turmoil (e.g., Bordeleau et al. (2009) and Dickson (2009)). Subsequent amendments and ongoing refinements aim to address critics including the procyclicality of Basle Accords.

Based on these two capital requirements, we use two capital ratio measurements. The first capital ratio is computed as the ratio of bank's capital over its RWA. The second capital ratio, called hereafter leverage capital ratio, is the inverse of the balance sheet leverage ratio, and is obtained as the ratio of shareholders' book equity over total assets. The capital buffer or cushion is the excess capital above the minimum regulatory capital ratio.

We find that Canadian banks are well capitalized, and hold more capital buffer in recession than in expansion, which explains in part why they weather well the recent financial crisis.[5] We also document the countercyclical behaviour of Canadian banks capital buffer. Furthermore, exploring the specific role played by the Basle capital regulations in this cyclical relationship, we find that this countercyclicality is more pronounced over the 1998-2009 period after the 1996 amendment to the Basle I Accord and the Basle II period. Thus, the introduction of Basle Accords and the balance sheet leverage limit imposed by the Canadian banking regulator were somewhat effective in rendering Canadian banks' capital countercyclical to business cycles. We therefore provide evidence that Canadian banks ride

[4] Besides the minimum regulatory capital requirement, Basel imposes a maximum balance sheet leverage ratio, measured by the ratio of assets to shareholders' equity. From 1982 to 1991, a cap leverage ratio of 30 was in effect for large banks in Canada. In 1991, the limit was decreased to 20, and this limit remains until 2000, when it was allowed to reach 23 for institutions that demonstrate that, in substance, they (i) meet or exceed their risk-based capital targets (e.g., 7% and 10%) (ii) have total capital of a significant size (e.g., $100 million) and have well-managed operations that focus primarily on a very low risk market segment (iii) have a four-quarter average ratio of adjusted risk-weighted assets to adjusted net on- and off-balance sheet assets that is less than 60% (iv) have adequate capital management processes and procedures (v) have been at "stage 0" for at least four consecutive quarters (vi) have no undue risk concentrations

[5] Among other reasons are the conservative mortgage practices, the banks non reliance on money market wholesale funding, the banks higher liquidity ratios, etc. (e.g., Northcott et al. (2009), Ratnovski and Huang (2009)).

the business and regulation cycles, which underscore the appropriateness of both a micro and macro-prudential “through-the-cycle” capital adequacy requirements outlined in current consultative proposals to strengthen the banking sector resilience (e.g., Goodhart and Persaud (2008), Arjani (2009) and Brunnermeier et al. (2009), BIS (2010)). Effectively in September 2010, in what known as Basle III, banks will have to hold 4.5% "Core Tier-1" capital when compared with their RWA, more than double the current 2% plus an additional 2.5% “Conservation buffer" to cover them in crises. Furthermore, under Basle III, banks may face an additional "contra cyclical" requirement to hold another "buffer" as much as 2.5%, albeit the details have yet to be finalised, during the good times, when there is a build-up of debt in the global economy.

We also find that positive variations in bank’s capital buffer increase its risk exposure, especially the idiosyncratic risk. By and large, Canadian banks are more precautious and conservative in their risk taking, and the positive relationship between capital variation and risk can be seen as a hedge against adverse economic events. This finding supports the view that Basle and leverage constraints imposed by the Canadian regulator, the Office of the Superintendent of Financial Institutions (OSFI), have been able, in some extent, to better align Canadian banks risk taking with their capital base.

Moreover, our simulations show that it is better for banks to build up their capital buffer during economic booms in order to avoid both an increase in risk and a decrease in performance to cope with capital impairment in economic downturns. Therefore, capital buffer can be seen as a hedge against performance deterioration occurring in economic downturns.

Several policy implications can be drawn from our analyses. First, from the Canadian experience, a rigorous and disciplined implementation of both risk-based and non-risk-based capital requirements may contribute to mitigate the well-documented procyclicality associated with the current Basle risk-based capital charges. Second, our study confirms that an increase in capital requirement should occur during normal or booming economic periods since adding additional capital (per unit) in recession time costs more for banks in terms of performance.

The rest of the paper is structured as follows. In section II, we present our empirical framework. In section III, we describe the data and present the descriptive statistics. In section IV, we discuss and interpret the empirical results. We conclude in section V.

II. Empirical framework

On the one hand, previous research such as Shrieves and Dahl (1992), Jacques and Nigro (1997), Rime (2001), use a system of two simultaneous equations to study the relationship between banks risk and capital. On the other hand, Kwan and Eisenbeis (1997) and Altunbas et al. (2007) formulate a system of three simultaneous equations to study endogenously banks capital, risk and efficiency (derived from stochastic cost frontiers). Note that, although our specification follows these works, we depart from these previous authors by focusing on capital buffer instead of capital ratio under business cycles and banking regulations. We use the following system of simultaneous equations:[6]

$$\Delta BUF_{j,t} = f_1(SIZE_{j,t}, GNPG_t, \Delta RISK_{j,t}, \Delta PERF_{j,t}, BUF_{j,t-1}, REG_t, DREG_t, GNPG_t \times DREG_t), \tag{1}$$

$$\Delta RISK_{j,t} = f_2(VTSX_t, TERM_t, CV_{j,t}, GNPG_t, \Delta BUF_{j,t}, \Delta PERF_{j,t}, RISK_{j,t-1}, REG_t, DREG_t, GNPG_t \times DREG_t, \Delta BUF_{j,t} \times DREG_t), \tag{2}$$

$$\Delta PERF_{j,t} = f_3(CR3_t, SIZE_{j,t}, GNPG_t, \Delta BUF_{j,t}, \Delta RISK_{j,t}, PERF_{j,t-1}, REG_t, DREG_t, GNPG_t \times DREG_t, \Delta BUF_{j,t} \times DREG_t), \tag{3}$$

where the dependent variables are respectively: $\Delta BUF_{j,\,t}$ the variation of the capital buffer of bank *j* at time *t*, $\Delta RISK_{j,t}$ the variation of risk of bank *j* at time *t* and $\Delta PERF_{j,t}$ the variation of performance of bank *j* at time *t*. We use the first differences of the dependent variables, as proposed by Arellano and Bond (1991), to eliminate possible serial correlations. Below we define in details the variables used in the equations.

As in Fonseca and Gonzalez (2009), capital buffer, BUF, is measured by the difference between bank capital ratio and the minimum regulatory capital ratio. We use mainly two capital ratio measurements. The first capital ratio, CAP, is computed as the ratio of bank's capital over its risk-weighted assets (RWA). The second capital ratio, called hereafter leverage capital ratio, CAPL, is the inverse of the balance sheet leverage ratio, and is obtained as the ratio of shareholders' book equity over total assets. The capital buffer with the first capital ratio is computed as the difference between CAP and the minimum regulatory capital requirement; it will be denoted by BUFR. The buffer with the second capital ratio measure is

[6] We run a multivariate regression model using a three stage Least-Squares (3SLS) estimation method to account for potential endogeneity between variables. Since our research questions focus on three key bank variables (capital buffer, risk and performance), it is then appropriate to use a system of three simultaneous equations. Furthermore, for the choice of our instruments and to check for possible serial correlation problem, we use the Sargan over-identifying test.

denoted by BUFL and is measured by the difference between CAPL minus the inverse of the balance leverage ratio cap fixed by the Canadian banking regulator.[7] When necessary, we also compute the economic capital ratio, CAPE, using the value at risk (VaR) based on banks assets distribution.[8] Economic capital buffer BUFE is obtained as the difference between the bank's actual capital ratio and its economic capital ratio.

We use as risk measure, total equity risk (TRISK), measured as the standard deviation of daily banks' market equity returns over the past quarter as in Anderson and Fraser (2000) among many others. We also use other different metrics of risk: a market idiosyncratic risk measure (IRISK) and a hybrid risk measure, the implicit volatility of the assets (ARISK). The idiosyncratic risk measure, IRISK, is the standard deviation over the last quarter of daily observations of the error term in a multifactor market model.[9] The risk measure ARISK is the implicit volatility of asset returns (σ_V) obtained using Ronn and Verma (1986) approach.[10]

As performance measure, we use the banks' mean of daily stock market returns (RET) over the last calendar quarter. For robustness check, we use alternative performance metrics: (i) the return on assets (ROA) obtained as the ratio of net income over total assets and (ii) the Tobin's Q (QTOB) computed as market value of equity divided by its book value.

The explanatory variables are:

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[7] As stated previously, the minimum regulatory requirement in Canada for the ratio of capital over RWA was 8% since 1988, and changes to 10% in 2000. From 1982 to 1991, a balance sheet cap leverage ratio of 30 was in effect for large banks. In 1991, the limit was decreased to 20, and this limit remains until 2000, when it was increased to 23.

[8] The VaR is computed using assets distribution at the 99.97% confidence level, which supposes a credit rating of at least AA+ for each bank of the sample. Asset value is derived from the contingent claim analysis as in Ronn and Verma (1986).

[9] The market multifactor model we used follows the one in Chen et al. (2006) and Pathan (2009), in which we add an additional factor for exchange rate risk as follows : $R_{j,t}= \beta_{0,t} + \beta_{m,j} R_{m,t}+ \beta_{I,j} U_{I,t}+ \beta_{x,j}U_{x,t} + \varepsilon_{j,t}$, where $R_{j,t}$ is the equity return of bank *j* at time *t*, $R_{m,t}$ is the market premium, $U_{I,t}$ represents the interest rate risk premium computed as the difference between long term Canadian government bond yield and T-bill yield, $U_{x,t}$ is the exchange rate premium computed as the difference between the exchange rate of the Canadian dollar per US dollar (first used currency after the Canadian dollar) and unity, and $\varepsilon_{j,t}$ is the error term.

[10] Total asset value (V) and its implicit volatility (σ_V) are obtained by solving a system of equations based on shareholders' equity defined as a call option: $K = V\,N(x) - \rho\, B\, N(x-\sigma_V\sqrt{T})$, with $x = [\mathrm{Ln}\,(V / \rho\, B) + (\sigma_V^2 T/2)]/ \sigma_V \sqrt{T}$ and $\sigma_K = \sigma_V\, V\, N(x)/K$, where V is the implicit total asset value (the first unknown), K is the market value of equity, B is the book value of bank total debt, σ_K is the standard deviation of bank's equity returns, σ_V is the unobserved bank asset return volatility (the second unknown), ρ is a regulatory parameter, *T* is the maturity of the debt, we use 1 year by assumption, N(.) is the standard cumulative normal distribution function and Ln is the logarithmic operator. The parameter ρ equals 0.97 as in Ronn and Verma (1986) and Giammarino et al. (1989) for American and Canadian banks respectively. This constant has also been tested by Gueyie and Lai (2003) for a sample of Canadian banks.

- $SIZE_{j,t}$ represents the log of total assets of bank *j* at time *t* and is used to control for the size effect (e.g., Jacques and Nigro (1997), Rime (2001) among others). We expect this variable to have a negative impact on the variation of capital buffer and performance;
- $GNPG_t$ is the growth rate of the gross national product in real terms[11] at time *t*. We use the GNP instead of the GDP (gross domestic product) because the GNP includes the GDP and other net labor and foreign capital incomes, used to account for international banking activities. It is used to capture economic trend or business cycles (e.g., Ayuso (2004), Lindquist (2004));
- $CR3_t$ is the income concentration ratio at time *t* computed as the ratio of total net income of the three largest banks divided by total net income of the sector. This variable is used to proxy for the level of concentration and competition in the banking industry (e.g., Bikker and Haaf (2002), Beck et al. (2006), Alegria and Schaeck (2008)). This variable is expected to have a positive impact on performance;
- REG_t is the variable controlling for the regulatory regime. It measures the number of quarters between time *t* and the date of introduction of the most recent regulation or amendment.[12] For example, say we are at t=1993, REG_t=1993-1988+1=6 since the last regulation in effect is Basle I introduced in 1988. Instead if t=2000, then REG_t=2000-1998+1=3 since the last regulation in effect since 1998 is the 1996 amendment of Basle I;
- $DREG_t$ are dummy variables to control for the Basle I effect and the 1996 amendment and Basle II effects, respectively. DREG indexed by 1, DREG1, takes value of 1 over the period 1988 to 1997, and zero elsewhere. DREG indexed by 2, DREG2, has value of 1 from 1998 to 2009 and zero elsewhere;
- $GNPG_t \times DREG_t$ is the cross product of $GNPG_t$ and the regulatory regime dummy $DREG_t$ and captures the interaction between business cycles and regulatory regimes;
- $\Delta BUF_{j,t} \times DREG_t$ is the cross product of $\Delta BUF_{j,t}$ and the regulatory regime dummy $DREG_t$ and captures the interaction between variations in capital buffer and regulatory regimes;
- $CV_{j,t}$ is the charter value, used to control for banks incentives for self risk taking, e.g., Jokipii (2009), Keeley (1990). It is calculated as follows:

[11] The reference year is 2002.

