The Impact of Regulatory Risk-Based Capital Requirements on Credit Crises

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Abstract

There has been a lot of controversy surrounding the impact of regulatory standards, in particular the Basel framework, on crises that occurred soon after these standards were spread across the banking industry. Indeed, whereas it is at the heart of the Basel approach, sought by the Bank of International Settlements (BIS) and its committee on Banking Supervision (BCBS), to have a "level playing field" and make banks "safer" entities, the question of whether this goal can be attained through enforcing capital requirements is still contentious. In this research, we look into whether the capital cushions could have almost single-handedly affected the viability of banks during the 2007-2009 subprime crisis as they did during the 1990-1991 crunch. The alternative is whether factors such as leverage, liquidity, securitization and others overshadowed the purpose these cushions were set up for in the first place. Using a bank panel dataset obtained from the FDIC, our results support the alternative hypothesis by showing how capital requirements, when combined with some of these other factors, can have contrasting effects on a bank's behavior depending on its capital position. This has strong policy implications with regard to the ongoing Basel III efforts as not taking these results into account could entail several more "Basels" before the intended goal is met.

Keywords: Capital Adequacy, Basel, Credit Crunch

"The Committee does not possess any formal supranational supervisory authority. Its conclusions do not have, and were never intended to have, legal force. Rather, it formulates broad supervisory standards and guidelines and recommends statements of best practice in the expectation that individual authorities will take steps to implement them through detailed arrangements - statutory or otherwise - which are best suited to their own national systems." (BCBS (2009))

1. Introduction

The first initiative by Basel (I) was published in 1988 (BCBS (1988)) to set the minimum threshold for banks in terms of capital requirements. This capital was intended to "cushion" shocks suffered by the banking sector as well as other related financial institutions. Initially published in mid-2004 (BCBS (2004)), the second framework (II) was revised in 2006 (BCBS (2006)). Although

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several other updates have since been introduced[1], the Standardized Approach based on the concept of a risk-weight (RW[2]) remained almost the same as in the previous regulation[3].

Through constantly revised assessments, the BCBS has tried to maintain its target of bank safety by motivating the changes in Basel II based on shortcomings of Basel I. While it is not the target of this research to delve into their critical assessment, it is essential to highlight any major changes between the two regulations. The most notable change was arguably in the category of fully secured residential mortgages which saw their RW decrease from 50% to 35%. This second round lowering has been heavily questioned in the aftermath of the crisis (Blundell-Wignall and Atkinson (2010)) especially as Basel I critics such as Breeden and Isaac (1992) and Hall (1993) had already argued that the initial RWs were arbitrarily chosen and did not reflect the inherent risk in these loan instruments.

It is without a doubt that the goal behind enforcing risk-based capital requirements (RBC) is to improve the resilience of banks in difficult times. However, history has served notice that crises did hit the banking sector almost immediately after these standards came into existence. More precisely, the Basel I and II regulations were followed, almost within an equal span of time, by the 1990-1991 and 2007-2009, hereafter first and second, crises[4]. This is quite a coincidence in view of the fact that Bernanke and Blinder (1992) observed that some policies take effect on bank lending only six months after enforcement and do not completely adjust until after two years. Hence, this can be seen as a viable explanation for the timeline chosen in this study.

This paper focuses on the crises mentioned above for two reasons[5]. First, they both originated in the U.S. before affecting other countries; thus creating an adequate scene for comparative purposes while controlling for country-specific demand. Second, both crises were classified as credit crunches; whereby, for reasons that will be unveiled shortly, banks were impaired at extending credit to the market, following the news of a regulatory tightening. Whether or not there is a causal link between the two events is at the core of this research.

From a different, albeit related perspective, leverage was globally recognized as one of the main culprits for the second crisis. Indeed, Gilbert (2006) states that up until mid-2005 only the two largest U.S. banks did not fall below the 5% leverage requirement for well capitalized institutions. As a matter of fact, the use and study of the leverage ratio (LR) began well before that of the capital ratio (CR)[6]. One of the earliest examples is given by Bernanke and Lown (1991) who agreed with Syron (1991) to dub the 1990-1991 crisis period as a "Credit Crunch" which stemmed from a "Capital Crunch". They were also the precursors for using the capital-to-asset ratio, a.k.a. leverage, as an explanatory variable for changes in loan supply in order to test the hypothesis of whether regulatory bodies were to blame for the lending slowdown. Although the authors claim to be testing for a regulatory capital effect, i.e. RBC, they were in fact testing for the leverage effect.

Still, while the LR is implemented on a discretionary basis by the three main U.S. banking

[1] Up to one point the regulation was referred to as Basel II.5.

[2] The RW is a measure attributed to different asset classes based on their respective credit risk.

[3] Set aside from allowing for the use of credit ratings, both external and internal.

[4] The second framework was therefore not fully enforced by all countries prior to the onset of the second crisis.

[5] Over the past two decades, the impact of capital requirements has been examined for crises that have shaken banks not only in the U.S. For instance, Watanabe (2007) finds a negative correlation between real estate lending and the bank's capital-to-asset ratio during the Asian crisis.

[6] Leverage is not to be confused with the traditional corporate finance connotation of Debt/Equity. In fact both "capital" measures differ mainly in their denominator: LR uses Unweighted assets (UWA) whereas CR uses RW-assets (RWA) in relation to capital (numerator).

regulators (OCC, FDIC and FED), it attracted a lot of attention (and criticism) in the wake of the credit crunches. This is especially true as it was documented as being the binding capital constraint on banks rather than the Basel requirements themselves (Baer and McElravey (1993), Peek and Rosengren (1994), Kiema and Jokivuolle (2010), Blundell-Wignall and Atkinson (2010) and more recently Cathcart et al. (2012)). Also, Moosa (2010) argues that leverage is an indicator of a desire to maximize profit and is hence a call for excessive risk-taking. Miu et al. (2010) agree that, taken as a standalone measure, a low LR is indeed reflective of riskier balance sheets. This can explain why the second crisis began with an overcapitalized banking industry and ended with a wave of deleveraging that continues until today.

In the past, however, other authors such as Avery and Berger (1991) have downplayed the negative effect of leverage under the premise that its role is not to focus on off-balance sheet items. In other words, it does not take into account the fact that large banks tend to shift high proportions of their assets to off-balance-sheet Special Purpose Vehicles (SPVs). A reminder that assets in the LR are un-weighted and therefore are not adjusted for any of the bank's risks in contrast to the CR (Thakor (1996)). Consequently, as the proportion of assets with high RW increases, the CR tends towards the LR and hence holds no additional benefit. It therefore becomes essential to dissociate the CR from the LR effects in any study of capital requirements.

Some authors such as Blum (2008) have found empirical evidence that the two measures have a synergetic effect when combined together as leverage can compensate for deficiencies in RBC requirements. It also insures that banks will hold the first-best level of capital. However, as it turns out during the second crisis, RBC requirements had a counter-beneficial effect due to, in some part, leverage. This had already been revealed, but to a lesser extent during the first crisis. Indeed, according to Hall (1993), better Tier 1 capital translated into higher cumulative losses for dangerously leveraged banks. This lead the author to assert that a country and/or sector specific LR can be detrimental to RBC. In that respect, the banks' preliminary increase in CRs is seen as an excuse in order to obtain a lower "technical" LR requirement from the regulators.

Moreover, Buehler et al. (2010) affirm that the LR's predictive power for distress becomes non-existent when combined with the CR. According to them, imposing such dual measures is not beneficial in any way. This certainly downplays efforts by the Basel III Committee hinting at establishing the LR as a "backstop" measure amongst the new requirements. Although the Basel Committee stands firm on its belief that "the benefits of a risk-sensitive capital framework outweigh [any] potential concern", Blundell-Wignall and Atkinson (2010) highlight that seeking to achieve a certain imposed LR can push banks to arbitrage the weights to ensure their CR barely goes beyond its specified target. This changes the requirements into maximum rather than minimum targets thus creating distortionary effects. One such effect is to shift banks towards low risk-weighted assets which materializes in a cutdown on lending.

Despite all the criticism, leverage did not single-handedly hurt the financial sector during the second crisis. In that respect, liquidity and risk management also had severe impacts. In the U.S and U.K. for example, Northern Rock, Bear Stearns and Goldman did not suffer from a shortage of capital[7] prior to the crisis. Noticeably, this remained true until the day the first two faltered. Yet, according to Moosa (2010), the first held a large proportion of illiquid assets which triggered a run on its deposits; while the second was dangerously leveraged prior to its collapse, thus amplifying the adverse market movement at that time. On the other hand, over consecutive days during the

[7]Note that UK supervisors impose higher bank-specific capital requirements than Basel in conjunction with the Capital Requirement Directive (Ediz et al. (1998)). This was exemplified in the UK's veto at the 2011 EU Summit.

crisis, Goldman had a series of "25-sigma moves" resulting from its use of Gaussian return models like VAR. Herein, the underlying theory predicts that such an event could only occur once in every 1.3×10^{135} years. According to Greenspan et al. (2010), these unforseen moves could also be related to limited tail risk accuracy and other risk management pitfalls.

Setting aside these aggravating factors, which are currently being examined by the Basel III commission[8], one can still ask was there any role played by RBC in the second crisis? More generally, how adequate is the "capital adequacy" requirement - pillar I of the three Basel pillars?

Before looking at unwanted effects stemming from the capital requirements themselves, we are aware that the general framework does suffer from some internal shortcomings which are outside the scope of this research: for instance, portfolio invariance, single global risk factor, contagion and counterparty risk, interest rate risk, procyclicality, quality of hybrid instruments, subjectivity of input parameters. For some, these deficiencies warranted the complete dismissal of the idea of a uniform international financial regulation following the subprime crisis (Moosa (2010)).

Yet, the blame cannot be attributed solely to the regulators as other market players had their say in pushing the limits of the regulation. These players include Credit Rating Agencies (CRAs), Government Sponsored Enterprises (GSEs), Too Big to Fail institutions (TBTFs) and Special Purpose Vehicles (SPVs). Despite not falling under the responsibility of the Basel regulators per se, the latter's role was to keep a watchful eye on the practices of these players (an opinion shared by the former Federal Reserve Chairman (Greenspan et al. (2010))[9]). While the focus remains on the incentives generated by the requirements themselves, our emphasis on RBC will bear in mind the role of these market players.

Regardless if one agrees with the literature trend that points the finger at Basel for failing to achieve its goal, what can factually be stated is that, in retrospect, the regulation certainly did not prevent any of the crises. Even midway through the second crisis, OpRisk and Compliance revealed that "Basel II is dead, long live Basel III". In sum, Basel has suffered two setbacks to its ability to absorb shocks on banks as the imposed capital requirements did relatively little to alleviate the heavy losses that ensued.

The literature is divided as to what role(s) capital played during these crises with regards to two main elements: risk and growth. Somewhat related to our objective in this research, the former has become a stream on its own due to, on one hand, the contributions of Koehn and Santomero (1980), Kim and Santomero (1988), Gennotte and Pyle (1991), Blum (1999) and Montgomery (2005), to name only a few. These authors believe banks become less risk averse when compensating for the utility loss due to increases in capital. The side contesting this point of view began with Furlong and Keely (1987) and Furlong and Keely (1989) who showed that stricter leverage requirements result in a decrease in total bank risk. This idea was re-introduced by many authors, namely, Keely and Furlong (1990), Shrieves and Dahl (1992), Calem and Rob (1999) and Blum (2008).

As stated in the above literature, since either high or low levels of capitalization can generate the incentive for risk-taking, Basel cannot be held accountable for such behavior on behalf of banks. We therefore choose to focus our attention on the second element, growth. More formally, the RBC

[8]The draft regulation attempts to derive lessons of the past in order to solidify the previous framework(s). At the time of writing, efforts are heading in the direction of incorporating the LR to the regulation on an international level along with raising the minimum Tier 1 ratio to 6%. While the minimum total capital will remain at 8%, it will be supplemented with a new conservation buffer (2.5%), a countercyclical buffer (0-2.5%) and a SIFI buffer (1-2.5%) for TBTF institutions. Tier 3 capital will be scratched altogether while Tier 2 instruments (especially hybrids) will come under heavier scrutiny.

[9]Although he as well was criticized for keeping interest rates too low during the crisis (Nichols et al. (2011)).

Credit Crunch Hypothesis (CCH), defined by Berger and Udell (1994), explores whether during a credit crunch, risky banks, constrained by low[10] CRs, will tend to reduce lending more than others.

Following the first crisis, the majority of authors blamed Basel I for exacerbating the downturn. Bernanke and Lown (1991) claim that, rather than raise capital through equity, banks post-Basel I tried to meet the requirements by selling assets and diminish their lending thus affecting the RWAs in the CR specification. They also note the absence of any securitization-related effect on lending[11]. Baer and McElravey (1993) study the impact of capital requirement increases on banks' diminished lending and find that the proportion of banks constrained as a result of that increase was at its highest at one point during the first crisis. This re-asserted the findings in Moore (1992) despite the fact some have argued that for most American banks the requirements did not increase their overall capital holdings (Brinkmann and Horvitz (1995)).

To decouple the effects of each component in the CR, Hall (1993) regressed the growth rate of RWA against beginning-of-period RBC ratios and loan-growth using both time-series (macroeconomic) and cross-sectional (microeconomic) data. The essence of the method lies in that the author does not overlook the fact that a flight to quality is a natural occurrence during downturns. Therefore, to assess whether Basel had any additional effect, he compares the portfolio changes from 1988 to 1992 to those of the earlier five recessions. Still, he finds that the lending slowdown is more noticeable during this crisis compared to the previous ones and concludes it is unlikely that Basel could not have had a hand in these adjustments.

In contrast, one of the findings of Peek and Rosengren (1995) was that a large negative shock to capital was not enough, on its own, to cause a crunch. But this does not seem to contradict the authors' belief that sufficient and/or non-binding RBC can diminish bank losses. They choose New England (NE) as their test bench since it became notorious for being the worse affected region in the U.S. during the first crisis. The authors build on their seminal article by introducing Japanese holding companies in Peek and Rosengren (1997) and find that RBC still plays a role even at the level of subsidiaries.

The work by Kishan and Opiela (2000), Chiuri et al. (2001) and Chiuri et al. (2002) is also testament to the previous model's flexibility. Although the authors focus on developing countries, they point out that the reduction of poor quality lending resulting from a positive effect of capital requirements can be negated by the drying up of bank liquidity. This is a compelling statement because it highlights a potential causal link between RBC, liquidity and good quality lending in the context of emerging markets. The latter certainly did reveal itself as will become clearer in the context of the subprime crisis in developed countries. This was mainly due to the deterioration in screening for borrowers' creditworthiness and negligence substituting for due diligence. Hence, even if Basel did have a hand in causing the crises, there could have been other contributing factors. A goal of this research would be to isolate which ones.

Notwithstanding the appealing features in the Peek and Rosengren (1995) model, the benchmark for our empirical work will be based on the paper by Berger and Udell (1994), henceforth B&U. Aside from tractability, one argument in favor of using the B&U model is the distinction it makes between the RBC CCH and the leverage CCH. The latter are just two out of four Supply-side hypotheses these authors investigated; loan examination and voluntary risk-entrenchment being the remaining two. Overall, the first three are considered to be regulatory induced while the latter one

[10] We will show later that high CRs can also drive a bank towards the same result in a less direct manner.

[11] Clearly, this cannot be discounted for any study of the 2007-2009 crisis.

is non-regulatory. Their paper also investigates two Demand-side hypotheses which we account for as well by using additional macro-economic and time-related variables[12].

Using data from the Federal Deposit Insurance Corporation (FDIC)'s Quarterly Consolidated Reports of Condition and Income (Call Reports), B&U come to the conclusion that the RBC CCH is not implicated in a verifiable causal way to the first crisis. This is in contrast with some of their other hypotheses and, more importantly, with the mainstream literature opinion at the time. However, this research differs with a crucial assumption that is made by the authors in support of their finding: the uniformity in bank behavior with regard to various assets categorized in RW buckets. Our first contribution will be in disproving this assumption which leads us to argue that it does not hold for discounting the RBC CCH for either first or second crisis. This allows for the reconciliation of B&U's results with contemporaneous work.

It also opens up the possibility for examining if any of the validated hypotheses withstands the test of time going into the subprime crisis. In fact, B&U had foreseen that even if the RBC CCH was rejected for the first crisis, its importance could become instrumental in the future with the advent of additional types of risk. This goes hand in hand with the statement by Barajas et al. (2004) that the enhancement of the RW scheme for credit risk valuation under Basel II should make loans more sensitive to new risk factors. This has certainly fueled the incentive to explore the RBC CCH from a different angle as well as investigate further plausible hypotheses for the second crisis. Indeed, the merit of our approach is that it showcases the relative importance of the different factors tested simultaneously. What's more, the variables chosen to illustrate the liquidity hypothesis are in line with the Basel III approach and should hence serve as a first hand validation.

Note that the second crisis is even more controversial as the element of whether or not the new regulations were enforced by the time the crisis unfolded is still subject to debate. We address this issue before proceeding with the model. Another difference, as mentioned earlier, is that the worse affected area is not the same for each crisis. We direct our efforts accordingly towards establishing in a clear-cut manner which states fall under this umbrella in order to control for region-specific demand factors for the second crisis.

Hence, this paper tries to build on the similarities and/or differences between the two crises in an effort to clarify the actual impact Basel had each time. In essence, we attempt to verify whether the "credit crunches" can be jointly regarded as "capital crunches" as the term was coined for the first of the two crises. Overall, this will allow for a forward looking assessment of what the new Basel III accord will bring, suggesting whether or not the new regulation will be a fruitful enhancement, especially regarding the coexistence of the CR and LR.

Our research features closely connected aspects with other work in the literature starting with Barajas et al. (2004) who explore the RBC CCH in developing countries. Interestingly, many of these countries were contemplating, at the time of writing, to engage in the adoption of Basel II. Still, the study is exclusive to the impact of Basel I. The authors stress that although loan lending per se increased after the Basel Accord, its growth rate slowed down in some countries due to an increase in both regulatory scrutiny and sensitivity to certain risk factors. On the other hand, Berger and Bouwman (2010) use data spanning from 1984-2009[13] in order to assess the differential impact of bank capital during normal times as well as in five financial crises. Two out of the five are the ones used for comparative purposes in this research. Their work can be seen as complementary

[12]The authors named these hypotheses "macro-regional" and "secular decline" accordingly.

[13]Obviously this entails a data homogeneity issue since Call Reports did not feature Basel requirement data variables prior to 1990 and hence had to be manually collected from the FED. The same occurs in Furfine (2000).

to ours as it focuses on the risk and profitability components with regard to CRs, abstracting from any growth analysis. Their results stress the fact that capital does improve the banks' survival rates regardless of size. Still, their work has no comparative value to account for any Basel-related impact as they incorporate other market and "fake" crises. Finally, from a return point of view, Demirguc-Kunt et al. (2010) find that over a cross-section of countries, a firm's market value is more sensitive to LR than CR despite admitting that stock returns are an imperfect performance indicator.

This research is thereby structured as follows. In section 2 we provide the justification for a causal link between Basel and the second crisis. In section 3 we describe the empirical framework. We then run the model and elaborate on its findings in section 4. Section 5 showcases the results of our robustness tests. Finally, we conclude with the main contributions and policy implications along with possible extensions for future work.

2. Motivation

2.1. Basel II and the Subprime Crisis

Compared to the first crisis, labeled the "second most shallow" recession by Greenspan et al. (2010), the second crisis was the worst since the Great Depression as has often been quoted by White House officials. It has been blamed on a decade of seemingly endless prosperity as well as low inflation and long-term interest rates. Together, these factors contributed to the reduction of global risk aversion to unprecedented levels. Hence, if Basel were to be held responsible this time again, the stigma on the regulators would certainly be higher.

2.1.1. Using Basel II as a point of impact

Set aside the few changes in RWs which yielded a final version of the CR (McDonough Ratio), the minimum capital requirement section remained virtually the same in the updates that followed the first Basel II paper in 2004. In fact, the final guidance took effect in April 2008 which only dealt with more advanced features of the regulation such as the Internal Ratings Based Approach and the Advanced Management Approach. Not to mention that, as per Berger et al. (1995), the worldwide full implementation of Basel II was initially scheduled for 2011[14].

Still, one cannot automatically cast out any linkage between Basel II and the new crisis simply based on effective implementation dates. The reason for that is twofold: first, banks, in order to gain competitive advantage have interest in implementing the regulations as soon as possible (a.k.a. regulatory arbitrage) unless there is doubt that these will change again[15] which is not the case here. In that respect, Hall (1993) confirms that banks worldwide had already gained some insight into the RBC guidelines as early as 1987 (joint US/UK agreement). Being a decisive member of the G-20, the U.S., in 2004 just like in 1988, had no excuse not to have begun implementing at least the established sections regarding capital requirements. Moreover, Montgomery (2005) spotted that coefficients on book-based capital-to-asset ratios (LR) in Japan were insignificant during the pre-Basel I years but turned significant almost immediately afterwards. This finding attests to the speed the impact of the news is felt, albeit for guidelines outside the regulation per se.

[14] i.e. a year after Basel III was endorsed at the Seoul Summit. For a full review on the exact timing for enforcing capital requirements in relation to the crises, we refer the readers to the IMF Article IV Consultation documents.

[15] Or there is some particular gain from delaying the implementation process.

Second, the timeline for the roll-out of Basel I was as follows: the first set of regulations was adopted in 1988, full set by 1989, beginning of phase-in around 1990, yet only fully implemented in 1992 (i.e. post-crisis). Still, a survey by the Federal Reserve Board showed a shift from commercial and other loans to residential mortgages as early as 1989 (Shrieves and Dahl (1995)). What's more is that Hancock and Wilcox (1994) stress their assumption that going into the crisis, banks acted as if the 8% threshold for the CR had already been implemented. At the time, this change affected the calculation of minimum CRs[16] much more than in between Basel I and II. These authors as well as various others including Avery and Berger (1991), Shrieves and Dahl (1992) and Angkinand (2003)) constitute the backbone for a causal effect between Basel I and the first crisis which goes beyond the actual phasing-in of the regulation. In similar fashion, we motivate our choice of Basel II as a point of impact for the second crisis.

2.1.2. The Critical Change in Basel II

A crucial change which came with the new regulation was the lowering of the RW on collateralized residential mortgages from its previous level of 50% down to 35%, placing them in a category closer to T-Bills than risky loans. Overall, the layer of equity required from banks saw only a "modest increase" (Greenspan et al. (2010)) if not a diminishment compared to what happened after Basel I (Benink and Kaufman (2008)). This could be seen as an incentive for banks to hold more of these mortgages on their books in order to economize on capital. The reason was that the collateral embedded in these instruments categorized them alongside lower RW assets while still generating a higher than normal economic rent for the undertaken level of risk.

Blundell-Wignall and Atkinson (2010) state that collateral plays a big part in deciding the RWs for assets which explains why mortgages (RW=50%) are considered safer than C&I loans (RW=100%). This is irrespective of the creditworthiness of each borrower and other quality components as remarked by Tanaka (2002) and Watanabe (2007). In view of what happened during the crisis regarding the over-valuation of this collateral when the housing bubble exploded, the regulatory incentive to take on more mortgages may be seen as misplaced thus adding to the criticism of Basel II[17].

2.1.3. The Basel II effect on loan growth: a two-way street

In the words of Kishan and Opiela (2000) the credit channel is formed by two subchannels: the borrower net worth channel (BNWC/demand) and the bank lending channel (BLC/supply). While the main factor that contributed to the crunch did not come from the conventional demand side as in deposit draining, supply was affected by a "relatively" exogenous[18] effect linked to the deterioration of loan quality on the part of mortgage buyers. Thus the BNWC did contribute to the change in supply unlike what happened during the first crisis where the cutdown on supply was mostly independent from the borrower pool. This will not be the first time such a point is made: Yoshikawa et al. (1994) do not consider RBC in particular but argue that a credit crunch can be induced by a demand rather than a supply shift, albeit for different reasons than those mentioned here. On that note, Baba (1995) shows that in a disequilibrium framework, the weakest factor between demand and supply determines the actual size of bank lending.

[16] Reduction in the role of loan loss reserves which are part of Tier 2.

[17] Still, lowering the RW on mortgages (without adequate safeguards) might not have been entirely misplaced. Avery and Berger (1991) have lent some support to the first lowering of RW down to 50%.

[18] This adjective is used to stress that bank behavior was partly responsible for that deterioration.

Comparing with the first crisis estimates reported in Milne (2002), it seems that banks prior to the subprime crisis were well over-capitalized. According to Chami and Cosimano (2010), in the early stages of the second crisis, the top 25 banks in the U.S. and Europe had a Tier 1 CR of 8.3% and 8.1% while Total CR was 11.4% and 11.6%, respectively[19]. This induced banks into thinking they could take on excessive risk, a.k.a. moral hazard (Brinkmann and Horvitz (1995)). Once defaults started to occur on bank loan portfolios, the equity layer was systematically eroded by the losses. This pushed banks to contract their lending, thus turning the subprime crisis into a credit crunch. In other words, the write-offs against equity capital due to Non-Performing Loans (NPLs[20]) carried more weight this time than the decreases in RWA due to mortgage investment, thus bringing down the CRs.