[12] We observe four regulatory regimes over our sample period. The clock starts after each new regulation, i.e. four times: (i) the first quarter of 1983 when qualitative regulatory capital management laws were introduced; (ii) at the beginning of 1987 with the introduction of Basle I; (iii) in 1997 when the Basle amendment to introduce market risk as a risk category were made and finally in 2004 with the introduction of Basle II.

CV = Ln((BVA + MVE – BVE) / BVE), where BVA is the book value of assets, MVE is the market value of equity and BVE is the book value of equity. The higher the charter value, less likely is the incentive for risk taking;

- $VTSX_t$ the volatility of the market index proxy for Canadian market risk. It has been calculated as the standard deviation of daily returns of the S&P/TSX Composite index[13] over the last quarter. The index includes, among other firms, the six Canadian chartered banks of our sample. We expect a positive relationship between this market risk and our banks' risk measure;
- Finally, $TERM_t$ the difference between the yield on Canadian government long term bonds and the T-bill yield, captures shocks on the term structure of interest rates.

III. Data and descriptive statistics

As of December 31st 2009, the Canadian banking sector comprises 22 Canadian banks, 26 subsidiaries of foreign banks and 22 branches of foreign banks offering a range of full financial services. The whole Canadian banking sector had approximately C$2900 billion of asset under management as of end 2009. Our sample is composed of the six big Canadian chartered banks. As of last quarter of 2009, the six banks of the sample are ranked in terms of assets size as follows: the Royal Bank of Canada (RY), the Toronto-Dominion Bank (TD), the Bank of Nova Scotia (BNS), the Bank of Montreal (BMO), the Canadian Imperial Bank of Commerce (CM) and the National Bank of Canada (NA). They represent approximately 90% of the total asset of the Canadian banking sector in general and 75% of the assets of the deposit institutions sector in particular.

All banks specific variables have been calculated using data extracted from Bloomberg and supplemented by data collected manually from the annual reports. For Canadian economic variables, we obtain the data from various sources and publications from Statistics Canada and the Bank of Canada.[14] The sample is composed of quarterly observations from 1982 to 2009. Table 1 presents the definition and descriptive statistics (number of observations, means and standard deviations) for the variables. The number of observations used is relatively substantial in Canadian banking study.[15] For a better reliability of the

[13] This index was the TSE 300 index before 2002.

[14] For the capital-to-RWA ratio before 1988, we use the ratio of capital to assets as in Flannery and Rangan (2008).

[15] We use more than 600 quarterly book observations. Shaffer (1993), who tested the competition among Canadian banks, uses only annual data between 1965 and 1989, i.e., only 24 observations. Nathan and Neave (1989) use 39 observations, D'Souza and Lai (2004) use 125 quarterly observations, Gueyie and Lai (2003) use 115 annual observations, and in the best case, we have Allen and Liu (2007) with 480 quarterly observations.

estimations, we perform a synchronisation between market and accounting data as in Claessens et al. (1998) and Easton and Gregory (2003) for instance.[16]

INSERT TABLE 1 HERE.

We observe an average capital buffer BUFL of 0.44%, BUFR of 0.84% and BUFE of 1.43% for the six banks. The average quarterly stock return (RET) is 3.63% with standard deviation of 13.88%. The quarterly average ROA is 0.20% and average Tobin's Q (QTOB) is 1.4175. Per quarter total equity risk (TRISK) is 11.88%, idiosyncratic risk (IRISK) is 4.76% and implied asset volatility (ARISK) is 0.70%.

Table 2 presents the correlation matrix between the variables. BUFL is positively correlated with BUFE (11.7%) and negatively correlated with BUFR (-7%). The correlations between the risk measures are positive: 24.9% between IRISK and TRISK, 39.9% between ARISK and TRISK and 10% between ARISK and IRISK. Equity return (RET) has a positive correlation of 56.8% with BUFE, 7.3% with BUFL and a negative correlation of -3.4% with BUFR. RET is negatively correlated with TRISK (-13.9%), and ARISK (-57.3%), but has a very low positive correlation with IRISK (0.3%). BUFL and BUFE are negatively correlated with all three measures of risk, while BUFR is negatively correlated with TRISK and has a low positive correlation with IRISK and ARISK.

INSERT TABLE 2 HERE.

As discussed briefly in the introduction, the business cycle phases are constructed based on the information obtained from the US National Bureau of Economic Research (NBER).[17] The reasons behind the use of data from NBER are the followings. First, no Canadian governmental institution publishes the business cycles as done by the NBER. Only Statistics Canada gives some information on the level of production per period, but not enough information on the behaviour of the business cycles. The second reason is the strong correlation between the United States and Canada business cycles (99.43%) since the two

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[16] Indeed, accounting data are generally slightly delayed relative to market data, but this lag is usually short. Therefore, since we are using available quarterly data, we take as lag one quarter.

[17] Over our study period (1982-2009), there seems to be at least three economic cycles. The first cycle goes from the beginning of our sample period (1982) and reaches its peak in 1993 following the European monetary crisis and the beginning of the Mexican crisis (significant devaluation of the pesos). The second cycle then begins and continues in 1997 with the Asian crisis, and the downturn aggravates with the Russian and Argentinian crises in 1998 to reach its trough in Canada and the USA around year 2000 with the Internet bubble burst. The third and last crisis in our sample covers the year 2007 with the subprime mortgage crisis in the USA, which later becomes a global financial crisis, and reaches its trough around the end of 2008.

economies are highly interrelated. We also check if there is an adjustment delay of more than one quarter, but instead find that this lag is much smaller.

IV. Results

As we mentioned in the introduction, we address the following four research questions: (1) Are Canadian banks capital buffer counter to business cycles? (2) Are Canadian banks capital buffer sensitive to changes in capital regulation? (3) How sensitive are Canadian banks' risk to changes in capital buffer? (4) What is the impact of induced changes in capital buffer on Canadian banks' performance? Note that, to answer questions 3 and 4, we account for business cycles and regulatory changes (or cycles).

4.1. Are Canadian banks capital buffer counter to business cycles?

Using the business cycles information, we create three data panels associated to business cycles: (i) Unconditional phase of business cycles, in which we consider the full business cycles without making a distinction between troughs and peaks; (ii) Economic expansion phase considers only peak periods; and (iii) Economic recession phase considers only trough periods. For each panel, we calculate the capital ratios CAP, CAPL and CAPE of Canadian banks. From these capital ratios, we calculate the associated capital buffers BUFR, BUFL and BUFE as follows. BUFR is the difference between the bank's capital ratio, measured by capital divided by RWA, and the minimum regulatory capital requirement (either 8% or 10%). BUFL is equal to shareholders' book equity over total assets (CAPL) minus the inverse maximum balance sheet leverage ratio cap imposed by the Canadian regulators (either 1/30, 1/20 or 1/23). BUFE is obtained as the difference between the bank's actual capital ratio, CAP, and its economic capital ratio, CAPE.

The descriptive statistics for each economic phase, given in Table 3, show that, on average, Canadian banks hold capital buffer BUFL of 0.44% and BUFR of 0.83%. Moreover, BUFL in recession (0.64%) is higher than in expansion (0.41%). The same hold for BUFR, with 0.76% in expansion and 2.32% in recession. We also observe that, irrespective of the economic phase, CAP is on average above CAPE, which seems to suggest that Canadian banks hold more capital than what is "economically" required, since economic capital can be viewed as the level of capital banks have to hold to remain technically viable (Kretzschmar et al., 2010) in fully disciplined market with no government safety net. By and large, these first results buttress the soundness of the Canadian banking sector.

INSERT TABLE 3 HERE.

The graphs in Figure 1 plot capital buffers and business cycles over the sample period. The graphs seem to suggest a countercyclical relationship between capital buffer (BUFR and BUFL) and business cycles over the sample period.

INSERT FIGURE 1 HERE.

As further analysis, we conduct a multivariate analysis using the simultaneous equations (1-3). The results are presented in Table 4. From Panels A, B and C of Table 4, we obtain a negative relationship between variations in capital buffers ($\Delta BUFR_t$, $\Delta BUFL_t$, $\Delta BUFE_t$) and real GNP growth ($GNPG_t$) over the sample period. Results from Table 5 with metrics of risk (IRISK and ARISK) and Table 7 performance measures (ROA and QTOB) depict again countercyclicality of capital buffer and business cycles. As in Ayoso (2004), we compute the elasticity of capital buffer BUFL with respect to business cycles using the following equation: $\text{Ln}(BUFL) = \beta_0 + \beta_1 \text{Ln}(GNPG) + \varepsilon$, where the slope of the regression, β_1, represents the elasticity coefficient. We find a negative elasticity of -2.10%. This confirms the countercyclicality between capital buffer and business cycles; however this relationship may be affected by the capital regulation.

INSERT TABLE 4 HERE.

Many critics point up the Basle capital regulations as being by design procyclical to business cycles. Thus, in the next section we examine whether the cyclical relationship found above are sensitive to changes in the regulatory enviroment. We therefore address our second research question below.

4.2. Are Canadian banks capital buffer sensitive to changes in capital regulation?

Figure 2 shows the business cycles and the regulatory regimes over the study period. Recall, there are three regulatory regimes in our sample period: (1) the period before Basle I Accord, i.e. from 1982 to 1987, (2) the period from 1988 to 1997 corresponding to the initial Basle I Accord, and (3) the period of 1998-2009 after the 1996 amendment to the Basle Accord and the spirit of Basle II period.

INSERT FIGURE 2 HERE.

Figure 3 plots the average ratio of banks' capital over RWA and the balance sheet leverage ratio measured by total assets divided by shareholders' book equity over time in the Canadian banking sector. As shown in Panel A of Figure 3, overall, on average, banks' capital to RWA has increased over the study period.[18] However, we observe that this capital ratio has reached its lowest levels from 1988 to 1996, when Basle I Accord was in effect. In the late 90s, however, Canadian banks' capital to RWA starts to increase and becomes stable (more or less) after 2002. Even, when they were under-capitalized over the period of the late 80s to the early 90s, Canadian banks adjust quickly toward their targets and hold sufficient buffer, which makes them well capitalized after 1997.

The explanations for these observed trends are the followings. First, before 1988, there was no risk-adjusted capital ratio requirement, since Basle I Accord was introduced in 1988. Therefore, after the introduction of Basle I regulation, since banks had to account for their credit risk in the denominator of their capital ratio, the ratio becomes lower. However, with the 1996 amendment, the Canadian regulator, not only maintains the minimum regulatory capital requirement, but also reduces the leverage ratio limit. Indeed, as mentioned before, Canadian banking supervisory authority has fixed a cap on the balance sheet leverage ratio of 30 from 1982 to 1991. Late in 1991, the limit was decreased to 20, and the ceiling remained until 2000 when it was increased to 23 under certain conditions. Also, after 2000, the minimum regulatory ratio of capital-to-RWA was increased from 8% to 10% in Canada. All these regulatory changes have contributed to increase the capital level in the Canadian banking sector after 1998, since one would have expected the capital ratio to decrease or remain more or less the same as before after the introduction of market risk as a new risk category.[19]

INSERT FIGURE 3 HERE.