In sum, the CR is affected by two forces. One which acts on the component related to RWA and the second which is linked to the banks' capital cushion. Therefore, banks can achieve a certain CR by either increasing their capital, decreasing total assets or shifting to lower risk-weighted (RWA) assets. Definitely, reduction in lending rather than recapitalization is seen more often than not as the easier way out to maintain a target CR. This is more so the case when economic conditions are deteriorating (Jackson et al. (1999)) and/or when the changes in regulation are essentially minor (Hyun and Rhee (2011)). Clearly, both conditions were met for the second crisis as the U.S. slid into recession while the CR requirements did not change that much from the days of Basel I.

More generally, one can regard the first crisis as an example of a decrease in bank riskiness, owing to a flight to quality to meet capital requirements (decrease in RWA), which resulted in a direct adverse effect on growth. Yet, what appears to be true for the second crisis is a different cause-effect relation. More specifically, the indirect consequences of the increase in risk-taking (decrease in capital) lead to a subsequent slowdown in growth. Clearly, this relates back to the unresolved impact of Basel on bank risk-taking. Obviously, if such a two-way street is found to be true this will lessen blame on the regulators. The rest of this paper is dedicated to verifying the claim for the second crisis.

2.2. Theoretical Basis

The B&U assumption concerning the uniformity of bank behavior can be stated as follows: under the RBC CCH, one should expect a uniform movement into/out of a certain RW-bucket, in this case the 0%/100% category, when the bank is subjected to a regulatory change (like Basel) which impacts capital requirements.

However, as per Keely and Furlong (1990), banks make decisions on the basis of an investment, rather than a RW, opportunity set. Of course the point we make here can be more easily understood if one chooses mean-variance decision-making rather than utility maximization[21] as one could erroneously consider that a bank derives the same utility, in terms of capital requirements, from all assets in a certain RW-category. However, this can be countered by assuming the banks' utility function is dependent on more than just capital (Kamada and Nasu (2000)). This is normally the case as one might argue for instance that profit and tax are among the leading parameters.

Moreover, in the words of Rochet (1992), competitive portfolio managers are responsible for establishing the overall behavior of a bank. Such claim requires a certain level of granularity that cannot be met by simply considering assets as being part of a bucket (RW-category) for reasons

[19] On an international level, Demirguc-Kunt et al. (2010) find median values of 9.7% and 11.9%.

[20] Defined as 90 days or more past due and non-accrual.

[21] The two can be mapped into each other in modern portfolio theory (Efficient-Market Hypothesis).

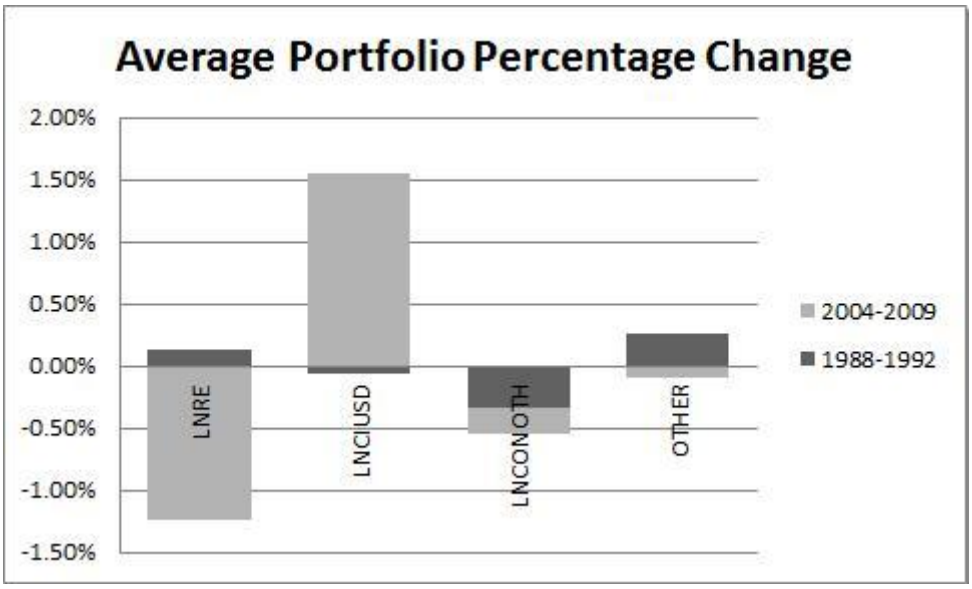

Figure 1: Change in portfolio composition from managers' perspective for various loan categories in credit crunches.

such as diversification gains[22]. In that respect, Merton (1995) made a stand against the regulators' idea of asset categorization instead of estimating the underlying instruments' contribution towards portfolio risk. In other words, for their uniform assumption to hold, B&U seem to be looking at matters from the regulators' point of view; whereas explaining a bank's decision-making regarding lending for instance has to be seen from a portfolio manager's eye.

In order to do just that, the average change in percentage portfolio composition for each loan category is computed from the Call Reports during crisis and pre-crisis periods following the news of imminent Basel regulation. This is done for both crises. The results shown in Figure 1 showcase how managers changed their overall perception of the risk inherent to each loan class. This was reflected in the change in lending behavior, in two out out of three loan categories belonging to the two highest RW-classes. For example, whereas the composition increased for residential real-estate mortgages (LNRE) during the first crisis, it decreases during the second for reasons stated previously. Clearly, this would seem counterfactual at first if not seen from a portfolio composition perspective especially as mortgage percentage growth was higher than the overall portfolio growth in both crises. The opposite is true for commercial and industrial loans (LNCIUSD); whereas the only class that was perceived almost identically was consumer lending (LNCONOTH). This substantiates an obvious pattern reversal in risk aversion at loan level rather than RW class[23].

Therefore, one must differentiate between a certain category of loans' growth rate and its change in percentage allocation within the portfolio. So, presuming that under the RBC CCH, the reaction by banks to capital regulations will be uniform in each RW category is flawed, according to the assumptions of this research. This allows for a re-interpretation of B&U's results in a manner more reflective of the Basel I impact on the 1990-1991 credit crunch. Consequently, this would probably realign their findings with the vast majority of the literature in corroborating the RBC CCH. Still,

[22] Although doing so allows for profit maximizing derivations such as Tanaka (2002)

[23] Note that the impacts for LNRE and LNCIUSD are far more pronounced during the second crisis compared to the first.

while the meaning of the results is likely to change, the basis for their model remains intact. We therefore set out to see how it performs for the second crisis.

3. Testing the Basel II Impact on the 2007-2009 Crisis

3.1. Data and Sample Description

Our data is culled from a single source based on required bank filings, the FDIC Call Reports[24] over the period 2004Q3-2009Q2. Our final dataset comprises of almost 10,000 banks and more than 100,000 bank-quarter data points. In comparison, B&U's sample size consisted of more than 600,000 observations as they used a much longer control period dating back thirteen years prior to the first crisis[25].

In this setup we establish the control and crisis periods in the following manner. We use the first time period after the Basel II declaration, i.e. the third quarter of 2004, as the start of the control period. In line with what we observe for the first crisis, this gives time until the second revision in 2006 for the changes in bank behavior to take place. As for the beginning of the crisis, our choice of the third quarter of 2007 agrees with that of Berger and Bouwman (2010), Moosa (2010) and Gambacorta and Marques-Ibanez (2011). Finally, inspecting the changes in GDP for the U.S, the second quarter of 2009 was the last one in which growth was negative. In contrast with the conservative approach in Demirguc-Kunt et al. (2010)[26], this lead us to concur with Atkins and Hall (2009) that was the end of the U.S. recession[27].

3.2. Variable Definition

The table below lists, among others, the variables used in B&U's model along with their control and crisis period averages. The dotted line separates the authors' original variables from the additional ones we define in order to determine the scenario for the crisis.

We start with our focus on growth for each of the four RW classes (RB0, RB20, RB50 and RB100) as well as on individual asset types that fall into these categories. For instance, under RB100, we have as dependent variables[28] commercial and industrial loans (CILN), real estate loans (CRLN) and installment/consumer loans (INLN). This is followed by the main RISK factors in Panel C which allow for the testing of various hypotheses: Tier 1 and Total CRs (RBC CCH), LR (leverage CCH), and NPL to total assets ratio (risk-retrenchment).

Most macroeconomic variables in Panel D are obtained from Datastream except for state unemployment (STUNEMP, US Bureau of Labor Statistics), state income (STGROW, US Bureau of Economic Analysis), BAA-AAA spread and Treasury interest rates for various maturities (FED). We also added the inverse money velocity defined in Barajas et al. (2004) as "the absolute annual

[24]This shelters us from having a huge discrepancy in the the number of observations for each bank, what Gambacorta and Marques-Ibanez (2011) call the "cost in terms of the representativeness of the sample". Indeed, merging two disparate databases yields a significant difference in the number of data points for two of their dataset variables, Tier 1 and EDF. A similar problem arises in Nichols et al. (2011) and Demirguc-Kunt et al. (2010) where the panel set is unbalanced as data is not available for all banks every year.

[25]Still our R^2 are of similar magnitude to theirs.

[26]These authors chose the first quarter of 2009 as the crisis end.

[27]Some authors base their intuition on the assumption that a recession ends when GDP output returns to its pre-recession level. However, following the second crisis, France and Germany were declared out of recession on the first occurrence of positive growth; despite the fact that fundamentally, two quarters are necessary to call the end of a recession.

[28]The growth rate in all variables is scaled by the GNP deflator.

Table 1: Variable Definition and Sample Means

Symbol	Definition	Control	Crisis
	A. Endogenous Asset Growth Rates		
CILN	Real quarterly growth rate of commercial and industrial loans	0.020	0.014
CRLN	Real quarterly growth rate of commercial real estate loans	0.027	0.031
INLN	Real quarterly growth rate of installment loans	-0.008	-0.003
RB100	Real quarterly growth rate of assets in RW 100% category	0.019	0.015
USTRA	Real quarterly growth rate of U.S. Treasuries&Agency obligations	-0.011	-0.208
RB0	Real quarterly growth rate of assets in RW 0% category	-0.021	0.014
USTA	Real quarterly growth rate of U.S. Agency obligations	0.089	-0.130
USTREAS	Real quarterly growth rate of U.S. Treasuries	-0.091	-0.071
CURR	Real quarterly growth rate of currency and coin	-0.009	0.008
RSLN	Real quarterly growth rate of residential real estate loans	0.011	0.028
TLRE	Real quarterly growth rate of total real estate loans	0.019	0.019
TLN	Real quarterly growth rate of total loans	0.017	0.016
RMBS	Real quarterly growth rate of RMBS	-0.017	0.075
FGNMA	Real quarterly growth rate of RMBS guaranteed by FNMA, FHLMC or GNMA	-0.020	0.069
RB20	Real quarterly growth rate of assets in RW 20% category	0.000	0.002
RB50	Real quarterly growth rate of assets in RW 50% category	0.008	0.041
(The growth rates are measured in continuous-time terms as $\dot{Y}_{it} \equiv lnY_{it} - lnY_{it-1}$ for bank i at time t)			
	B. Credit Crunch Dummy Variable		
CRUNCH	Dummy variable equals one for crunch periods	0.000	1.000
	C. Bank Perceived Risk Variables (RISK)		
	(Each averaged over the four previous quarters)		
T1RAT	Negative of the ratio of Tier 1 capital to RWA	-0.216	-0.207
TOTRAT	Negative of the ratio of Total capital to RWA	-0.227	-0.218
LEVRAT	Negative of the ratio of Tier 1 capital to UWA	-0.118	-0.118
NPFRAT1	Ratio of nonperforming loans to UWA	0.005	0.012
CRRAT	Ratio of commercial real estate loans to UWA	0.155	0.167
LIQRAT	Negative of the ratio of liquid assets to UWA	-0.116	-0.098
LCR	Dummy variable based on Basel III LCR	0.999	0.992
T2RAT	Negative of the ratio of Tier 2 capital to total RWA	-0.011	-0.011
NPFRAT2	Ratio of nonperforming residential loans to UWA	0.005	0.013
NPFRAT3	Ratio of nonperforming assets to UWA	0.007	0.015
LLP	Provision for Loans and Lease Losses	1882.702	9284.494

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Table 1: (continued)