[18] After a secular decrease of banks' capital as shown in Saunders and Wilson (1999) from 1893 to 1982.

[19] Indeed, as an illustrative example, suppose that with Basle I, an hypothetic bank has risk-weighted assets (RWA) of 100 and book capital level of 10, this corresponds to a capital ratio of 10%. Now suppose that after 1998 following the major amendment of Basle I to account for market risk in its asset risk calculation, the bank's RWA becomes 120. Thus, keeping all else constant, i.e. asset unchanged and capital remains at 10, mechanically, the new capital ratio becomes 8.33%. This nominal decrease in the bank's capital ratio is simply due to the change in RWA calculation. Thus, if the bank does not increase its capital level, the capital buffer would be less than before. To obtain a capital ratio higher than the previous capital ratio, the marginal increase in capital should be more than that on the RWA, which has been the case in the Canadian banking sector. As pointed out by Bordeleau et al. (2009) and Dickson (2009), the balance sheet leverage ratio requirement seems to have contributed to Canadian banking sector resilience to the recent financial crisis turmoil. On the economic capital cushion side, we also observe a U shape relationship over time. The wedge between regulatory and economic capitals is very wide before 1996, and after that period, we observe a drastic reduction in the gap and regulatory capital becomes better align with economic capital, which was the intended objective of the capital regulation.

To address the sensitivity of Canadian banks capital buffer to regulatory changes, we introduce in the regression equations regulatory variables (REG, DREG1 and DREG2). Recall, time elapsed since the regulatory regime is in effect is captured with the variable REG_t which counts the number of periods between current time *t* and the last time the capital regulation was introduced. Changes in regulatory regimes are controlled with dummy variables DREG1 and DREG2, respectively, for Basle I (in Model 1) and 1996 amendment of Basle I Accord and Basle II (in Model 2). Model 3 includes both regulatory regimes dummies. The regression results are presented in Table 4.

We control for the combined effects of business cycles and the regulatory environments by using the cross product of GNPG and DREG1 (in Model 1 to control for Basle I regulation) and DREG2 (in Model 2 to control for the 1996 amendment of Basle I and Basle II regulations). When we control for the effect of the Basle regulations, the relationship between BUFR and GNPG becomes positive over the initial Basle I Accord period, but remains negative after the amendment was introduced (Panel A of Table 4). Using the leverage capital buffer measure, BUFL, the negative impact of $GNPG_t$ on capital buffer remains irrespective of the regulation in place (Panel B of Table 4). In sum, the introduction of Basle Accords and the balance sheet leverage cap imposed by the Canadian banking regulator were somewhat effective in rendering Canadian banks' capital countercyclical to business cycles.

The regulatory dummy DREG1 has a negative significant impact on the variation of BUFL, while the dummy DREG2 has a positive impact on it. Indeed, after 1991, the balance sheet leverage ratio limit has been decreased from 30 to 20, and later to 23 after 2000, also, after 2000, the ratio of capital to RWA has been increased from 8% to 10%, all these probably contribute to boost up the capital base of Canadian banks.

However, the regulatory variable REG has a significant negative effect on capital buffers BUFR and BUFL. It then looks like Canadian banks are curving down their capital and risk (although the coefficient of REG in the risk equation is negative but not significant) following a change in regulation. This is consistent with the second pillar of Basle II on maintaining a permanent supervisory review process.

Additional analyses using the economic capital buffer, BUFE, presented in Panel C of Table 4 show a positive relationship between business cycles and economic capital buffer over the two Basle regulatory environments, and the positive coefficient is higher under the initial Basle I regulatory environment than after the amendment and Basle II periods. This finding supports the view that Basle and leverage constraints imposed by the Canadian regulator, the Office of the Superintendent of Financial Institutions (OSFI), have been able to better align, in some extent, Canadian banks risk taking with their capital position.

Having studied the behaviour of Canadian banks capital buffer through the business and regulatory cycles, we now turn our attention to the impact of the changes in capital buffer on Canadian banks' risk and performance.

4.3. How sensitive are Canadian banks' risk to changes in capital buffer?

Figure 4 shows the pattern of Canadian banks equity risk TRISK, the Canadian stock market risk VTSX and business cycles. We observe a comovement between VTSX and business cycles, while the relationship between TRISK and business cycles seems ambiguous.

INSERT FIGURE 4 HERE.

To address the question of banks' risk sensitivity to changes in their capital, we use our system of simultaneous equations. We use three risk measures: TRISK, bank equity risk, IRISK, bank idiosyncratic risk and ARISK, implicit bank asset risk. The results are presented in Table 4 for TRISK, Table 5-A for IRISK and Table 5-B for ARISK. For ease of exposition, we focus on BUFL to discuss our results. The unreported results with BUFR are more or less the same.

INSERT TABLE 5 HERE.

We find that positive variations of banks' capital buffer increase the risk exposure TRISK and IRISK. Indeed, positive variations in capital buffer BUFL yields positive significant variations in banks' idiosyncratic risk IRISK (see Table 5-A). Also, positive variations in economic capital buffer BUFE impact positively and significantly TRISK (see Table 4-C). By and large, Canadian banks are precautious and conservative in their risk taking and capital regulation is somewhat effective in linking higher with bigger capital buffer.

From our results, there seem to exhibit a countercyclical relationship between all three measures of risk and the business cycles over the period 1988-2009, especially after the 1996 amendment to the Basle I Accord. Therefore, the positive relationship between capital variations and risk can be seen as a hedge against adverse economic events.

Regarding the impact of regulation changes on the risk, the sign of the Basle I regulation dummy, DREG1, is positive. But DREG2, the dummy variable capturing the 1996 amendment to Basle I and Basle II regulation, is negative. Thus, subsequent amendments to Basle I and Basle II regulations have contributed in some extent to reduce risk in the Canadian banking sector.

Furthermore, we calculate the elasticity between capital buffer and risk in each economic phase using the following regression equation: Ln (RISK) = $\beta_0 + \beta_1$Ln (BUFL) + ε, where β_1 is the elasticity coefficient. We use alternatively our three risk measures: TRISK, IRISK and ARISK. The results presented in Table 6 show negative sensitivity coefficients for market risk measures TRISK and IRISK with respect to capital buffer in each economic phase. However, when we use TRISK, we find an increase in the elasticity from expansion to recession. With ARISK and IRISK, the elasticity decreases from expansion to recession. Thus, based on implied asset volatility and idiosyncratic risk, it seems that Canadian banks would pay more attention to risk sensitivity to variations in capital buffer in recessions than in expansions.

INSERT TABLE 6 HERE.

Since variations in both capital buffer and risk impact banks' risk adjusted return on capital and hence their performance, in the next section, we analyse the impact of changes in capital buffer on banks' performance.

4.4. What is the impact of induced changes in capital buffer on Canadian banks' performance?

Figure 5 shows graphically the pattern of Canadian banks' performance, measured by equity returns, and business cycles. Banks' equity returns appear to be procyclical to business cycles before 1996, and afterwards, the relationship seems to be countercyclical. These behaviours can be explained by a combination of several factors. First, following the 1987 Banking Act, allowing banks to hold ownership in investment dealers, non interest income increases in the income structure of Canadian banks, this may explain in part the procyclical behaviour between 1988 and 1996. Second, the development of market derivatives and credit securitization in the late 90s enables banks to hedge the market risk component of their portfolio. Third, with the development of securitization, the introduction of market risk as a distinct risk category in 1998 pushes banks to reshuffle their assets portfolio towards assets with low market risk charges. These last two arguments may explain the countercyclicality of banks performance observed after 1996.

INSERT FIGURE 5 HERE.

To address the question related to the impact of capital buffer variations on banks' performance, we resort to our system of simultaneous equations once again. The results are presented in Table 4 when equity return (RET) is used as performance measure, and in Tables 7-A and 7-B when ROA and Tobin's Q (QTOB) are used respectively as performance measures. Here also, for ease of exposition, we focus on BUFL for the discussion of our results. The unreported results with BUFR are more or less the same. As the results show, overall, the coefficient of GNPG is negative, especially after the 1996 amendment to the Basle I Accord. Hence, equity returns as well as the other performance measures are countercyclical to business cycles after the 1996 amendment to the Basle I Accord.

INSERT TABLE 7 HERE.

In addition, positive variations in capital buffer impact positively banks' equity return and ROA variations. Therefore, the market tends to value positively variations in capital buffer. Using ROA as a proxy for bank efficiency, we also observe that variation in bank risk has a positive significant impact on ROA variation, consistent with Saunders et al. (1990) and Altunbas et al. (2007) who found positive relation between banks' efficiency and their risk.

The regulatory environment dummy DREG1 has a positive impact on banks' performance and DREG2 has a negative impact on it. This may be explained by the fact that before the introduction of Basle I, Canadian banks were well capitalized and then could easily meet the capital requirement of Basle I. With the Basle I amendment and subsequent refinement and the leverage ratio constraint imposed by the Canadian regulatory authority, the cost of capital of Canadian banks increases since they had to comply with these regulations.

As further analysis, we compute the elasticity between capital buffer and performance in each economic cycle phase using the following equation: $\mathrm{Ln}(PERF) = \beta_0 + \beta_1 \mathrm{Ln}(BUFL) + \varepsilon$, where PERF is either RET, ROA or QTOB and β_1 is the elasticity coefficient. The sensitivity results are presented in Table 8. The performance measures are more sensitive to capital buffer variation during recessions than expansions. Indeed, one unit variation in BUFL will cost more to the bank during economic contraction. For instance, following a one unit instantaneous positive variation in BUFL, a bank will gain roughly 0.055 in ROA in expansions or loose 0.166 in contraction phases. Therefore, to possibly alleviate the deterioration of performance in economic downturns, banks may find helpful to build up their capital buffer prospectively in expansions to avoid the deteriorating performance in bad economic times.

INSERT TABLE 8 HERE.

Next, we perform a simulation exercise by computing the implied performance induced by changes in the balance sheet leverage ratio using the sensitivity coefficient obtained in Table 8 above. For that purpose, since the actual leverage ratio limit is set at 23, we vary it from 23 to 16, which yields leverage capital buffer BUFL from 0% to 1.90%. The simulation results conditional on economic phases are presented in Table 9. For example, when capital buffer increases from 0% to 0.41% (i.e. leverage ratio decreases from its current 23 level to 21), it implies a 0.05% increase in ROA in expansion and 0.22% decrease in ROA in recession. Regarding the performance metric, RET, the same patterns are observed with different orders of magnitude.

INSERT TABLE 9 HERE.

V. Conclusion

In this paper, we examine the cyclical behaviour of Canadian banks capital buffer (defined as the difference between the current capital level and the minimum capital requirements) and analyse its impact on banks' risk and performance through the business cycles and the different Basle regulatory regimes. Our work departs from previous literature on capital buffer in many respects. First, this is the first study on Canadian banking sector to use a comprehensive dataset over a relatively long period (1982- 2009). This sample period enables us to account for at least three business cycles and three major regulatory regimes: (1) the regulatory regime before 1988, (2) the period from 1988 to 1997 corresponding to the initial Basle I regulatory environment, and (3) the period of 1998-2009 of the 1996 amendment to the Basle I Accord (which introduces market risk as a distinct risk category) and the period with the spirit of Basle II. Second, in the aftermath of the subprime credit crisis, given the resilience of the Canadian banking sector, studying the cyclical behavior of capital buffer with business cycles and regulatory changes is of paramount importance. Third, given that it has been shown previously that capital buffer, risk and performance are endogenously determined and impact each other; we study simultaneously the relationship between these key bank variables. To our knowledge, this is the first paper to address comprehensively these issues related to capital buffer, business cycles, risk, performance and regulatory changes in the Canadian context.

We have addressed the following research questions: (1) Are Canadian banks capital buffer counter to business cycles? (2) Are Canadian banks capital buffer sensitive to changes in capital regulation? (3) How sensitive are Canadian banks' risk to changes in capital buffer? (4) What is the impact of induced changes in capital buffer on Canadian banks' performance?

We find that Canadian banks are well capitalized, and hold more capital buffer in recessions than in expansions, which explains in part why they weather well the recent financial crisis. We also document the countercyclical relationship between Canadian banks capital buffer and the business cycles. Furthermore, exploring the specific role played by the Basle capital regulations in this cyclical behaviour, we find that this countercyclicality is more pronounced over the period 1998-2009 after the 1996 amendment to the Basle I Accord and the Basle II period. Thus, the introduction of Basle Accords and the balance sheet leverage cap imposed by the Canadian banking regulator were somewhat effective in rendering Canadian banks' capital countercyclical to business cycles. These evidences explain why and how Canadian banks ride the business and regulation cycles, which underscore the appropriateness of both a micro and macro-prudential "through-the-cycle" capital adequacy framework advocated in various current consultative proposals to strengthen the banking sector resilience.

We also find that positive variations of bank's capital buffer increase its risk exposure, especially the idiosyncratic risk. By and large, Canadian banks are precautious and conservative in their risk taking and the positive relationship between capital variations and risk can be seen as a hedge against adverse economic events. This finding supports the view that Basle and leverage constraints imposed by the Canadian regulator, the Office of the Superintendent of Financial Institutions (OSFI), have been able to better align in some extent Canadian banks risk taking with their capital.

Moreover, our simulations show that it is better for banks to build up their capital buffer during economic booms in order to avoid both an increase in risk and a decrease in performance to cope with capital impairment in economic downturns. Therefore, capital buffer can be seen as a hedge against performance deterioration occurring in economic downturns.

Two main policy implications can be drawn from our analyses. First, from the Canadian experience, rigorous and strict implementation of both risk-based and non-risk-based capital requirements may contribute to mitigate the well-documented procyclicality associated with the current Basle risk-based capital charges. Second, our study confirms that an increase in capital requirements should occur during normal or booming economic periods since adding additional units of capital in recession times cost more for banks in terms of performance.

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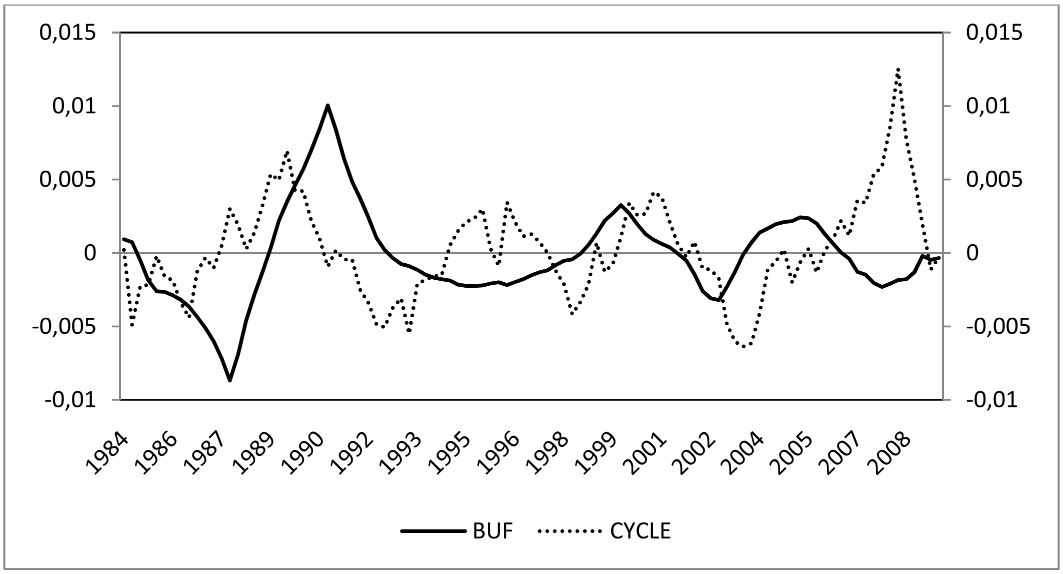
Figure 1: Banks' capital buffer and business cycles in Canada

The right hand side axis gives values of business cycles measured by the real GNP growth ratio. The left hand side axis represents values of capital buffer. To compute the two variables values (GNP growth and capital buffer), we use a Hodrick Prescott (HP) filter to adjust for the seasonal components, and then calculate the moving average over 12 quarters.

A- BUFR and business cycles



B- BUFL and business cycles

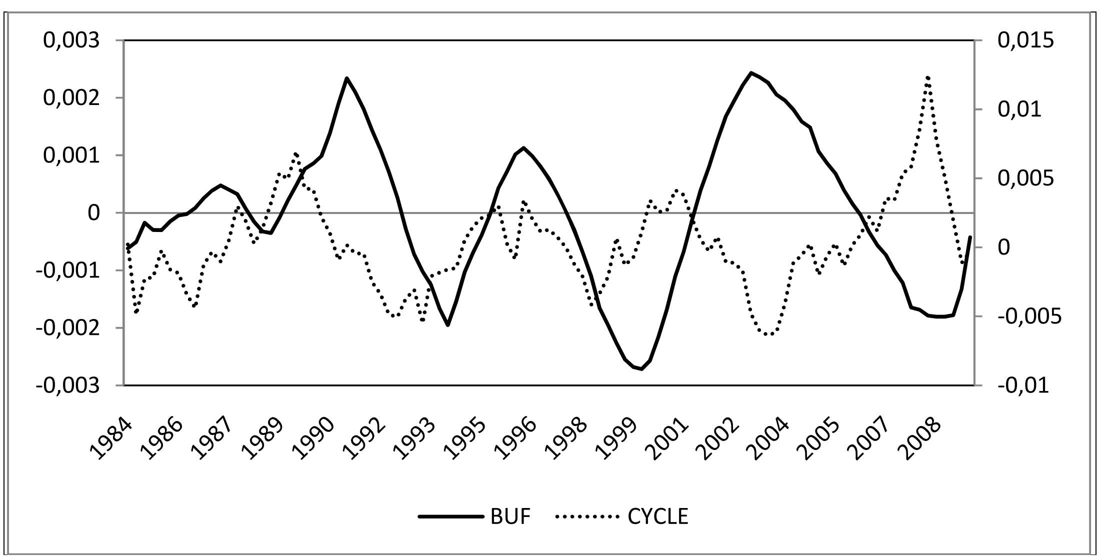


Figure 2: Business cycles and capital regulations

The gray areas designate major changes in capital regulation in the Canadian banking sector: (1) the introduction of Basle I in 1988, (2) the 1996 amendment of Basle I to take effect in 1998, and (3) the spirit of Basle II period starting in 2004. To compute the variable values, we use a Hodrick Prescott (HP) filter to adjust for the seasonal components, and then calculate the moving average over 12 quarters.

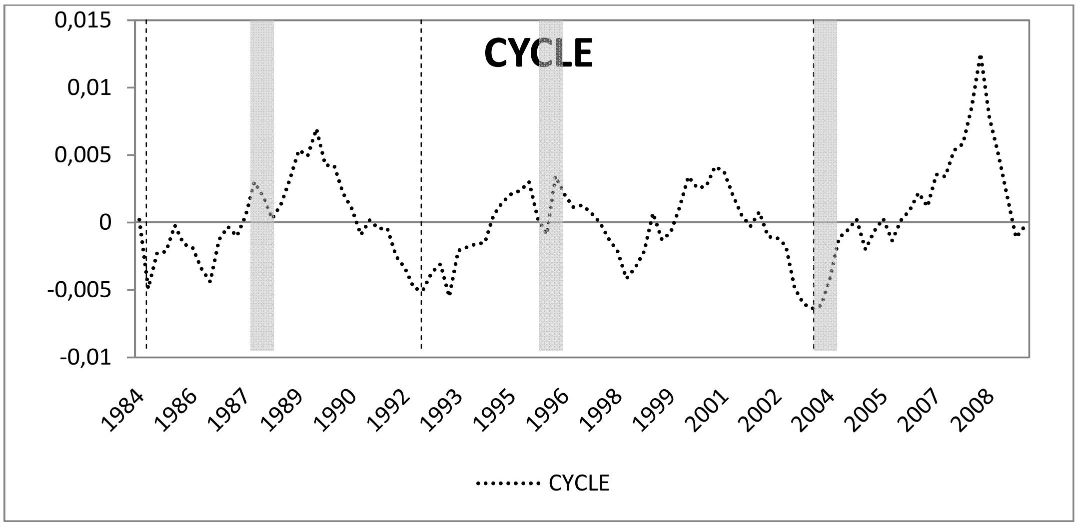
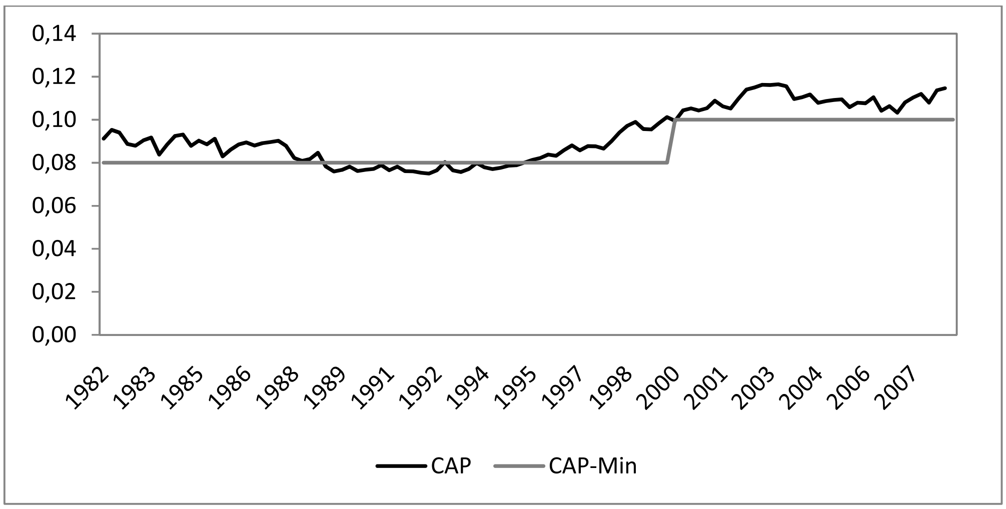


Figure 3: Trend of banks' capital and leverage ratio between 1982 and 2009

Before the introduction of Basle I in 1988, the bank's capital ratio was computed as the ratio of bank's capital to total assets, and after 1988, it is computed as capital over RWA and has been extracted from the official publications of the Canadian banks. Before 1988, we consider a minimum capital ratio of 8% as fixed by Basle I in 1987. In 2000 the minimum capital ratio was increased to 10% in Canada. The graphs show the average ratios for the six big chartered banks. In the second graph (Panel B), the right hand scale is for the capital ratio (CAP) measure and the left hand scale for the balance sheet leverage ratio measure. For the maximum leverage ratio, Canadian banking supervisory authority has fixed a cap balance sheet leverage ratio of 30 from 1982 to 1991. Late in 1991, the limit was decreased to 20, and the ceiling remained until 2000 when it was increased to 23 under certain conditions.

A- Capital/RWA



B- Capital/RWA and Asset/Equity

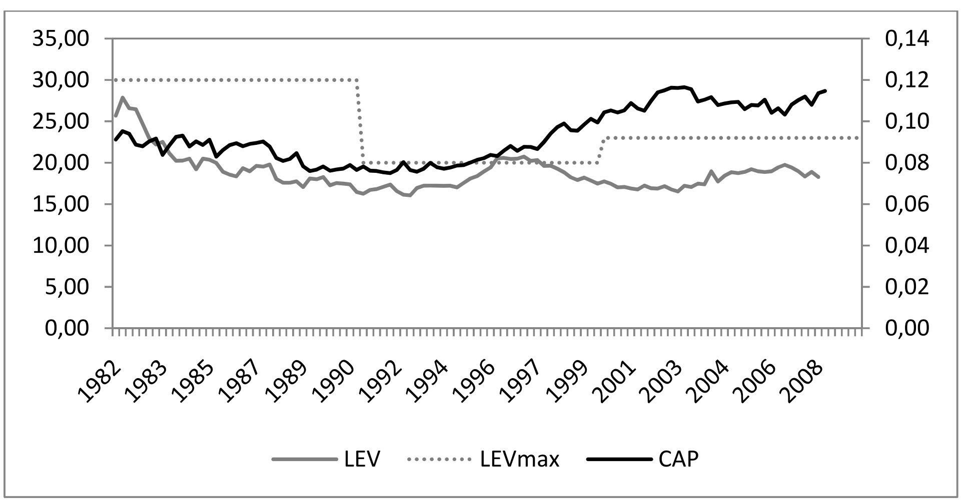


Figure 4: Canadian banks risk, market risk and business cycles

The left hand side axis gives values of the business cycles measured by the real GNP growth rate. The right hand side axis represents the levels of average banks' equity risk (TRISK) and Canadian market equity risk (VTSX). To compute the three variables values, we use a Hodrick Prescott (HP) filter to adjust for the seasonal components, and then calculate the moving average over 12 quarters.