Symbol	Definition	Control	Crisis[1]
LLPCHOFF1	Total Net Charged-Off Loans and Lease Losses	275.082	1332.062
LLPCHOFF2	Provision for Loans and Lease Losses as % of net charge-offs	0.822	2.097
LNCHOFF	Ratio of residential loan chargeoffs to total charge-offs	0.013	0.015
(Each RISK variable[2] is also included as 1/2 RISK^2, CRUNCH*RISK, and 1/2 CRUNCH*RISK^2.)			
	D. Macroeconomic and Regional Variables (Each lagged one quarter)		
GNPGROW	Real growth rate of GNP (%)	1.403	0.188
UNEMP	National unemployment rate (%)	4.967	5.675
STGROW	Real state income growth (%)	0.007	-0.001
STUNEMP	State unemployment rate (%)	4.760	5.914
NE	Dummy variable, equals 1 for New England states	0.042	0.038
BAA-AAA	Difference in yields between Moody's BAA and AAA rated LT bonds	0.853	1.706
RF3MO	Interest rate on three-month Treasury securities	3.815	1.730
DM3GDP	Absolute annual change in the ratio of money and quasi-money to GDP	0.004	0.016
INFL	Inflation Rate (%)	3.136	2.566
GDPCAP	GDP Per Capita	4.760	5.914
SW	Dummy variable, equals 1 for South West states	0.040	0.045
(The square of RF3MO is also included.)			
	E. Time and Seasonal Variables		
TIME	Time trend, starts at 1 in 2004:Q3 and incremented by 1 each quarter	6.500	16.500
SEAS1	Dummy, equals 1 for the first quarter of the year	0.250	0.250
SEAS2	Dummy, equals 1 for the second quarter of the year	0.250	0.250
SEAS3	Dummy, equals 1 for the third quarter of the year	0.250	0.250
(Observations in the fourth quarter constitute the base group.)			
	F. Term Structure Slope Variables (Each lagged one quarter)		
SLOPE+	Slope of the term structure if it is (+). Calculated as the 30YR[3] Treasury rate less RF3MO, divided by the duration of a 30YR Treasury (x10 to adjust units). Set to 0 if the slope is (−).	0.923	2.066
SLOPE-	Same as SLOPE+ except that is set to 0 if the slope is is positive rather than negative.	-0.029	-0.000
(The SLOPE+ and SLOPE-variables are also included as $1/2SLOPE+^2$ and $1/2SLOPE-^2$)			

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Table 1: (continued)

Symbol	Definition	Control	Crisis[1]
	G. Bank Size and Competition Variables		
MEDIUM	Dummy variable, equals 1 if \$100 million $\leq$ UWA $<$ \$1 billion	0.499	0.535
LARGE1	Dummy variable, equals 1 if \$1 billion $\leq$ UWA $<$ \$10 billion	0.056	0.063
LARGE2	Dummy variable, equals 1 if UWA $\geq$ \$10 billion	0.012	0.012
HERF	Herfindahl index of local market concentration	0.125	0.127
SHARE	Bank's share of local market deposits	0.098	0.094
(Banks with less than \$100 million in total assets are in the base group.)			
	H. Primary Federal Regulator Identity Variables		
OCC	Dummy, equals 1 if bank is OCC-regulated	0.215	0.197
FDIC	Dummy, equals 1 if bank is FDIC-regulated	0.582	0.601
OTS	Dummy, equals 1 if bank is OTS-regulated	0.099	0.098
(Banks that are Federal Reserve-regulated are in the base group.)			
	I. Profit and Spreads		
S_CILN	Spread of Commercial and Industrial loans	0.036	0.031
S_LNRE	Spread of Residential loans	0.025	0.022
S_INLN	Spread of Consumer loans	0.040	0.044
S_RMBS	Spread of RMBS	0.036	0.022
S_USTR	Spread of Treasuries	-0.004	-0.004
S_EQ	Spread of Equity	0.088	-0.001
NINCRAT	Net Interest Income as a percent of average earning assets	0.041	0.038
	J. Securitization		
XRERAT	Serviced for others Residential loans divided by total serviced for others assets	0.839	0.790

[1]The Credit Crunch Period corresponds to 2007Q3-2009Q2, and the Control Period corresponds to 2004Q3-2007Q2
[2]Except the newly added ones
[3]Changed to 20YR due to data availability

change in the ratio of money and quasi-money to GDP" (DM3GDP, IMF International Financial Statistics). This should account for shifts in public's demand for bank deposits. Another variable we use is inflation (INFL), as in Hall (1993), to gauge the impact of any inflationary component during this crisis. We also resort to GDP per capita (GDPCAP), as in Angkinand (2009), to complement the growth rate in GNP (GNPGROW).

For consistency with B&U, we include time and seasonal variables[29] in Panel E. These are supplemented in Panel F with interest rate term structure variables such as SLOPE. We obtain Bond duration from CRSP. Note that the separation between positive and negative slopes is designed to control for added demand and supply effects as per B&U. Moreover, we control for bank size and competition[30] in Panel G. Note the addition of the OTS variable to the three regulatory dummy variables (OCC, FDIC and FED) to uncover any thrift-related effect as part of Panel H. All remaining variables will be explained in the upcoming sections. We now proceed to interpret the findings between the two crises.

3.3. Estimate Comparison between Crises

Overall, what was common between the two crises was the decrease in the riskiest asset category (RB100). Similarly, as in the first crisis, individual loan categories pertaining to that class did not behave in uniform manner (cf. Figure 1). For instance, commercial and industrial loans ($C\&I$) decreased whereas commercial real-estate loans decreased in similar fashion to their behavior during the previous crisis. This was not the case for consumer loans which had contrasting behaviors between the two crises. While the decrease in $C\&I$ loans is clearly indicative of a credit crunch[31], the increase in real-estate loans despite the related market turmoil is not that straighforward to interpret. B&U had previously blamed this upward trend on a change in accounting standards. Although this hypothesis could have been true at the time the only viable explanation this time is a change in bank's risk appetite.

In contrast to the first crisis where the market observed a flight to quality, US Treasuries and Agency Obligations fell by an order of magnitude during the second. However, the risk category RB0 which contains treasury securities had a much stronger increase than in the first crisis, even forcing a sign reversal. That was despite the fact that treasuries account for the largest proportion of this category[32]. This goes against B&U's claim that during the first crisis, the shrinking of non-Treasury components was behind the very small increase in RB0 relative to US Treasuries.

With regard to capital requirements, both CRs and LR increased in absolute value from the levels they were at in the first crisis[33]. This is illustrative of the magnitude of overcapitalization and low leverage. However, unlike the first crisis where they increased between pre-crisis and crisis periods, the reaction this time was the opposite; except for leverage which seems quite resilient to any change as was also picked up by Hall (1993)[34] during the earlier crisis[35]. This is proof to what

[29] All seasonal variables are equal because by construction it so happens that we have the same number of quarters belonging to each seasonal group.

[30] The Herfindahl index is computed internally from the dataset.

[31] Hall (1993) comes to the same conclusion.

[32] Close to 40% during the first crsis according to B&U.

[33] A possible justification for this overcapitalization is provided later when we mention the effects of securitization on bank capital.

[34] Between 1990 and 1992, the average LR increased by less than a third of the absolute growth in CR.

[35] However, our central estimates conceal the fact that overleveraging and deleveraging occurred within very small spans of time prior to and during the crisis respectively; which is probably why no change is observed here. On the other hand, this explains why deleveraging efforts continue as we speak, years after the crisis.

was stated earlier that in the first crisis, banks were responding to the new regulations and hence increased their capital cushions; whereas during the second crisis, the pre-crisis inflated cushions became eroded by losses. Hence our result for the second crisis agrees with B&U's claim that Basel regulation was effective in changing bank behavior. However, in this instance, due to the banks' leveraged positions, their tendency seems to be towards a more risky appetite.

One of the most important variables that emerged as the leading risk indicator is the NPL ratio (NPFRAT1). Contrary to the first crisis, this ratio went up by almost 150%[36] the level it was at prior to the second crisis[37]. Although B&U demonstrated that Basel I pushed banks towards loan examination and voluntary risk-entrenchment, this was hardly the case during the second crisis which was characterized by lack of due diligence and predatory lending. The losses could also have spread to corporate loans which would explain the increase in BAA-AAA spread that is used to control for borrower risk at the corporate level[38].

In terms of macroeconomic variables, the second crisis period saw a drop in GNP growth along with an increase in unemployment at both national and state levels. Note that, according to B&U's estimates, national level unemployment decreased during the first crisis. According to Hancock and Wilcox (1994), such a fall in unemployment rate should not always be regarded as a sign of economic strength, as this might also be because of other effects such as the "discouraged worker".

This could also reflect on why competition is bleak at state level. The overall magnitude of the Herfindahl index (HHI) was halved compared to the first crisis indicating an increase in competition or a decrease in market power. This is consistent with our finding that the number of banks in New England (NE) doubled between the two crises[39]. A smaller decrease is also observed for deposit SHARE competition. However, whereas the HHI increased during the crisis compared to the control period, SHARE had the opposite behavior.

To resolve the matter we turn to national level, as opposed to state-level, indicators. Wright and Quadrini (2009) prove not only that, in the second crisis, both indicators reflect a sharp decrease in competition, but also the speed at which that decrease happened is quite remarkable. Indeed, over the 1990-1992 period, the national HHI index remained more or less the same contrasting with the pattern that began soon afterwards and continued to increase[40] linearly up until 2004. This 'linear' trend continued until 2005, albeit less steeply until 2009 where the index doubled the level it was at in 2003. We believe this is due to the high number of take-overs and survivorship bias that succeeded the first crisis. This is important to bear in mind as Chami and Cosimano (2010) argue that competition in the banking sector could lead to a reduction in capital which constrains bank lending supply, relating to the concept of a "bank capital financial accelerator".

Finally, movements in the positive slope of the term structure of interest rates (SLOPE+) between crisis and control periods are opposite to the first crisis but this variable is clearly sensitive to the number of quarters used for each period. What matters is that we find a value of zero for

[36] More than a tenfold increase in anti-logarithmic terms.

[37] The reason is because the asset base of banks in terms of unweighted assets increased on average by an order of magnitude between the two crises. This can also be seen in the changes to MEDIUM and LARGE banks where the increase in FDIC-regulated banks mirrors that in the more numerous MEDIUM banks, whereas the (to a certain extent) lesser increase in LARGE banks is shown by an opposite but equal decrease in OCC-regulated banks.

[38] CRRAT was the only variable consistent in both crises (increase). However, B&U consider this a "surprising" finding. We will address this issue later on.

[39] This dummy variable will become obsolete as we will show NE is no longer the region that was mostly affected by the second crisis.

[40] Increases in the index reflect decreases in competition.

the negative slope during crisis times, where the number of quarters is roughly the same, This suggests a move toward safe investment on the long-term and agrees with B&U's explanation that keeping the levels of short term interest rates fixed (RF3MO), Treasury investments, on aggregate are responsive to changes in the slope of the interest rate curve.

3.4. Controlling for Demand Factors by Geographic Region

The SW variable in Panel D controls for the demand component originating from the South West states of California, Nevada and Arizona. This should mimic the effects of the NE variable that accounted for the worse affected regional states (New England) during the first crisis (see Peek and Rosengren (1992), Peek and Rosengren (1993), Peek and Rosengren (1994) and more recently Ghosh (2008)[41]).

In order to establish that the South-West region was indeed the worse affected, our starting point is the foreclosure survey conducted by Realtytrac (2009) which indicates that the number of foreclosures is the highest (5-9%) in the mentioned states along with Florida[42]. However, foreclosure by itself is not a direct measure of losses in dollar terms in the way that NPLs are[43]. For that purpose, in Figure 2, we use our three NPL variables NPFRAT1 (Black), NPFRAT2 (Gray), NPFRAT3 (Striped), as defined in Panel C, in order to ascertain which geographic states incurred the heaviest losses in ranking terms[44]. As can be seen from the graph, Arizona and Nevada did not figure amongst the worse affected states prior to 2008Q1; whereas, towards the end of the crisis, both were in the top five with Arizona occupying first place.

So far, these measures were computed in relative terms with respect to the state's asset base. However, banks in some states had such large balance sheets that these measures were diluted and did not showcase the true severity of the shock. This is the case of California. Indeed our values[45] show that while Nevada headed all states in terms of absolute loan loss, California also ranked around 10th on an average basis during the crisis.

Hence California cannot be discounted as a subset of the SW states that suffered the most. We therefore include it and find that the likelihood of belonging to the worse affected states doubled during the second crisis. Remarkably, the increase between control and crisis periods reported in Table 1 almost coincides exactly with NE's decrease in both crisis[46].

3.5. Credit Crunch Hypotheses - Revisited

Although the original RBC CCH tested by B&U focused on the lending behavior of banks constrained with low CRs, we apply an adapted version of that hypothesis for banks with high CRs. Based on the manner in which the second crisis unfolded, that too can have harmful consequences

[41] Mian and Sufi (2009) only look at ZIP code differences which does not capture regional effects

[42] Since we are only interested in accounting for an area-specific geographic component, although Florida did lead the group, it does not account for the factor we have in mind.

[43] Foreclosure does not reflect the value of the property itself or the size of the write-off. Also, foreclosures entail a legal factor which, depending on clients, may be postponed depending on the type of default and mortgage renegotiation (forbearance).

[44] A ranking of zero was given whenever the state fell outside the top 15.

[45] Not reported here, but available upon request from the authors.