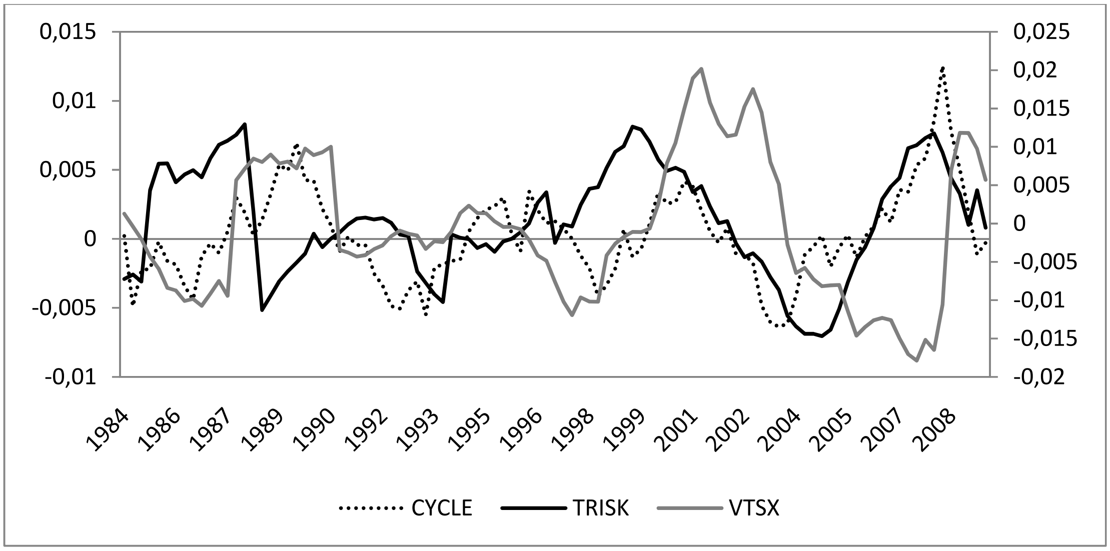


Figure 5: Banks' performance and business cycles

The left hand side axis gives values of the business cycles measured by the real GNP growth rate. The right hand side axis represents the levels of average banks' equity return (RET). To compute the two variables values, we use a Hodrick Prescott (HP) filter to adjust for the seasonal components, and then calculate the moving average over 6 quarters.

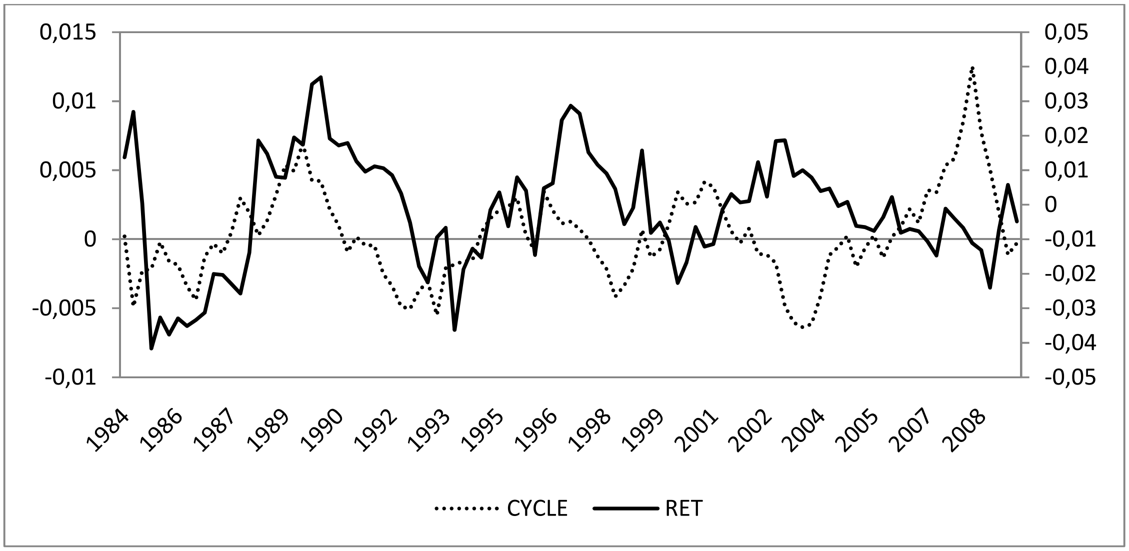


Table 1: Descriptive statistics of the variables (quarterly data from 1982 (Q1) to 2009 (Q2))

VARIABLES	DEFINITIONS	OBS	MEAN	STD. DEV.
CAP	Book capital ratio = GAAP book capital / Risk-weighted assets	637	0.0952	0.0336
CAPL	Inverse balance sheet leverage ratio = Shareholders' equity/ Total assets	641	0.0468	0.0077
CAPE	Economic capital ratio = VaR economic capital / Risk-weighted assets	647	0.0891	0.1637
BUFR	Regulatory capital buffer = CAP – Minimum regulatory capital	637	0.0084	0.0278
BUFL	Capital buffer based on banks' balance sheet leverage ratio = CAPL – (1/Leverage cap)	640	0.0044	0.0088
BUFE	Economic capital buffer = CAP - CAPE	617	0.0143	0.1685
ROA	Return on assets = Net income / Total assets	642	0.0020	0.0021
RET	One quarter equity return based on daily observations	635	0.0363	0.1388
QTOB	Tobin's Q = Equity market value / Equity book value	632	1.4175	0.5336
TRISK	Total risk = Standard deviation of daily equity returns over the last quarter	663	0.1188	0.0901
IRISK	Idiosyncratic risk = Standard deviation of errors in a multifactor model	628	0.0476	0.2482
ARISK	Implicit volatility of asset computed using Ronn and Verma (1986) approach	619	0.0070	0.0207
VTSX	Volatility of S&P/TSX index based on daily observations of one quarter	666	0.0674	0.0417
CR3	Concentration ratio = Total net income of 3 biggest banks/ Total net income of all banks	642	0.4460	0.6949
TERM	Interest rate term premium = Long term government bond yield minus TBill yield	660	0.0117	0.0179
GNPG	Quarterly growth rate of Gross National Product (GNP) in real terms	636	0.0200	0.0487
CV	Logarithm of charter value	643	3.0829	0.1638
DREG1	Dummy variable equals 1 over the period 1988-1997 and 0 elsewhere	672	0.3571	0.4795
DREG2	Dummy variable equals 1 over the period 1998-2009 and 0 elsewhere	673	0.4279	0.4951
REG	Cumulated quarters from the last amendment or capital regulation	673	13.9614	8.8573

Table 2: Pairwise correlations between banks' specific variables (607 observations)

The sign (*) indicates significativity level at 5%. Correlations are expressed in percentage, values equal to or higher than 33% are in bold.

	BUFL	BUFE	BUFR	RET	QTOB	ROA	TRISK	IRISK	ARISK	CV	SIZE	CAPL	TERM	VTSX	GNPG	CR3
BUFL	100															
BUFE	11.7*	100														
BUFR	-7.0*	-0.5	100													
RET	7.3*	**56.8***	-3.4	100												
QTOB	**41.4***	2.9	-18.9*	-0.3	100											
ROA	-26.9*	2.3	6.3	2.7	3.2	100										
TRISK	-2.6	**-42.9***	-9.5*	-13.9*	2.8	-3.1	100									
IRISK	-3.7	-11.1*	1.3	0.3	-7.3	-1.7	24.9*	100								
ARISK	-7.3	**-96.9***	0.7	**-57.3***	-2.5	-2.7	**39.9***	10.0	100							
CV	**-42.4***	-5.9	**-58.7***	-3.1	16.3*	14.3*	12.2*	0.6	4.0	100						
SIZE	**59.5***	-0.5	-21.5*	2.9	**72.8***	-9.7*	1.7	-3.2	-1.3	-5.3	100					
CAPL	**-48.9***	-4.6	**-57.2***	-4.0	0.6	14.4*	9.5*	1.1	3.5	**94.7***	**-20.9***	100				
TERM	2.8	1.2	-28.3*	0.5	4.2	-7.9*	-1.7	-6.6	0.6	1.3	17.1*	2.3	100			
VTSX	18.4*	0.3	-7.7	3.3	14.5*	-6.9	5.9	1.9	-3.0	3.3	**33.1***	4.4	12.4*	100		
GNPG	-6.0	-1.8	-0.1	-6.1	0.5	8.6*	2.1	-4.1	3.4	6.2	-6.5	4.6	-2.5	-15.8*	100	
CR3	**-69.5***	-7.7	14.2*	-2.4	**-65.8***	17.0*	0.7	4.1	6.0	18.0*	**-74.7***	28.2*	-4.2	**-43.5***	2.0	100

Table 3: Aggregate capital buffer measures

Economic capital is calculated with the Value at Risk (VaR) at the 99.97 % confidence level. Regulatory capital buffer (BUFR) is defined as the difference between banks' capital ratio and minimum regulatory capital ratio. Leverage based capital buffer (BUFL) is equal to the difference between ratio of shareholders' equity to assets and the inverse of regulatory ceiling on an unweighted leverage ratio. Economic capital buffer (BUFE) is defined as the difference between banks' capital ratio and their economic capital ratio.

Business cycles	Capital ratio (CAP)	Economic capital (CAPE)	Inverse leverage ratio (CAPL)	Regulatory capital buffer (BUFR)	Economic capital buffer (BUFE)	Leverage based capital buffer (BUFL)
Expansion	9.37%	7.92%	4.68%	0.76%	1.45%	0.41%
Recession	10.57%	9.07%	4.66%	2.32%	1.50%	0.64%
Non conditional	9.52%	8.09%	4.68%	0.83%	1.43%	0.44%

Table 4-A: Estimation results of the simultaneous equations of variations in regulatory capital buffer (BUFR), risk (TRISK) and performance (RET)

This table presents regression results of simultaneous equations systems of changes in capital buffer, risk and performance. The estimations are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls for all capital regulations using DREG1 and DREG2. In this table, we use total equity risk (TRISK) as risk measure, and equity return (RET) as performance measure. Regulatory capital buffer (BUFR) is calculated as the difference between banks' capital ratio and the minimum regulatory capital ratio. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFR			ΔTRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFR_{i,t}$	_	_	_	0.802 (0.54)	0.336 (0.15)	-0.328 (0.21)	-0.852 (0.38)	-3.434 (0.98)	-1.120 (0.43)
$\Delta TRISK_{i,t}$	-0.005 (0.92)	-0.005 (0.83)	-0.008 (1.46)	_	_	_	-0.165 (1.63)	-0.185* (1.77)	-0.147 (1.45)
$\Delta RET_{i,t}$	0.002 (0.73)	0.001 (0.04)	0.004 (1.42)	0.328*** (11.56)	0.328*** (11.50)	0.328*** (11.75)	_	_	_
$BUFR_{i,t-1}$	-0.194*** (8.56)	-0.135*** (6.59)	-0.258*** (10.41)	_	_	_	_	_	_
$TRISK_{i,t-1}$	_	_	_	-0.680*** (16.28)	-0.683*** (16.04)	-0.665*** (16.12)	_	_	_
$RET_{i,t-1}$	_	_	_	_	_	_	-0.923*** (20.09)	-0.922*** (19.69)	-0.917*** (19.97)
$SIZE_{i,t}$	0.015*** (6.82)	0.011*** (3.92)	0.005* (1.81)	_	_	_	0.031 (1.61)	0.101*** (2.97)	0.055 (1.34)
$LEV_{i,t}$	-0.001* (1.80)	-0.001** (2.35)	-0.001 (0.80)	_	_	_	_	_	_
$CV_{i,t}$	_	_	_	0.054** (2.15)	0.035 (1.50)	0.054** (2.12)	_	_	_

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Table 4A : Continued

	ΔBUFR			ΔTRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$CR3_t$	_	_	_	_	_	_	0.006	0.006	0.006
							(0.89)	(0.89)	(0.81)
$VTSX_t$	_	_	_	0.132*	0.132	0.139*	_	_	_
				(1.65)	(1.60)	(1.75)			
$TERM_t$	_	_	_	-0.043	-0.087	-0.060	_	_	_
				(0.23)	(0.46)	(0.32)			
$GNPG_t$	-0.020***	0.012	-0.019	0.092	0.128	0.258*	-0.208	-0.110	-0.342
	(2.59)	(1.40)	(1.58)	(0.99)	(1.36)	(1.92)	(1.41)	(0.71)	(1.55)
REG_t	-0.001*	-0.001**	-0.001**	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(1.95)	(2.02)	(2.05)	(0.34)	(0.57)	(0.38)	(0.35)	(0.34)	(0.27)
$DREG1_t$	0.003***	_	0.010***	0.006	_	0.010	0.030**	_	0.019
	(3.79)		(7.27)	(0.76)		(0.90)	(2.27)		(0.99)
$DREG1_t*GNPG_t$	0.059***	_	0.057***	-0.051	_	-0.166	0.133	_	0.265
	(4.25)		(3.44)	(0.31)		(0.88)	(0.51)		(0.86)
$DREG1_t*\Delta BUFR_{i,t}$	_	_	_	-1.974	_	-2.464	3.559	_	4.109
				(1.30)		(1.55)	(1.49)		(1.57)
$DREG2_t$	_	-0.001	0.013***	_	-0.001	0.007	_	-0.058***	-0.025
		(0.74)	(6.25)		(0.11)	(0.64)		(2.87)	(0.86)
$DREG2_t*GNPG_t$	_	-0.039***	-0.008	_	-0.173	-0.356**	_	-0.044	0.284
		(2.89)	(0.50)		(1.16)	(2.03)		(0.18)	(0.99)
$DREG2_t*\Delta BUFR_{i,t}$	_	_	_	_	0.313	-1.026	_	0.716	2.021
					(0.13)	(0.59)		(0.19)	(0.71)
Obs	622	622	622	622	622	622	622	622	622
R-Square	0.141	0.090	0.184	0.131	0.131	0.138	0.459	0.430	0.458
Chi-Square	102.34	60.12	145.80	338.57	338.78	352.05	518.81	492.73	523.27
Sargan	65.162	216.913	270.180	65.162	216.913	270.180	65.162	216.913	270.180
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4-B: Estimation results of the simultaneous equations of variations in leverage based capital buffer (BUFL), risk (TRISK) and performance (RET)

This table presents regression results of simultaneous equations systems of changes in capital buffer, risk and performance. The estimations are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls for all capital regulations using DREG1 and DREG2. In this table, we use total equity risk (TRISK) as risk measure, and equity return (RET) as performance measure. Capital buffer (BUFL) is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFL			ΔTRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFL_{i,t}$	_	_	_	1.951	0.503	2.566	2.815	6.689*	2.803
				(0.88)	(0.22)	(1.14)	(0.80)	(1.72)	(0.79)
$\Delta TRISK_{i,t}$	0.001	0.001	0.001	_	_	_	-0.170*	-0.158	-0.160
	(0.29)	(0.20)	(0.37)				(1.68)	(1.56)	(1.58)
$\Delta RET_{i,t}$	-0.001	0.001	-0.001	0.328***	0.328***	0.327***	_	_	_
	(0.03)	(0.57)	(0.02)	(11.65)	(11.64)	(11.60)			
$BUF_{i,t-1}$	-0.226***	-0.214***	-0.229***	_	_	_	_	_	_
	(11.17)	(10.43)	(11.25)						
$TRISK_{i,t-1}$	_	_	_	-0.685***	-0.684***	-0.680***	_	_	_
				(16.43)	(16.50)	(16.30)			
$RET_{i,t-1}$	_	_	_	_	_	_	-0.927***	-0.914***	-0.923***
							(20.14)	(19.88)	(20.06)
$SIZE_{i,t}$	-0.005***	-0.008***	-0.006***	_	_	_	0.036*	0.127***	0.075*
	(8.19)	(8.22)	(5.13)				(1.82)	(3.55)	(1.88)
$LEV_{i,t}$	-0.001***	-0.001***	-0.001***	_	_	_	_	_	_
	(9.62)	(7.77)	(9.25)						
$CV_{i,t}$	_	_	_	0.066***	0.041*	0.060**	_	_	_
				(2.59)	(1.72)	(2.23)			
$CR3_t$	_	_	_	_	_	_	0.008	0.007	0.008

							(1.12)	(1.11)	(1.11)
$VTSX_t$	_	_	_	0.156**	0.141*	0.152*	_	_	_
				(2.06)	(1.77)	(1.90)			

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Table 4B : Continued

	ΔBUFL			ΔTRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$TERM_t$	_	_	_	-0.124	-0.189	-0.172	_	_	_
				(0.69)	(1.06)	(0.95)			
$GNPG_t$	-0.003	-0.007**	-0.001	0.081	0.139	0.276**	-0.172	-0.083	-0.291
	(1.05)	(2.02)	(0.00)	(0.93)	(1.50)	(2.06)	(1.23)	(0.54)	(1.33)
REG_t	-0.001***	-0.001***	-0.001***	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(3.15)	(2.66)	(3.23)	(0.38)	(0.45)	(0.45)	(0.57)	(0.75)	(0.66)
$DREG1_t$	-0.002***	_	-0.002***	0.010	_	0.015	0.032**	_	0.016
	(6.93)		(3.95)	(1.23)		(1.30)	(2.35)		(0.82)
$DREG1_t*GNPG_t$	-0.009	_	-0.012*	-0.017	_	-0.206	0.195	_	0.318
	(1.57)		(1.77)	(0.11)		(1.11)	(0.79)		(1.06)
$DREG1_t*\Delta BUF_{i,t}$	_	_	_	-0.442	_	-0.429	-0.174	_	-0.113
				(0.84)		(0.82)	(0.21)		(0.13)
$DREG2_t$	_	0.003***	0.001	_	-0.001	0.008	_	-0.073***	-0.037
		(6.52)	(1.04)		(0.10)	(0.71)		(3.47)	(1.25)
$DREG2_t*GNPG_t$	_	0.001	-0.006	_	-0.204	-0.334*	_	0.045	0.230
		(0.12)	(0.92)		(1.40)	(1.90)		(0.19)	(0.81)
$DREG2_t*\Delta BUF_{i,t}$	_	_	_	_	-0.119	-0.103	_	0.348	0.318
					(0.16)	(0.14)		(0.30)	(0.27)
Obs	622	622	622	622	622	622	622	622	622
R-Sq	0.209	0.182	0.211	0.125	0.134	0.127	0.452	0.432	0.451
Chi-Square	100.22	56.42	142.07	340.90	343.03	144.93	497.11	485.67	491.61
Sargan	376.557	210.502	588.031	376.557	210.502	588.031	376.557	210.502	588.031
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4-C: Estimation results of the simultaneous equations of variations in economic capital buffer (BUFE), risk (TRISK) and performance (RET)

This table presents regression results of simultaneous equations systems of changes in capital buffer, risk and performance.The estimations are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls for all capital regulations using DREG1 and DREG2. In this table, we use total equity risk (TRISK) as risk measure, and equity return (RET) as performance measure. Economic capital buffer (BUFE) is calculated as the difference between banks' capital ratio and the economic capital ratio measured on the basis of a 99.97% bank value at risk (VaR) of one quarter. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFE			ΔTRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFE_{i,t}$	_	_	_	1.115***	0.885***	1.058***	-0.335***	-0.213***	-0.452***
				(7.15)	(10.39)	(7.22)	(3.11)	(2.80)	(3.86)
$\Delta TRISK_{i,t}$	-0.402***	-0.337***	-0.362***	_	_	_	-0.444***	-0.301***	-0.391***
	(5.52)	(4.43)	(5.03)				(5.33)	(3.86)	(4.65)
$\Delta RET_{i,t}$	0.233***	0.046	0.262***	-0.221***	-0.020	-0.227***	_	_	_
	(5.32)	(0.97)	(6.29)	(3.64)	(0.41)	(4.00)			
$BUFE_{i,t-1}$	-0.580***	-0.639***	-0.577***	_	_	_	_	_	_
	(14.65)	(15.22)	(14.77)						
$TRISK_{i,t-1}$	_	_	_	-1.376***	-1.256***	-1.307***	_	_	_
				(11.08)	(13.90)	(11.57)			
$RET_{i,t-1}$	_	_	_	_	_	_	-1.146***	-1.056***	-1.187***
							(19.68)	(19.34)	(19.76)
$SIZE_{i,t}$	0.012	0.012	-0.028	_	_	_	0.030	0.104***	0.074*
	(0.81)	(0.70)	(0.92)				(1.39)	(2.94)	(1.75)
$LEV_{i,t}$	-0.003	-0.003*	-0.002	_	_	_	_	_	_
	(1.56)	(1.94)	(0.85)						
$CV_{i,t}$	_	_	_	0.131***	0.098***	0.102**	_	_	_
				(2.67)	(2.79)	(2.20)			

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Table 4C : Continued

	ΔBUFE			ΔTRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$CR3_t$	_	_	_	_	_	_	0.007	0.005	0.008
							(0.94)	(0.76)	(1.05)
$VTSX_t$	_	_	_	0.192*	0.113*	0.206**	_	_	_
				(1.81)	(1.82)	(2.00)			
$TERM_t$	_	_	_	0.132	0.053	0.177	_	_	_
				(0.50)	(0.34)	(0.69)			
$GNPG_t$	-0.134	-0.053	-0.471**	0.177	0.036	0.534*	-0.229	-0.149	-0.558**
	(0.97)	(0.34)	(2.08)	(0.96)	(0.23)	(1.83)	(1.39)	(0.89)	(1.96)
REG_t	0.001	0.001	0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(0.40)	(0.23)	(0.61)	(1.10)	(1.16)	(1.33)	(0.61)	(0.55)	(0.49)
$DREG1_t$	-0.011	_	0.001	0.017	_	0.017	0.035**	_	0.020
	(0.83)		(0.06)	(1.03)		(0.74)	(2.30)		(0.92)
$DREG1_t*GNPG_t$	0.451*	_	0.788***	-0.526*	_	-0.861**	0.155	_	0.489
	(1.88)		(2.63)	(1.65)		(2.25)	(0.54)		(1.31)
$DREG1_t*\Delta BUFE_{i,t}$	_	_	_	-0.114	_	-0.122	0.363***	_	0.467***
				(0.84)		(0.94)	(3.13)		(3.76)
$DREG2_t$	_	0.007	0.028	_	-0.004	0.002	_	-0.063***	-0.037
		(0.47)	(1.07)		(0.32)	(0.09)		(2.91)	(1.14)
$DREG2_t*GNPG_t$	_	0.118	0.516*	_	-0.097	-0.575	_	0.123	0.511
		(0.48)	(1.81)		(0.40)	(1.58)		(0.48)	(1.45)
$DREG2_t*\Delta BUFE_{i,t}$	_	_	_	_	0.223***	0.110	_	0.757***	1.196***
					(2.58)	(0.65)		(4.57)	(5.57)
Obs	610	610	610	610	610	610	610	610	610
R-Sq	0.426	0.341	0.439	-1.873	-1.302	-1.573	0.281	0.333	0.256
Chi-Square	373.58	318.46	406.27	402.49	290.96	390.56	479.02	466.76	496.75
Sargan	183.015	31.217	202.911	183.015	31.217	202.911	183.015	31.217	202.911
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5-A: Estimation results of the simultaneous equations of variations in capital buffer (BUFL), idiosyncratic risk (IRISK) and performance (RET)