[46] This is merely an artifact of non-monotonicity in our sample period as the SW banks decreased by twice as much during the crisis then they did in the control period which is also almost twice as long by construction. Yet, during the early stages of the crisis (first four quarters), there was a strong increase in SW banks to levels surpassing even those at the beginning of the control period which is responsible for the upward push in the estimates.

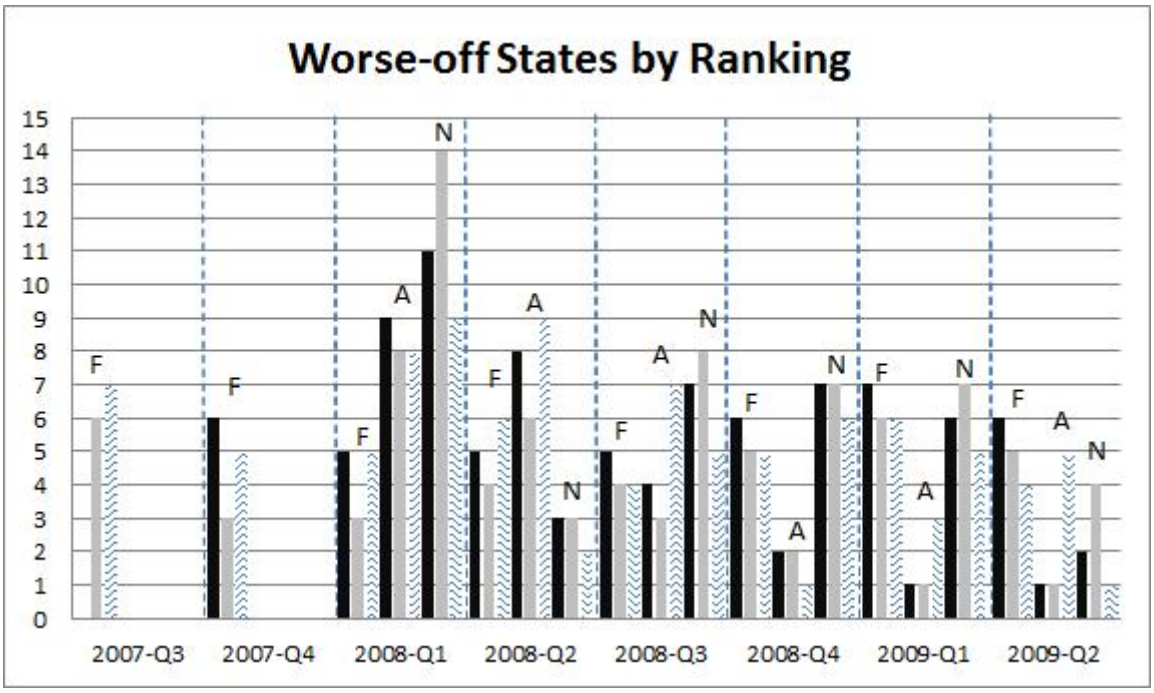

Figure 2: Variation in South West worse affected states (2007-2009) *Source: Authors' calculation*

on lending. Also, aside from the RBC and Leverage CCHs, there are also other distinct hypotheses which could potentially jeopardize RBC. After, revisiting the Voluntary Risk-Retrenchment hypothesis that prevailed during the first crisis, we introduce new hypotheses related to liquidity, profit and securitization. This will complete the overview of the variables listed in Table 1.

3.5.1. Voluntary VS Coercive Risk-Retrenchment CCH

One of the non-regulatory supply-driven hypotheses which combined the impacts of Leverage and NPLs was the Voluntary Risk-Retrenchment CCH. Testing for such a hypothesis during the second crisis would seem misplaced as it is based on banks voluntarily reducing their risk-seeking activity which would lead to a cutdown on risky lending (supply-side). However, such behavior can also be coerced when banks are obliged to respond to high losses coming their way from their borrowers (demand-side). Note that this is not a typical demand effect in the sense of a decrease in demand for loans or deposits per se. In fact, it stems from the repercussions of an initial phase of high risk-seeking activity on behalf of the banking sector. We thereby dub the new hypothesis *Coercive Risk-Retrenchment CCH.*

3.5.2. Liquidity CCH

Loutskina and Strahan (2009) have re-iterated the fact that a bank's willingness to supply credit can be driven by funding and liquidity. In fact, as stated in Demirguc-Kunt et al. (2010), the once considered liquid RMBS holdings rapidly deteriorated once the crisis unfolded. We therefore construct two liquidity indicators as part of the RISK factors in Panel C:

1. LCR is a dummy variable constructed on the basis of the short-term Liquidity Coverage Ratio

currently under development in Basel III[47] to address one shortcoming of the CR. The latter is defined as the ratio of high quality liquid assets to net cash outflows and should be greater than 100%. However, the ratio is not to be calculated based on the daily performance of banks but rather based on a thirty day stress scenario. In other words, the denominator of the LCR could turn negative during dire conditions which would necessitate coverage by highly liquid assets. Since we cannot backtest the banks' performance and do not have the stress scenario at our disposal, we construct a modified LCR ratio using the daily performance of banks under the premise that as banks entered the crisis, this could be considered a stress scenario in itself. Hence, if the net cash outflows[48], proxied by the conventional IBEFTAX, are positive or if the bank has enough liquid assets[49] to cover any inbalance in cashflows, our LCR measure takes a value of 1; otherwise 0. Unfortunately, as shown in Table 1, this ratio decreased by a very small margin between control and crunch periods. This is due to the fact that although the number of established illiquid banks almost quadrupled, compared to the overall number of banks, this remained only a small proportion.

2. Although our LCR proxy remains the closest approximation we have to the regulators' designated variable, in order to address the tractability issue, we define the variable LIQRAT as the ratio of Total Quality Liquid Assets to UWA, pre-multiplied by a negative sign to mimic the logic behind some of the RISK variables (see section 4).

3.5.3. Profit and Spreads CCH

Basel regulators have stressed the importance of abiding by all three pillars of the regulation in order to clear any speculation that pillar I on its own did not fulfill its purpose. In other words, whereas it is the duty of pillars II and III to account for it, excessive profit seeking activity, a.k.a. predatory lending, seems to have jumped off the barriers of regulation during the recent crisis. In fact, the words of B&U for the first crisis acquired even more significance during the second as they highlighted the fact banks were still willing to issue mortgages on the same terms and conditions as they did in previous times, even though the mortgagees' creditworthiness had deteriorated. This lead Nichols et al. (2011) to account for profit variables such as ROE[50], ROA and NIM (Net Interest Margin) in their model. We use the latter in the definition of our NINCRAT variable in Panel I, scaled by UWA to obtain a relative measure that is more consistent across banks.

This paper will not have been the first occurrence of using spreads to measure excessive profit-seeking bank activity. Hall (1993) expressed that in the first crisis, spreads between loans and Tbills went up by 50 bp. This was re-emphasized by Gambacorta and Marques-Ibanez (2011) who argued that revenues also had an impact regarding loan supply movements. However, to make the spread more specific to a particular item on the balance sheet (S_i), we compute one for each of the individual categories **i** as well as equity: S_CILN, S_LNRE, S_INLN, S_RMBS, S_USTR, S_EQ (Panel I). Each spread is computed using the formula below. In the case of the ROE spread, it is

[47] We would have done the same for the second (long-term) liquidity ratio, the Net Stable Funding Ratio; however, our database is not sufficiently granular in order to accommodate the breakdown as defined by the regulators.

[48] Defined as cumulative expected cash outflows minus cumulative expected cash inflows.

[49] Note that the items that serve as liquid assets are incorporated in a standalone variable in the FDIC database.

[50] Because it is not risk-adjusted, ROE can be a misleading measure for performance as it can be boosted by leverage. It does, however, reflect the extent to which capital is viewed as a regulatory tax. It can also create the incentive to trim down low-return assets to increase CRs.

simply the ROE itself minus the rightmost term in the formula.

$$S_i = \frac{Total\ Loan\ i\ Interest}{Total\ Loan\ i\ Amount} - \frac{Total\ Deposit\ Fees}{Total\ Deposit\ Amount} \tag{1}$$

From the estimates in Table 1, it is clear that banks rushed to decrease the spreads on loans and equity in an attempt to reverse the slowdown[51]. This attests to the fact that these spreads were plainly above their rational levels pinpointing the excess in bankers' profit maximization behavior.

3.5.4. Securitization CCH

Securitization was also an important manifestation of the crisis that started with the boom in CDS and CDOs and increased spectacularly in the years prior to the credit crisis (Greenspan et al. (2010) and Gambacorta and Marques-Ibanez (2011)). Despite its clear benefits, one negative impact is that it distorts the riskiness of some instruments which no longer exhibit the adequate RW[52]. A potent example in Jablecki (2009) shows how CRs become artificially inflated due to securitization activity which could explain the overcapitalization prior to the crisis. As it turns out, 20% of loans securitized can lead to a 25% increase in CRs.

Relating back to liquidity, Altunbas et al. (2007) believe that banks involved in securitization are either less liquid or maintain a lower level of capital: as in the previous example, those banks with inflated CRs can choose to decrease their capital levels to reduce the tax burden and use the additional funds to increase lending.

The second pitfall of securitization is regarding growth. Used as an instrument for risk-hedging, securitization can affect financial stability as it leads to weaker borrower screening. This translates into a positive relationship with lending as shown empirically by Altunbas et al. (2007) and Gambacorta and Marques-Ibanez (2011). The former authors find that banks with securitization activities can lend up to three times as much as a normal bank. They use the ratio of securitized loans to total assets to quantify the actual securitization flow. Yet, their paper dates back to 2007 and therefore does not reflect the changes that occurred in the transition going into the crisis. We account for this in the analysis as the regression benefits from both a control and experimental setup which extends beyond 2007. On the other hand, their specification is very broad as it accounts for securitization as a whole; whereas in our paper, we devise a securitization ratio in Panel J particularly catered to the crisis-implicated portions of banks' securitized portfolios, i.e. residential loans (XRERAT).

Gambacorta and Marques-Ibanez (2011) on the other hand, start off with a measure of securitization based on quartile distribution. They transform this into a dummy variable which does not quantify the impact of securitization as a continuous variable would. Furthermore, they do not account for NPLs and cannot therefore disentangle the effects of both. Indeed, if securitization has an effect which is not already subsumed in NPFRAT1, it will prove significant in the regression we conduct. Another important aspect of our enhanced model is that it observes the impact of securitization along with capital RISK variables whereas both papers above stress securitization on its own or with other variables, not related to capital, such as monetary policy.

[51] With the exception of consumer loans. Again, a proof against the uniform assumption alluded to previously.

[52] Unfortunately, according to Blundell-Wignall and Atkinson (2010), even the new Basel III framework does not solve this fundamental problem.

4. Methodology

4.1. The RISK-factor model

In the following, we set out to test whether the same reasoning can be applied to the second crisis as was done for the first using as a starting point the following RISK-factor model.

$$\begin{aligned}\dot{Y}_{it} = \alpha + \beta CRUNCH_t + \sum_{j=1}^{5} \delta_j RISK_{ijt} + \frac{1}{2}\sum_{j=1}^{5} \phi_j RISK_{ijt}^2 \\ + \sum_{j=1}^{5} \gamma_j CRUNCH_t RISK_{ijt} + \frac{1}{2}\sum_{j=1}^{5} \theta_j CRUNCH_t RISK_{ijt}^2 \\ + \sum_k \lambda_k X_{ikt} + \epsilon_{it}\end{aligned} \tag{2}$$

The main focus of this research is on the RBC CCH. But the other two, leverage and risk-retrenchment CCHs will prove indispensable. Hence, under the null that the crisis was regulatory-induced, the log growth rate in asset category (CILN, CRLN, INLN, USTRA) or RW-class (RB100, RB0), $\dot{Y}$, is regressed on a CRUNCH dummy variable, various RISK factors (see Panel C), interaction terms denoted as CR_RISK, marginal contributions denoted as SQ_RISK and SQ_CR_RISK and a vector of macroeconomic and control variables X listed in Panels D through J. The interaction terms are used to point out the effect of these RISK factors during the course of the crisis as opposed to the full length of the study period; while marginal terms bring out any non-linear effects in these RISK factors depending on their actual level.

We opt for a random-effects panel regression model. Having included quasi-time-independent variables such as SIZE and REGULATOR, one can infer that a random-effects model would be more amenable than a fixed-effects one. Otherwise, the explanatory power in those variables would be absorbed by the intercept[53]. Indeed, we run both types of models ourselves for the new crisis and find that time-independent variables are mostly devoid of any explanatory power in the fixed-effects version. Not to mention that our version of events during the crisis is more easy to grasp with the results obtained from the random-effects case as we point out later.

In fact, Ediz et al. (1998) confirm having used a random-effects specification for similar purposes. Their justification for doing so is that they do not wish to condition their estimates on the particular sample. On the other hand, Nichols et al. (2011) opt for a fixed-effects regression which does not include any time-invariant regressors. Moreover, while the use of a fixed-effects model can be intuitively justified for banks on an international scale with a country-specific intercept[54], at national level, there may be a component related to unobservable country characteristics which are uncorrelated with the observable variables. Such variables include quality of supervision and regulation according to Gambacorta and Marques-Ibanez (2011). These authors still attempted at running the fixed-effects model but ran into difficulties because of the high number of parameters. Consequently, they deemed their results as 'rather unstable', suffering from autocorrelation. Based on the latter, our choice of random-effects seems justified[55].

[53] And as such, the coefficients on these variables would not have turned out significant as they did in most of B&U's regressions.

[54] Unless that intercept is made to vary with time as with Demirguc-Kunt et al. (2010).

[55] Of course, the normal alternative to abiding by this selection process would be to conduct a Haussman test.

4.2. Empirical Notes

We point out a few empirical notes which allow for a clear comparison between the work conducted on the first crisis and our framework.

- We use Newey-White estimators to account for serial correlation.
- A negative sign is appended to the capital RISK categories in order to make them increasing in RISK: i.e. a higher (in absolute value) CR/LR is less risky.
- All RISK variables were computed as the quarterly average over the previous year going back from the current date in order to remove any endogeneity related to loan growth[56]. This is a more practical way than overcoming the identification problem by having to select valid instrumental variables that are independent of the supply shock as in Watanabe (2007).
- 30 YR Treasuries were still discontinued at the start of our control period (Andelman (2005)). Therefore, duration and interest rates were not available for this maturity. Instead of extrapolating from past or future values, we take a more solid approach by using the second closest maturity posted by the FED, the 20YR bond[57]. On the other hand, since bonds come in multiple issues, we compute duration as the average over all bonds issued in a certain year with the given maturity.
- One of our goals was to include OTS-regulated banks as they were perceived to have had an important role during the crisis. Instead of computing the growth in U.S. Treasuries per se, we were compelled to use an aggregate variable of U.S. Treasuries and Agency Obligations (USTRA) which comprises U.S. Treasuries (USTREAS) and Agency Obligations (USTA). The reason, as stated on the FDIC RIS database, is that after the second quarter of 1996 these banks no longer reported Treasuries on a separate basis from other government obligations. Therefore, using the variable accounting for Treasuries only (USTREAS), which other banks submit as part of their Call Reports, would have resulted in a large number of missing values for thrift filers.
- In order to account for mergers, failures, data errors and estimation errors we exclude the observations for a particular bank in a given quarter when either the growth rate in total assets went beyond 0.25 or that in the riskiest and/or safest RW-category (RB100/RB0) exceeded 0.75 in absolute value for the designated quarter. This method also excludes non-"mature" banks as in Peek and Rosengren (1994).

5. Results and Discussion

5.1. Applying the original B&U model to the 2007-2009 subprime crisis

When running the baseline model[58] over the second crisis period we notice interesting features in comparison with the first crisis which are important to highlight. One such feature is the systematic opposite signs between T1RAT and TOTRAT despite the fact that in our case the coefficients turn

[56] An indicator to that is the lag (L_{-}) appended to these variables in Table 1.
[57] In fact, we do the same for 10YR and 5YR Treasuries and our results are not sensitive to this specification.
[58] Using only the B&U variables in Table 1.

out insignificant. However, during CRUNCH time, they become significant for CRLN and RB100 where the deterioration in CRs reported in our estimates would have arguably had the strongest impact[59]. Yet more investigation is needed to understand why the same effect occurs for the non-risky category USTRA. As a matter of fact, these categories reflect the strongest size effect hinting to a plausible interaction between CR and bank size for particular types of loans. Note also that, over the first crisis, regulatory bodies always had a negative effect whenever they were found significant. However, for this crisis, this turned into a positive effect with FDIC-regulated banks, in particular, for the categories mentioned above.

Moreover, leverage had a highly negative effect on the riskiest RW class, RB100, but shows no clear signs on real-estate. This suggests once more that bank behavior is not necessarily uniform across asset classes in responding to RBC changes as well as in the context of leveraging. Such behavior is substantiated by Gambacorta and Marques-Ibanez (2011) on the basis that leverage does not reflect the capital adequacy of banks. Not to mention that, as was the case during the second crisis, accounting practices could have misconstrued its informative power[60].

More importantly, NPFRAT1 is highly negatively significant for risky categories in line with the first crisis. This is also true for RB0; contrasting with the positive effect on USTRA as the latter benefits from negative loan performance. In addition, this finding is perfectly compatible with the net increases in NPLs reported earlier in our estimates. Notice that CRRAT has a positive impact on RB100 but turns negative in two out of three risky categories thus casting doubt on its role as an overall risk measure. We therefore disregard the results from this variable[61].

Macro variables impact the safest categories the most probably because the riskier categories were affected by other factors. This is a notable difference with the previous crisis where it was shown, for instance, that GNPGROW almost always had strong positive effects in all categories while unemployment did not always have the expected sign. In our case, while the latter is insignificant in the risky categories at both national and state levels it does have a significant positive effect on the safest categories which is expected during crisis times. State income, on the other hand, was negative whenever it was found significant, except for RB0 where the effect is positive as in B&U.

Competition variables were mostly insignificant probably because most banks engaged in similar risk-taking behavior. Understandably, NE lacked the significance it had during the first crisis, despite the doubling in number of banks mentioned earlier. Strangely, the sign on NE for the most significantly affected categories, RB100 and RB0, was the same despite their radically different risk profiles according to the RW-scheme. Seasonal variables had the strongest significance for these RW-categories and showcased one sign alternation during the course of the year for each RW category. TIME, on the other hand, as noted in B&U, was mostly significant for USTRA and RB0 but with unexpectedly opposite signs, despite the similarity in risk profiles between the two. Note that all dependent variables mentioned in this section were the most affected by the negative portion of the slope, SLOPE- and SQ_SLOPE-[62].

[59] INLN is also significant probably as it belongs to the same RW-class. But this is not the case for CILN which, unlike the other two categories, is restricted to loans at corporate level. Later, we show that this significance disappears in different categories as well.

[60] This pushed the authors to substitute leverage with Tier 1 RBC as it can better reflect a banks' solvency and does not suffer from comparability issues across countries.

[61] B&U remained inconclusive about it regarding the first crisis.

[62] The positive portion is more sign consistent though.

Table 2: RISK-factor model applied to the 2007-2009 subprime crisis

	CILN		CRLN		INLN		RB100		USTRA		RB0	
	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat
INTERCEPT	0.046	0.506	-0.037	-0.453	-0.095	-0.930	0.010	0.973	-0.426	-1.521	-0.220***	-6.702
CRUNCH	-0.036	-1.225	-0.041*	-1.680	-0.011	-0.339	-0.002	-0.430	-0.163**	-2.433	0.014*	1.768
L_T1RAT	0.476	0.356	-0.230	-0.587	-0.640	-1.546	-0.051	-0.563	0.266	0.294	-0.023	-0.151
L_TOTRAT	-0.467	-0.350	0.234	0.597	0.643	1.554	0.047	0.518	-0.262	-0.289	0.029	0.183
L_LEVRAT	-0.131	-0.913	0.010	0.136	-0.182*	-1.897	-0.106***	-5.617	-0.048	-0.247	-0.019	-0.763
L_NPFRAT1	-0.935**	-2.421	-1.254***	-3.651	-0.736*	-1.881	-1.180***	-12.628	1.771*	1.848	-0.275**	-2.064
L_CRRAT	-0.251***	-2.600	-0.324***	-6.141	-0.013	-0.219	0.069***	9.067	-0.041	-0.396	0.076***	5.425
SQ_L_T1RAT	3.244	0.864	0.046	0.087	0.577	0.637	0.055	0.224	0.309	0.263	0.260	0.737
SQ_L_TOTRAT	-3.244	-0.864	-0.046	-0.086	-0.577	-0.637	-0.055	-0.224	-0.309	-0.263	-0.259	-0.736
SQ_L_LEVRAT	-0.302	-1.155	-0.079	-0.593	-0.362**	-2.055	-0.229***	-5.429	0.081	0.205	0.065	1.253
SQ_L_NPFRAT1	6.477	0.607	16.943*	1.828	15.257	1.031	13.785***	2.860	-12.793	-0.513	8.409*	1.714
SQ_L_CRRAT	1.246***	2.672	0.884***	5.415	-0.182	-0.645	-0.174***	-5.793	0.696	1.605	-0.145***	-2.653
CR_L_T1RAT	-0.531	-0.359	1.430**	2.197	1.057*	1.682	-0.280*	-1.761	4.581**	1.997	0.022	0.078
CR_L_TOTRAT	0.523	0.354	-1.426**	-2.196	-1.060*	-1.687	0.285*	1.767	-4.579**	-1.993	-0.014	-0.048
CR_L_LEVRAT	-0.077	-0.401	-0.102	-0.698	-0.034	-0.209	-0.053*	-1.821	-1.185***	-3.070	0.126***	3.121
CR_L_NPFRAT1	0.356	0.736	0.300	0.628	-0.888	-1.556	0.304***	2.720	-1.796	-1.113	0.125	0.663
CR_L_CRRAT	0.206*	1.872	-0.050	-0.544	0.041	0.339	-0.041***	-4.112	-0.119	-0.475	0.018	0.769
SQ_CR_L_T1RAT	-4.021	-1.156	1.992	1.218	0.705	0.450	-0.085	-0.148	0.734	0.245	-0.233	-0.416
SQ_CR_L_TOTRAT	4.021	1.156	-1.992	-1.218	-0.705	-0.450	0.086	0.149	-0.734	-0.245	0.234	0.416
SQ_CR_L_LEVRAT	-0.097	-0.261	-0.160	-0.579	-0.091	-0.318	-0.066	-0.844	-1.967**	-2.553	0.201**	2.437
SQ_CR_L_NPFRAT1	-6.709	-0.600	-11.947	-1.158	-1.175	-0.072	-10.374*	-1.928	2.313	0.066	-7.908	-1.354
SQ_CR_L_CRRAT	-0.834	-1.612	0.137	0.494	0.057	0.095	0.100***	2.642	-1.144	-1.032	-0.120	-1.352
GNPGROW	0.016**	2.159	0.001	0.144	0.009	0.927	-0.000	-0.073	-0.106***	-5.085	-0.006**	-2.356
UNEMP	-0.012	-1.479	0.005	0.651	-0.001	-0.060	-0.000	-0.098	0.136***	4.859	0.028***	9.367
STGROW	0.016	0.116	-0.032	-0.176	-0.079	-0.384	-0.038*	-1.747	-1.833***	-3.581	-0.668***	-10.320
STUNEMP	-0.002*	-1.796	-0.000	-0.168	0.001	0.976	-0.001***	-5.897	0.008*	1.681	0.001	1.297
NE	0.018*	1.651	-0.019	-1.530	0.005	0.921	-0.006***	-4.394	-0.005	-0.252	-0.009***	-3.307
BAA-AAA	0.025	1.358	-0.001	-0.095	0.011	0.550	-0.001	-0.302	-0.230***	-4.543	-0.062***	-9.889
RF3MO	-0.008	-0.421	0.014	0.739	0.002	0.084	-0.003	-1.508	-0.055	-0.863	-0.033***	-4.277
SQ_RF3MO	0.004	0.676	-0.002	-0.393	0.004	0.467	0.001	1.504	0.038**	2.127	0.020***	8.784
TIME	-0.000	-0.012	0.003*	1.921	0.001	0.334	-0.000	-0.678	-0.010**	-2.081	0.005***	7.885
SEAS1	-0.001	-0.134	0.001	0.154	-0.010	-1.105	-0.005***	-6.394	-0.094***	-4.849	0.006**	2.055
SEAS2	0.015**	2.113	-0.002	-0.303	0.012	1.628	0.014***	16.726	-0.012	-0.717	-0.005**	-1.984
SEAS3	-0.009	-1.326	-0.007	-1.403	0.008	1.030	0.008***	10.488	0.004	0.240	-0.012***	-5.055

Table 2: (continued)