This table presents regression results of simultaneous equations systems of changes in capital buffer, risk and performance. The estimation are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls for all capital regulations using DREG1 and DREG2. In this table, we use idiosyncratic risk (IRISK) as risk measure, and equity return (RET) as performance measure. Capital buffer (BUFL) is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFL			ΔIRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFL_{i,t}$	_	_	_	11.969*	13.499**	11.711*	2.752	5.254	2.022
				(1.88)	(2.00)	(1.81)	(0.79)	(1.34)	(0.57)
$\Delta IRISK_{i,t}$	-0.001	-0.001	-0.001	_	_	_	-0.001	-0.004	-0.001
	(0.95)	(0.69)	(0.98)				(0.03)	(0.13)	(0.05)
$\Delta RET_{i,t}$	0.001	0.001	0.001	0.362***	0.349***	0.363***	_	_	_
	(0.37)	(0.86)	(0.41)	(4.56)	(4.37)	(4.56)			
$BUF_{i,t-1}$	-0.229***	-0.215***	-0.233***	_	_	_	_	_	_
	(11.29)	(10.48)	(11.36)						
$IRISK_{i,t-1}$	_	_	_	-0.768***	-0.769***	-0.768***	_	_	_
				(19.36)	(19.34)	(19.36)			
$RET_{i,t-1}$	_	_	_	_	_	_	-0.889***	-0.883***	-0.890***
							(21.48)	(21.28)	(21.50)
$SIZE_{i,t}$	-0.005***	-0.008***	-0.006***	_	_	_	0.022	0.071*	0.010
	(8.17)	(8.14)	(5.33)				(0.92)	(1.66)	(0.20)
$LEV_{i,t}$	-0.001***	-0.001***	-0.001***	_	_	_	_	_	_
	(9.83)	(7.97)	(9.32)						
$CV_{i,t}$	_	_	_	0.053	0.004	0.051	_	_	_
				(0.58)	(0.05)	(0.53)			

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Table 5A : Continued

	ΔBUFL			ΔIRISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$CR3_t$	_	_	_	_	_	_	0.005	0.005	0.005
							(0.61)	(0.64)	(0.58)
$VTSX_t$	_	_	_	0.219	0.231	0.213	_	_	_
				(0.82)	(0.81)	(0.74)			
$TERM_t$	_	_	_	-0.764	-0.889	-0.745	_	_	_
				(1.18)	(1.38)	(1.15)			
$GNPG_t$	-0.003	-0.008**	-0.001	-0.084	-0.147	-0.068	-0.193	-0.123	-0.396*
	(1.07)	(2.20)	(0.14)	(0.32)	(0.53)	(0.17)	(1.32)	(0.76)	(1.69)
REG_t	-0.001***	-0.001***	-0.001***	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(3.28)	(2.71)	(3.30)	(0.28)	(0.20)	(0.29)	(0.65)	(0.74)	(0.69)
$DREG1_t$	-0.002***	_	-0.002***	0.042*	_	0.041	0.025*	_	0.023
	(6.93)		(3.80)	(1.67)		(1.18)	(1.78)		(1.14)
$DREG1_t$*$GNPG_t$	-0.009	_	-0.012*	-0.112	_	-0.132	0.230	_	0.425
	(1.63)		(1.71)	(0.25)		(0.24)	(0.91)		(1.37)
$DREG1_t$*$\Delta BUF_{i,t}$	_	_	_	-0.549	_	-0.558	-0.064	_	-0.088
				(0.36)		(0.37)	(0.07)		(0.10)
$DREG2_t$	_	0.003***	0.001	_	-0.030	-0.001	_	-0.046*	0.001
		(6.45)	(1.22)		(1.20)	(0.02)		(1.92)	(0.01)
$DREG2_t$*$GNPG_t$	_	0.002	-0.005	_	0.067	-0.018	_	0.077	0.332
		(0.36)	(0.74)		(0.16)	(0.03)		(0.31)	(1.11)
$DREG2_t$*$\Delta BUF_{i,t}$	_	_	_	_	0.456	0.383	_	0.368	0.358
					(0.22)	(0.18)		(0.31)	(0.30)
Obs	610	610	610	610	610	610	610	610	610
R-Sq	0.214	0.186	0.216	0.380	0.376	0.380	0.442	0.431	0.445
Chi-Square	169.56	142.59	172.03	401.35	399.15	401.53	489.41	479.20	492.54
Sargan	30.255	18.753	30.880	30.255	18.753	30.880	30.255	18.753	30.880
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5-B: Estimation results of the simultaneous equations of variations in capital buffer (BUFL), implicit asset risk (ARISK) and performance (RET)

This table presents regression results of simultaneous equations systems of changes in capital buffer, risk and performance. The estimation are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls for all capital regulations using DREG1 and DREG2. In this table, we use asset implied volatility (ARISK) as risk measure, and equity return (RET) as performance measure. Capital buffer (BUFL) is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFL			ΔARISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFL_{i,t}$	_	_	_	-0.471 (0.93)	-0.659 (1.22)	-0.385 (0.76)	3.416 (0.88)	6.224 (1.46)	3.129 (0.80)
$\Delta ARISK_{i,t}$	0.014 (1.35)	0.015 (1.44)	0.015 (1.43)	_	_	_	1.616*** (2.77)	1.492** (2.57)	1.578*** (2.72)
$\Delta RET_{i,t}$	0.001 (0.92)	0.002 (1.49)	0.001 (0.99)	0.009 (1.26)	0.010 (1.38)	0.009 (1.28)	_	_	_
$BUF_{i,t-1}$	-0.230*** (11.30)	-0.216*** (10.49)	-0.232*** (11.33)	_	_	_	_	_	_
$ARISK_{i,t-1}$	_	_	_	-0.631*** (14.50)	-0.642*** (14.55)	-0.636*** (14.66)	_	_	_
$RET_{i,t-1}$	_	_	_	_	_	_	-0.962*** (18.12)	-0.949*** (17.98)	-0.961*** (18.17)
$SIZE_{i,t}$	-0.005*** (8.14)	-0.008*** (8.09)	-0.006*** (5.27)	_	_	_	0.006 (0.30)	0.068** (1.99)	0.033 (0.85)
$LEV_{i,t}$	-0.001*** (9.72)	-0.001*** (7.86)	-0.001*** (9.20)	_	_	_	_	_	_
$CV_{i,t}$	_	_	_	0.006 (1.11)	0.002 (0.50)	0.004 (0.66)	_	_	_

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Table 5B : Continued

	ΔBUFL			ΔARISK			ΔRET		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$CR3_t$	_	_	_	_	_	_	0.006	0.006	0.006
							(0.98)	(0.97)	(0.98)
$VTSX_t$	_	_	_	0.012	0.015	0.015	_	_	_
				(0.76)	(0.97)	(0.96)			
$TERM_t$	_	_	_	0.031	0.008	0.027	_	_	_
				(0.82)	(0.23)	(0.72)			
$GNPG_t$	-0.004	-0.008**	-0.002	0.039*	0.018	0.104***	-0.265	-0.140	-0.561**
	(1.33)	(2.20)	(0.38)	(1.87)	(0.78)	(3.09)	(1.60)	(0.78)	(2.06)
REG_t	-0.001***	-0.001***	-0.001***	-0.001	0.001	-0.001	0.001	0.001	0.001
	(3.25)	(2.71)	(3.24)	(0.26)	(0.00)	(0.26)	(0.87)	(0.81)	(0.79)
$DREG1_t$	-0.002***	_	-0.002***	0.002	_	0.002	0.021	_	0.017
	(7.08)		(3.97)	(1.18)		(0.61)	(1.40)		(0.78)
$DREG1_t*GNPG_t$	-0.007	_	-0.009	-0.085**	_	-0.148***	0.402	_	0.692*
	(1.24)		(1.30)	(2.36)		(3.33)	(1.38)		(1.91)
$DREG1_t*\Delta BUF_{j,t}$	_	_	_	-0.028	_	-0.024	-0.096	_	-0.081
				(0.23)		(0.20)	(0.10)		(0.08)
$DREG2_t$	_	0.003***	0.001	_	-0.002	-0.001	_	-0.047**	-0.017
		(6.44)	(1.15)		(0.79)	(0.25)		(2.16)	(0.55)
$DREG2_t*GNPG_t$	_	0.001	-0.004	_	-0.020	-0.106**	_	0.106	0.512
		(0.25)	(0.60)		(0.58)	(2.48)		(0.39)	(1.49)
$DREG2_t*\Delta BUF_{j,t}$	_	_	_	_	-0.045	-0.042	_	0.406	0.387
					(0.98)	(1.13)		(0.78)	(1.11)
Obs	610	610	610	610	610	610	610	610	610
R-Sq	0.216	0.187	0.217	0.252	0.235	0.263	0.282	0.280	0.290
Chi-Square	171.24	144.88	173.59	257.27	250.20	268.91	388.41	384.02	393.19
Sargan	32.674	19.597	31.468	32.674	19.597	31.468	32.674	19.597	31.468
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Elasticity of risk relative to capital buffer

Elasticity coefficients are obtained from the following regression: Ln (RISK) = $\beta_0 + \beta_1$ Ln (BUFL) + ε where BUFL is the capital buffer and RISK the risk measure. β_1 is the elasticity coefficient of RISK with respect to BUFL since $\Delta RISK/RISK = \beta_1 \Delta BUFL/BUFL$. BUFL is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio.We use three risk measures: TRISK the banks' total equity risk, IRISK the banks' market idiosyncratic risk, and ARISK the banks' implicit volatility of the assets. Unconditional phase of business cycles refers to the full business cycles without making a distinction between troughs and peaks. Expansion phase considers only peak periods. Recession phase considers only trough periods. Values in parentheses are the Student *t*-statistics.The signs *, **, *** indicate, respectively, significance level at 10 %, 5 % and 1 %.

Risk measures	TRISK	ARISK	IRISK
Unconditional phase	-1.417	4.329*	-4.752
	(0.708)	(1.708)	(0.954)
Expansion phase	-1.763	4.835*	-3.746
	(0.786)	(1.759)	(0.688)
Recession phase	-0.808	-77.342*	-12.582
	(0.178)	(1.931)	(1.186)

Table 7-A: Estimation results of the simultaneous equations of variations in capital buffer (BUFL), risk (TRISK) and performance (ROA)

This table presents regression results of simultaneous equations system of changes in capital buffer, risk and performance. The estimations are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls for all capital regulations using DREG1 and DREG2. In this table, we use total equity risk (TRISK) as risk measure, and return on asset (ROA) as performance measure. Capital buffer (BUFL) is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFL			ΔTRISK			ΔROA		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFL_{i,t}$	_	_	_	-0.471	-0.659	-0.385	3.416	6.224	3.129
				(0.93)	(1.22)	(0.76)	(0.88)	(1.46)	(0.80)
$\Delta TRISK_{i,t}$	0.014	0.015	0.015	_	_	_	1.616***	1.492**	1.578***
	(1.35)	(1.44)	(1.43)				(2.77)	(2.57)	(2.72)
$\Delta ROA_{i,t}$	0.001	0.002	0.001	0.009	0.010	0.009	_	_	_
	(0.92)	(1.49)	(0.99)	(1.26)	(1.38)	(1.28)			
$BUF_{i,t-1}$	-0.230***	-0.216***	-0.232***	_	_	_	_	_	_
	(11.30)	(10.49)	(11.33)						
$TRISK_{i,t-1}$	_	_	_	-0.631***	-0.642***	-0.636***	_	_	_
				(14.50)	(14.55)	(14.66)			
$ROA_{i,t-1}$	_	_	_	_	_	_	-0.962***	-0.949***	-0.961***
							(18.12)	(17.98)	(18.17)
$SIZE_{i,t}$	-0.005***	-0.008***	-0.006***	_	_	_	0.006	0.068**	0.033
	(8.14)	(8.09)	(5.27)				(0.30)	(1.99)	(0.85)
$LEV_{i,t}$	-0.001***	-0.001***	-0.001***	_	_	_	_	_	_
	(9.72)	(7.86)	(9.20)						
$CV_{i,t}$	_	_	_	0.006	0.002	0.004	_	_	_
				(1.11)	(0.50)	(0.66)			