SLOPE+	0.011	0.263	0.019	0.602	0.019	0.453	0.003	0.738	0.099	1.088	0.101***	8.232
SLOPE-	-1.568	-1.626	0.701	0.965	1.547	1.079	0.738***	8.168	13.421***	6.037	-2.152***	-7.103
SQ_SLOPE+	0.001	0.052	-0.003	-0.252	-0.004	-0.197	-0.002	-1.049	-0.087**	-2.156	-0.044***	-8.231
SQ_SLOPE-	-17.703	-1.621	6.718	0.808	16.814	1.030	8.079***	7.885	147.248***	5.842	-25.448***	-7.412
MEDIUM	0.005	1.452	0.019***	6.977	-0.001	-0.362	0.005***	9.003	0.015*	1.649	0.000	0.433
LARGE_1	0.009	1.140	0.026***	3.673	-0.011*	-1.703	0.008***	6.981	-0.024	-1.063	-0.000	-0.123
LARGE_2	0.051	1.223	-0.078**	-2.234	-0.008	-0.743	0.014***	3.545	0.023	0.400	0.018***	2.940
HHIA	0.040	0.980	0.033	0.765	-0.061**	-2.148	-0.005	-1.067	0.059	0.703	-0.004	-0.377
HHID	-0.054	-1.281	-0.033	-0.593	0.072**	2.474	0.010*	1.806	-0.108	-1.185	0.015	1.409
OCC	-0.021***	-4.533	-0.005	-1.000	-0.003	-0.756	-0.004***	-4.530	0.038***	3.194	0.002	1.329
FDIC	-0.014***	-2.966	0.006*	1.795	-0.001	-0.401	0.001*	1.945	0.033***	3.142	0.001	0.579
R^2	0.001		0.002		0.000		0.024		0.006		0.013	
Num Obs	119679		119679		119679		119679		119679		119679	

Finally, one clear anomaly that emerges from the regression and the previous estimate comparison is the difference in growth behavior between USTRA and RB0. In order to shed more light on the matter, we separate some of the underlying components of RB0 to see where the decreasing pattern in USTRA is coming from. Our estimates in Table 1 show that the two largest elements of RB0, Treasuries and Currency[63], did increase in the expected flight to quality. By deduction, the only component responsible for decreasing the aggregate variable USTRA were the non-mortgage obligations issued by GSEs, USTA. This is probably due to the sizable contraction that resulted from these agencies' mortgage-related products expansion which began in 1970. According to Greenspan et al. (2010), the latter accounted for 45% of newly purchased subprime mortgages as early as 2003 (five times the levels they were at in 2002[64]). We will address this issue further in the next section.

The results of the model applied to the constituent elements of RB0 are listed in Appendix A.1. First, the listed categories are very similar to USTRA in that they are not affected by the RISK variables as much as they are by the macroeconomic environment. Second, US treasuries are not impacted by the RISK variables during CRUNCH time (CR_*) as in the case of the aggregate variable USTRA. Yet, during this time, we can point out that the leverage impact on USTRA stems directly from Agency Obligations. Moreover, the coefficient on RF3MO for U.S. Treasuries alone is positive but not as significant as in the case of the first crisis, suggesting that, in comparison, even this type of instrument was less susceptible to macro-economic conditions. This is probably the reason the FED had to cut interest rates by half as shown in Table 1, especially in view of the high demand for that category of assets (flight-to-quality). Once more, the resulting negative sign of that variable on RB0 is due to USTA rather than USTREAS as seen in Appendix A.1.

5.2. Model Enhancement

Clearly, commercial real-estate loans were not the primary suspect during the second crisis. We therefore find it more sensible to inspect the behavior of the main culprit, residential real-estate loans. For that purpose, we rerun the baseline regression model using four new dependent variables as defined in Table 1: RSLN, TLRE, TLN, RMBS. As illustrated by our estimates, the acceleration in growth for RSLN and RMBS is a key point in our analysis; especially when compared to the slowdown in the "generic" loan categories of TLRE and TLN. This brings us back to our critique of the uniform behavior assumption.

In fact, even during the first crisis, other authors found similar results to ours: quoting from Bernanke and Lown (1991), 1-4 family mortgages had an accelerated growth after 1990. This was probably the result of thrift acquisitions and relatively favorable treatment of these loans caused by the new RW capital standard. Hall (1993) points to the first change in mortgage RW under Basel I claiming that the 50% RW attributed to these assets was responsible for their 30% growth between 1988 and 1992.

Our work validates a similar hypothesis, alluded to by Blundell-Wignall and Atkinson (2010), regarding the more recent shift in RW. Using the RSLN average estimates between control and crisis periods, we find that this time, a 30% dip in RW (down to 35%) was matched by a 150%[65]

[63]The sizable decrease in observations is because according to the FDIC, beginning 2001, this item was only required from banks with more than $300 million in total assets.

[64]An interesting point the authors make is that EU countries are prohibited from engaging in such GSEs which limits the threat of securitization.

[65]This is obviously an under-estimation as the contraction in lending occurred sometime during the crisis period. Note that the increase is in log terms.

increase in growth rate for this loan category. This coincides almost exactly with the growth rate in NPLs mentioned earlier and points out to the convexity of the function relating the RW of an asset class to its growth rate. In other words, this illustrates the impact a potential RW mis-calculation attributed to a certain asset category can have and strengthens the case about RBC's role during the second crisis. In fact, this is the first finding of its kind as there has never been, to the authors' knowledge, a similar two-phase real decrease in any other instrument category on which to found a similar argument. It is also important to recognize that the increase in RMBS was two and a half times that in RSLN which stresses the accentuating impact of securitization on lending.

In view of the fact that real-estate loans were given a smaller RW, it seems appropriate to inspect the two closest categories, RB20 and RB50, which banks chose from to report their mortgage assets based on type[66]. In fact, both categories grew during the crisis as did RB0. This re-enforced the perception that compared to RB100, these asset categories were still considered "safe". However, the notable difference is that RB20, which contains mortgages guaranteed by GSEs[67], grew at a slower pace than the others. This brings out the possibility that somewhere along the RW spectrum there could be an inbalance in the assessment of risk[68]. This could also be due to the cutdown on guaranteed mortgages as the blame started to fall on GSEs.

We now rerun the baseline version of the model accounting for the new elements we mentioned so far which are specific to the second crisis. Our results are summarized in Table 3 which shows a sizable increase in R^2 owing to the integration of the new regressors as compared to the original regression. Our first observation is that the INTERCEPT term is highly significant for all variables, unlike our baseline regression. This points to a mean systematic trend impacting all the relevant categories, from which each individual bank would stray, by construction, only in random fashion. Note that the RMBS coefficient is more than double that of the other categories emphasizing the sizable impact differential when it comes to this asset class in particular.

The CRUNCH term is also significant in most cases. However, we make an interesting observation in that, unlike B&U, the sign of the coefficient on the INTERCEPT term is the same as that on the CRUNCH term for all dependent variables[69]. In other words, the CRUNCH was responsible for the systematic effect that reduced lending in all individual categories. Although we cannot elaborate on the positive sign in the RMBS case, we can, however, assume that an instrument constructed on a pool of others would take longer to feel the effects of a decrease in these individual instruments.

Again, as per our baseline model and B&U's results, the opposite signs between T1RAT and TOTRAT is consistent for all second-stage regressions despite having no direct significant effect unlike the first crisis (Estrella et al. (2000)). One can infer that the effects must have been absorbed by other components of the regression. One such effect, as explained by Demirguc-Kunt et al. (2010) is leverage. Although it was previously found to determine in large part the behavior of RB100[70] (Table 2), leverage does not appear significant on an individual loan basis until the midst of the crisis period (CR_L_LEVRAT). This is undoubtedly because the negative effects of low leverage

[66] According to our discussions with FDIC, it would appear that because the regulations were not formally in place in the U.S. at the time, FDIC did not setup a new RW category in between 20% and 50% in its Call Reports.

[67] This category also contains a much more heterogeneous array of assets in terms of risk assessment than the other two "safe" categories.

[68] This requires an analysis similar to that of Avery and Berger (1991) (i.e. retuning the RWs in a seperate regression) which is outside the scope of this analysis. We leave this for future research.

[69] Despite the latter being insignificant whenever found positive.

[70] A reminder that the CR moves toward the LR as the RB100 proportion with respect to other classes increases.

Table 3: Enhanced RISK-factor model applied to the 2007-2009 subprime crisis

	RSLN		TLRE		TLN		RMBS		RB20		RB50	
	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat
INTERCEPT	-4.261**	-2.390	-3.096**	-2.220	-2.121***	-2.767	27.376***	3.538	6.839***	2.815	-10.883*	-1.823
CRUNCH	-0.052***	-3.623	-0.030*	-1.858	-0.027**	-2.328	0.041	0.711	0.013	0.517	-0.118***	-2.668
L_T1RAT	0.119	0.710	-1.314	-1.287	-0.056	-0.410	-0.251	-0.253	-0.297	-0.637	-0.564	-1.106
L_TOTRAT	-0.117	-0.700	1.310	1.288	0.057	0.417	0.258	0.259	0.290	0.613	0.566	1.108
L_LEVRAT	-0.063	-1.299	0.017	0.188	-0.063*	-1.935	-0.198	-1.113	0.096	1.201	0.116	1.097
L_NPFRAT1	-1.245***	-5.764	-1.204***	-5.558	-1.209***	-15.059	-2.073**	-2.286	0.638***	3.670	-1.410***	-3.153
L_CRRAT	0.048***	2.593	0.057***	2.708	0.036**	2.276	-0.007	-0.071	0.121***	6.436	0.054	1.208
SQ_L_T1RAT	0.353*	1.754	-3.651	-1.200	0.080	0.378	0.165	0.174	0.207	0.168	-0.762	-1.280
SQ_L_TOTRAT	-0.353*	-1.753	3.651	1.200	-0.080	-0.378	-0.165	-0.174	-0.206	-0.167	0.762	1.281
SQ_L_LEVRAT	-0.127	-1.190	-0.048	-0.310	-0.168***	-2.733	-0.398	-1.015	0.286**	2.140	0.137	0.729
SQ_L_NPFRAT1	27.991**	2.261	23.563*	1.740	17.275***	5.148	59.343*	1.850	-13.560***	-2.585	6.052	0.458
SQ_L_CRRAT	-0.156**	-2.270	-0.204***	-3.452	-0.092*	-1.812	0.333	0.920	-0.081	-1.130	-0.080	-0.496
CR_L_T1RAT	-0.456	-0.837	0.657	0.616	0.224	0.783	1.020	0.778	0.306	0.539	0.503	0.527
CR_L_TOTRAT	0.459	0.842	-0.651	-0.612	-0.224	-0.782	-1.037	-0.790	-0.279	-0.465	-0.459	-0.481
CR_L_LEVRAT	-0.213**	-2.255	-0.268**	-1.980	-0.146***	-3.200	-0.084	-0.300	0.019	0.101	-0.486**	-2.413
CR_L_NPFRAT1	0.659***	2.731	0.118	0.540	0.166*	1.867	1.003	0.778	-0.197	-0.893	-0.243	-0.390
CR_L_CRRAT	0.078**	2.552	-0.094***	-3.587	-0.005	-0.314	0.152	1.024	-0.185***	-5.342	0.097	0.877
SQ_CR_L_T1RAT	-0.143	-0.220	3.997	1.234	1.520	1.298	-0.678	-0.336	-0.053	-0.025	2.555	0.891
SQ_CR_L_TOTRAT	0.143	0.220	-3.997	-1.234	-1.520	-1.298	0.677	0.335	0.054	0.025	-2.554	-0.890
SQ_CR_L_LEVRAT	-0.386**	-2.233	-0.484**	-2.037	-0.213	-1.539	-0.417	-0.732	0.174	0.256	-0.496	-1.222
SQ_CR_L_NPFRAT1	-21.982*	-1.800	-16.861	-1.262	-11.556***	-3.275	-61.096*	-1.770	7.397	1.245	10.741	0.730
SQ_CR_L_CRRAT	-0.076	-0.708	0.264***	3.450	0.010	0.220	-0.914	-1.624	0.473***	3.602	-0.148	-0.297
LIQRAT	-0.098***	-9.082	-0.128***	-12.980	-0.105***	-16.027	0.165**	2.310	0.514***	34.443	-0.068***	-2.658
GNPGROW	0.016***	3.078	0.012**	1.997	0.009***	3.975	-0.126***	-3.838	-0.034***	-3.786	0.031	1.289
UNEMP	0.022	1.495	0.023**	2.071	0.013**	1.997	-0.240***	-3.809	-0.047**	-2.288	0.085*	1.760
STGROW	0.018	0.188	-0.098	-0.804	-0.073***	-2.577	0.373	0.868	0.487***	4.778	0.058	0.151
STUNEMP	-0.002***	-3.210	-0.002***	-4.143	-0.002***	-7.872	0.002	0.607	0.002***	2.747	-0.001	-0.412
DM3GDP	-0.033	-0.148	0.020	0.117	0.012	0.113	2.663**	2.419	1.156***	3.971	0.277	0.345
INFL	-0.006**	-2.279	-0.004*	-1.724	-0.003**	-2.265	0.036***	2.794	0.009**	2.499	-0.015	-1.543
GDPCAP	0.000**	2.468	0.000**	2.240	0.000***	2.903	-0.001***	-3.672	-0.000***	-2.992	0.000*	1.804
NE	-0.002	-1.040	-0.011***	-2.669	-0.004***	-3.141	-0.030*	-1.824	-0.004	-1.329	-0.002	-0.567
SW	0.013*	1.771	0.012**	2.057	0.010***	5.573	0.007	0.344	-0.020***	-5.004	0.003	0.189
BAA-AAA	0.046***	2.699	0.033**	2.421	0.022***	3.134	-0.215***	-2.825	-0.032	-1.379	0.097	1.632
RF3MO	-0.152***	-3.058	-0.092**	-2.070	-0.072***	-4.184	1.209***	4.827	0.286***	4.030	-0.300*	-1.677