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Table 7A : Continued

	ΔBUFL			ΔTRISK			ΔROA		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$CR3_t$	_	_	_	_	_	_	0.006	0.006	0.006
							(0.98)	(0.97)	(0.98)
$VTSX_t$	_	_	_	0.012	0.015	0.015	_	_	_
				(0.76)	(0.97)	(0.96)			
$TERM_t$	_	_	_	0.031	0.008	0.027	_	_	_
				(0.82)	(0.23)	(0.72)			
$GNPG_t$	-0.004	-0.008**	-0.002	0.039*	0.018	0.104***	-0.265	-0.140	-0.561**
	(1.33)	(2.20)	(0.38)	(1.87)	(0.78)	(3.09)	(1.60)	(0.78)	(2.06)
REG_t	-0.001***	-0.001***	-0.001***	-0.001	0.001	-0.001	0.001	0.001	0.001
	(3.25)	(2.71)	(3.24)	(0.26)	(0.00)	(0.26)	(0.87)	(0.81)	(0.79)
$DREG1_t$	-0.002***	_	-0.002***	0.002	_	0.002	0.021	_	0.017
	(7.08)		(3.97)	(1.18)		(0.61)	(1.40)		(0.78)
$DREG1_t*GNPG_t$	-0.007	_	-0.009	-0.085**	_	-0.148***	0.402	_	0.692*
	(1.24)		(1.30)	(2.36)		(3.33)	(1.38)		(1.91)
$DREG1_t*\Delta BUF_{i,t}$	_	_	_	-0.028	_	-0.024	-0.096	_	-0.081
				(0.23)		(0.20)	(0.10)		(0.08)
$DREG2_t$	_	0.003***	0.001	_	-0.002	-0.001	_	-0.047**	-0.017
		(6.44)	(1.15)		(0.79)	(0.25)		(2.16)	(0.55)
$DREG2_t*GNPG_t$	_	0.001	-0.004	_	-0.020	-0.106**	_	0.106	0.512
		(0.25)	(0.60)		(0.58)	(2.48)		(0.39)	(1.49)
$DREG2_t*\Delta BUF_{i,t}$	_	_	_	_	-0.045	-0.042	_	0.406	0.387
					(1.01)	(0.97)		(0.69)	(1.09)
Obs	610	610	610	610	610	610	610	610	610
R-Sq	0.216	0.187	0.217	0.252	0.235	0.263	0.282	0.280	0.290
Chi-Square	167.01	142.72	169.76	252.48	254.10	254.04	235.93	244.96	253.91
Sargan	34.636	29.765	39.532	34.636	29.765	39.532	34.636	29.765	39.532
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 7-B: Estimation results of the simultaneous equations of variations in capital buffer (BUFL), risk (TRISK) and performance (QTOB)

This table presents regression results of simultaneous equations systems of changes in capital buffer, risk and performance. The estimations are done using three-stage least squares regressions (3SLS). Financial statements data are quarterly observations from 1982 to 2009. Market measures were extracted from daily data converted to quarter. Model 1 includes a dummy variable for the Basle I regulation from 1988 to 1997, where the dummy variable DREG1 takes value 1 over the period 1988-1997 and 0 elsewhere. Model 2 includes a dummy variable for the 1996 amendment of Basle I and Basle II regulation from 1998 to 2009, where the dummy variable DREG2 takes value 1 over the period 1998-2009 and 0 elsewhere. Model 3 controls all capital regulations using DREG1 and DREG2. In this table, we use total equity risk (TRISK) as risk measure, and Tobin's Q (QTOB) as performance measure. Capital buffer (BUFL) is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio. All other variables are defined in Table 1. We include bank dummies to control for fixed effects of each bank. The Sargan test is used to test for the overidentification of the model. Values in parentheses are absolute values of Student t-statistics. Signs *, **, *** indicate respectively, significance level at 10 %, 5 % and 1 %.

	ΔBUFL			ΔTRISK			ΔQTOB		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta BUFL_{i,t}$	_	_	_	3.448* (1.65)	1.755 (0.80)	3.787* (1.80)	-20.944*** (4.50)	-19.341*** (3.72)	-20.479*** (4.38)
$\Delta TRISK_{i,t}$	0.003 (1.00)	0.002 (0.72)	0.003 (1.03)	_	_	_	0.176 (1.19)	0.167 (1.13)	0.176 (1.19)
$\Delta QTOB_{i,t}$	-0.009*** (5.37)	-0.008*** (4.76)	-0.009*** (5.00)	0.159*** (3.08)	0.127** (2.51)	0.152*** (2.94)	_	_	_
$BUF_{i,t-1}$	-0.191*** (9.42)	-0.189*** (9.15)	-0.198*** (9.68)	_	_	_	_	_	_
$TRISK_{i,t-1}$	_	_	_	-0.567*** (15.03)	-0.570*** (15.28)	-0.566*** (15.00)	_	_	_
$QTOB_{i,t-1}$	_	_	_	_	_	_	-0.117*** (4.76)	-0.124*** (5.16)	-0.123*** (4.95)
$SIZE_{i,t}$	-0.004*** (6.82)	-0.007*** (6.35)	-0.004*** (3.70)	_	_	_	0.156*** (3.61)	0.192*** (3.32)	0.240*** (3.57)
$LEV_{i,t}$	-0.001*** (8.44)	-0.001*** (7.51)	-0.001*** (8.40)	_	_	_	_	_	_
$CV_{i,t}$	_	_	_	0.041 (1.46)	0.038 (1.45)	0.035 (1.17)	_	_	_

Continued next page

Table 7B : Continued

	ΔBUFL			ΔTRISK			ΔQTOB		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$CR3_t$	_	_	_	_	_	_	-0.009	-0.008	-0.008
							(0.95)	(0.81)	(0.87)
$VTSX_t$	_	_	_	0.132	0.110	0.132	_	_	_
				(1.50)	(1.18)	(1.41)			
$TERM_t$	_	_	_	-0.148	-0.123	-0.180	_	_	_
				(0.75)	(0.62)	(0.91)			
$GNPG_t$	-0.002	-0.005	0.002	0.015	0.083	0.149	0.032	-0.019	0.006
	(0.59)	(1.49)	(0.31)	(0.19)	(0.97)	(1.19)	(0.17)	(0.10)	(0.02)
REG_t	-0.001***	-0.001***	-0.001***	-0.001	-0.001	-0.001	-0.002**	-0.003***	-0.002**
	(2.92)	(2.65)	(3.01)	(0.39)	(0.40)	(0.44)	(2.56)	(2.69)	(2.49)
$DREG1_t$	-0.002***	_	-0.002***	0.001	_	0.002	-0.007	_	-0.033
	(4.85)		(3.34)	(0.04)		(0.18)	(0.38)		(1.27)
$DREG1_t*GNPG_t$	-0.008	_	-0.012*	0.054	_	-0.074	-0.125	_	-0.090
	(1.44)		(1.69)	(0.38)		(0.43)	(0.38)		(0.22)
$DREG1_t*\Delta BUF_{i,t}$	_	_	_	-0.536	_	-0.517	0.349	_	0.486
				(1.12)		(1.08)	(0.36)		(0.50)
$DREG2_t$	_	0.002***	0.001	_	0.002	0.003	_	-0.013	-0.060
		(4.47)	(0.18)		(0.23)	(0.24)		(0.40)	(1.40)
$DREG2_t*GNPG_t$	_	0.001	-0.006	_	-0.157	-0.218	_	0.045	0.029
		(0.08)	(0.89)		(1.17)	(1.33)		(0.14)	(0.08)
$DREG2_t*\Delta BUF_{i,t}$	_	_	_	_	0.160	0.214	_	-1.874	-1.986
					(0.24)	(0.32)		(1.39)	(1.49)
Obs	620	620	620	620	620	620	620	620	620
R-Sq	-0.058	-0.030	-0.025	0.182	0.231	0.187	-0.096	-0.067	-0.082
Chi-Square	157.07	247.60	48.05	139.31	250.77	50.99	159.53	250.35	53.44
Sargan	79.277	69.129	83.307	79.277	69.129	83.307	79.277	69.129	83.307
Bank dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Elasticity of performance relative to capital buffer

Elasticity coefficients are obtained from the following regression: Ln(PERF) = $\beta_0 + \beta_1$ Ln(BUFL) + ε where BUFL is the capital buffer and PERF the performance measure. β_1 is the elasticity coefficient of PERF with respect to BUFL since ΔPERF/PERF = β_1 ΔBUFL/BUFL. BUFL is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio.We use three performance measures: RET banks' equity return, ROA banks's return on assets, QTOB banks' Tobins' Q. Unconditional phase of business cycles refers to the full business cycles without making a distinction between troughs and peaks. Expansion phase considers only peak periods. Recession phase considers only trough periods. Values in parentheses are the Student *t*-statistics. The signs *, **, *** indicate, respectively, significance level at 10 %, 5 % and 1 %.

Performance measures	ROA	RET	QTOB
Unconditional phase	3.206	-5.681	-2.955
	(1.250)	(0.884)	(1.622)
Expansion phase	5.516*	-5.126	-2.390
	(1.937)	(0.744)	(1.141)
Recession phase	-16.641	-6.764	34.885*
	(1.089)	(0.384)	(1.814)

Table 9: Simulation of performance conditional on variations in capital buffer and business cycles

Simulations are performed using the following regression equation: $Ln(PERF) = \beta_0 + \beta_1 Ln(BUFL) + \varepsilon$, where BUFL is the capital buffer and PERF the performance measure. The elasticity coefficient β_1 has been obtained with the historical data between 1982 and 2009. BUFL is calculated as the difference between the ratio of shareholders' equity to asset and the inverse of the regulatory ceiling on an unweighted leverage ratio. We use the current maximum balance sheet leverage ratio cap of 23. We use three performance measures: RET banks' equity return, ROA banks's return on assets, QTOB banks' Tobins' Q. Unconditional phase of business cycles refers to the full business cycles without making a distinction between troughs and peaks. Expansion phase considers only peak periods. Recession phase considers only trough periods.

Panel 1 : Unconditional phase

Asset/Book equity	BUFL	ROA	RET	QTOB
16	1.90%	0.19%	5.62%	1.24
17	1.53%	0.19%	5.69%	1.25
18	1.21%	0.19%	5.77%	1.25
19	0.92%	0.19%	5.86%	1.26
20	0.65%	0.19%	5.97%	1.28
21	0.41%	0.18%	6.13%	1.29
22	0.20%	0.18%	6.39%	1.32
23	0.00%	0.16%	7.92%	1.48

Panel 2: Expansion phase

Asset/Book equity	BUFL	ROA	RET	QTOB
16	1.90%	0.20%	5.91%	1.24
17	1.53%	0.20%	5.97%	1.24
18	1.21%	0.20%	6.04%	1.25
19	0.92%	0.19%	6.13%	1.26
20	0.65%	0.19%	6.24%	1.27
21	0.41%	0.19%	6.39%	1.28
22	0.20%	0.18%	6.63%	1.30
23	0.00%	0.14%	8.05%	1.43

Panel 3: Recession phase

Asset/Book equity	BUFL	ROA	RET	QTOB
16	1.90%	0.15%	4.43%	1.25
17	1.53%	0.16%	4.49%	1.16
18	1.21%	0.16%	4.56%	1.07
19	0.92%	0.17%	4.65%	0.97
20	0.65%	0.18%	4.76%	0.86
21	0.41%	0.19%	4.91%	0.73
22	0.20%	0.22%	5.16%	0.57
23	0.00%	0.41%	6.66%	0.15