Table 3: (continued)

SQ_RF3MO	0.032***	3.199	0.019**	2.222	0.014***	4.198	-0.240***	-4.710	-0.056***	-3.867	0.067*	1.857
TIME	-0.012**	-2.373	-0.009**	-2.232	-0.006***	-3.146	0.096***	4.225	0.023***	3.285	-0.027	-1.595
SEAS1	-0.017**	-2.373	-0.013**	-2.479	-0.013***	-4.662	0.155***	4.675	0.036***	3.452	-0.041*	-1.884
SEAS2	-0.004	-0.775	-0.002	-0.627	0.008***	4.832	0.104***	3.357	-0.008	-1.019	-0.021	-0.979
SEAS3	0.009***	3.766	0.008***	4.744	0.009***	6.904	-0.019*	-1.724	-0.008**	-2.174	0.012	1.354
SLOPE+	0.019	1.545	0.004	0.394	-0.008	-1.351	0.246***	3.698	0.079***	4.043	0.072	1.527
SLOPE-	0.215	0.636	0.494*	1.804	0.762***	4.029	-4.134**	-1.968	-2.186***	-3.761	-1.101	-0.853
SQ_SLOPE+	-0.034***	-3.341	-0.018**	-2.505	-0.010***	-3.167	0.151***	3.080	0.016	1.097	-0.079**	-2.146
SQ_SLOPE-	4.494	0.968	7.103**	2.034	9.459***	3.887	-64.634**	-2.478	-27.808***	-3.804	-7.984	-0.490
MEDIUM	-0.002	-0.957	0.002	0.950	0.001	1.195	0.018**	1.969	0.022***	13.918	-0.001	-0.272
LARGE_1	-0.008***	-3.283	-0.001	-0.549	-0.000	-0.353	0.007	0.468	0.036***	7.678	-0.012*	-1.663
LARGE_2	-0.018**	-2.049	-0.028	-1.612	0.000	0.040	0.021	1.088	0.051***	6.115	-0.005	-0.468
HHIA	-0.010	-0.519	-0.011	-0.719	-0.007	-1.427	0.058	0.791	-0.016	-1.433	-0.013	-0.464
HHID	-0.007	-0.260	0.002	0.087	0.011**	1.968	-0.048	-0.590	0.038***	3.109	0.040	1.251
OCC	-0.005	-1.503	-0.003	-1.390	-0.002**	-2.266	0.002	0.176	-0.003	-1.420	0.004	1.069
FDIC	0.001	0.242	0.003	1.642	0.002**	2.179	0.002	0.207	0.004	1.638	0.013***	3.464
OTS	-0.012***	-3.589	-0.015***	-4.817	-0.006***	-5.959	-0.028*	-1.776	0.014***	4.413	-0.002	-0.517
S_CILN	0.001	0.491	0.002	0.748	-0.001***	-3.164	-0.022***	-3.113	0.001*	1.888	0.000	0.119
S_LNRE	-0.155***	-3.076	-0.160***	-3.309	-0.000	-0.082	0.035	1.249	-0.003	-0.358	-0.103***	-2.883
S_INLN	0.082***	2.665	0.087***	2.796	-0.002	-0.483	-0.038	-1.106	0.004	0.711	0.046**	2.263
S_RMBS	0.000	1.319	0.000	1.411	0.000***	2.742	-0.013***	-2.622	-0.000***	-2.855	0.000	0.682
S_USTR	0.048	1.406	0.046	1.368	0.000	0.163	0.024	0.965	-0.005	-0.797	0.035	1.375
S_EQ	0.004	1.036	0.006	1.365	0.002*	1.959	0.002	0.552	0.002	1.517	0.003	1.036
NINCRAT	0.003	0.931	0.006	1.242	0.003	1.616	-0.016	-0.766	-0.084***	-11.075	-0.009	-0.367
R^2	0.007		0.014		0.016		0.004		0.036		0.001	
Num Obs	119583		119583		119583		119583		119583		119583	

could not be perceived before the incidence of the crisis which lead, as previously stated, to a wave of deleveraging. On the other hand, we note that leverage had no impact on RMBS probably because we are looking at the originating banks rather than the SPVs bearing in mind that a large proportion of RMBS is not sold directly to investors but through these entities. In fact, banks allowed themselves to attain such levels of leverage because of their ability to offload some of their loans to these third parties.

NPFRAT1 is again as the most prominent negative factor as in our first regression. This highlights the fact that the crunch was indeed induced by a demand, or borrower-related, shock. We notice that the coefficient on RMBS is twice as significant as individual categories and marginally three times more (SQ_NPFRAT1). The only occurrence of a positive impact among all RW categories is with RB20[71]. However, if we only select the proportion of loans related to FNMA and GNMA (Appendix A.1), we see that the sign on this component of RB20 is indeed negative. To find the asset responsible for the unexpected sign, we would need a similar breakdown as we did before with RB0. Unfortunately, the assets in RB20 are too heterogeneous and the FDIC database is not granular enough to support such a breakdown. The discrepancy amongst various risk categories stresses again the subject of a kink related to non-monotonous behavior between RW categories. This is clearly at odds with the linearity assumption in the RW scheme and has been referred to as one "regulatory loopholes" by authors such as Kamada and Nasu (2000). Note that the coefficients on RB20 and RB50, whenever significant, are usually of opposite sign. This can be an indicator that RSLN is indeed boot-strapped in between these two categories (RW=35%).

In sum, the combined effects of Leverage and NPLs are testament, as we suggested earlier in reference to B&U, to the validity of the coercive risk-retrenchment CCH. Still, this is not the only valid hypothesis. One of our central additions, liquidity, turns out to be very significant for this crisis as it affects all individual categories. The positive sign on RMBS can be traced back to our earlier statement that securitization can overcome liquidity issues and boost lending.

Macro variables appear to have played a more important role for the added types of instruments. Hence, the inclusion of INFL and GDPCAP seems to have been well-founded. Also, as DM3GDP captures the effect of money demand on loan supply, it appears significant for RB20 which accounts for a non-aggregate monetary component under "cash items in process of collection". We were surprised that individual loan categories remain unaffected by this factor although the opposite holds for RMBS.

Moreover, being located in the SW region did have a positive impact on lending which eventually accounted for the higher casualties in this region when defaults began their domino effect. NE maintains significance but has the opposite effect probably because these states did not suffer as much as the rest according to Realtytrac (2009). This was not the case for the first crisis where NE had the same impact as SW did for this crisis. Similarly, TIME and SEASONAL factors are extremely significant for all categories in more or less the same way as they did for the previous crisis. This contrasts with bank SIZE which does not turn out meaningful owing to the fact that, as mentioned earlier, all banks probably experienced similar behavior during the second crisis irrespective of their size. The same can be said to justify why competition was less significant than one would have expected. This is in contradiction to the first crisis where the primary objective of banks was to meet the capital targets and the way to attain it was different for different sized banks.

[71] Note that CRRAT had a positive impact on RB20 and all risky categories except for RMBS, despite having had a negative effect on the previous set of loan-type categories. This strengthens the case against it being viewed as a holistic risk measure.

However, one major difference with B&U is when we incorporate the OTS dummy, the significance from the other regulators is drained out showcasing the important role played by thrifts in the second crisis for both loans and RMBS.

Finally, as the interest rate on treasuries (RF3MO) increases, demand for these assets should increase. The opposite holds for individual risky categories. This is not consistent, however, at the level of RW categories which perceive the impact of this variable differently (RB0 VS RB20). The same can be said for SLOPE variables. One justification for this is that interest rate risk sensitivity is, by definition, outside the scope of RWs. Similarly, intuition would have it that spreads negatively affect the demand of the concerned loan category while promoting lending in others. This is indeed what we observe. Collectively however, they seem to account for the totality of the profit-seeking hypothesis which affects lending as NINCRAT shows no significance at all.

6. Robustness

In order to validate the results we found above, we run a series of robustness tests based on B&U's framework but tailored for the purposes of the second crisis.

First, following the subprime crisis much has been said about the impact of Tier 2 capital aside from that of Tier 1. Since we found earlier that Tier 1 capital does not have a directly significant effect on lending for the second crisis, we substitute the T1RAT with T2RAT while keeping TOTRAT in the regression. Since the latter was also found to be insignificant, we expect that T2RAT will behave similarly. Note that, although Table 1 does not show it due to the number of digits reported, T2RAT did fall in almost a monotonous way during the period under investigation. This alludes to the slow pace in converting these instruments into their loss-absorbing capacity. Still, this was meaningful enough to show up as significant as a marginal effect during the crisis period (SQ_CR_T2RAT) for one of the most critical assets, RMBS. The remaining variables retained their explanatory power.

Second, since NPFRAT1 (NPL ratio) can be sandwiched between assets as a generic class and real-estate loans, NPFRAT2 and NPFRAT3 reproduce the same effect as NPFRAT1. This was expected as the growth rates in Table 1 are very similar; hinting again to the fact that the majority of NPLs were indeed from the real-estate category.

Third, since banks which undertook a sizable amount of securitized assets were a minority compared to the full sample, inserting a securitization variable would entail losing a huge proportion of the dataset. However, if we just focus on the concerned banks only, we see that securitization, as captured by XRERAT, did have a strong adverse effect on lending, understandably restricted to the individual loan level (see Appendix B.1). Furthermore, the major factors outlined above such as NPLs and liquidity maintained their strong effects on lending[72].

Fourth, despite being discarded by B&U on the basis that they contain some degree of endogeneity as opposed to NPFRAT1, we chose to incorporate loan loss provisions (LLP) and Chargeoffs (LLPCHOFF1) in a manner reflective of Jayaratne and Strahan (1996). In fact, according to Avery and Berger (1991), chargeoffs are considered as 'flow measures' that hint to a bank's current performance; while based on Saadaoui (2011), NPFRAT1 has been vastly criticized as an "ex-post estimation of borrowers' default risk". For that purpose, the latter also choose to incorporate LLP as it accounts for both the ex-ante and ex-post nature of credit risk in preventing and covering

[72]Note that the OTS factor was removed since thrifts had a different reporting scheme for securitized assets.

losses, respectively. There is also documented evidence that LLP can impact on lending supply (Altunbas et al. (2007)), risk (Saadaoui (2011)) and performance (Demirguc-Kunt et al. (2010)). Nonetheless, what would also be deserving of attention is the interaction between the first two variables, LLPCHOFF2, which captures their ratio. Indeed, our estimates indicate that as banks were writing off bad loans from their accounting books, they were simultaneously making increased provisions for more losses to occur as they began to realize the severity of the crisis unfolding. However, since LLP and chargeoffs showed no significant effect when included alongside NPLs[73], we check if using them as instrumental variables can resolve the endogeneity issue. Indeed, if we use the proportion of real-estate chargeoffs, LNCHOFF, or LLP and LLPCHOFF1 together, we find that the significance of NPFRAT1 is preserved while the remaining significant regressors remain as such.

Furthermore, endogeneity concerns were also behind the averaging over previous quarters. We investigate how much this affected the overall estimation by removing the averaging step. As a result, most RISK factors become extremely significant for only the individual loan categories. This highlights the fact that RBC capital has no predictive power over downturns but rather is an indicator of current turmoil in the market. Notably as well, the opposite signs in CRs is preserved despite the fact that the ratios are significant. This proves that the identical result found earlier was not merely a coincidence. In fact, the coefficients on T1RAT and TOTRAT are almost the same in absolute value[74]. This could be explained in that, because of the restriction imposed on Tier 2[75], whenever a bank cannot meet its Total capital requirement, and is consequently penalized by regulators, any benefit on lending from meeting the Tier 1 target immediately becomes a burden on the bank. However, as soon as it meets its requirement, the benefit automatically takes effect but with no perceivable value coming from Tier 2 other than that already contained in Tier 1. The explanation for that lies in the adjective attributed to the main component of Tier 1 known as "core" capital.

Likewise, we remove the filtering that discarded certain observations from the sample based on suggested thresholds which could have been chosen haphazardly by B&U[76] or fitted to the circumstances prevalent at the time of the first crisis. Although we could have chosen a threshold more adapted to the second crisis, our aim was to reproduce B&U's setting meticulously. Once again, leverage and RBC appear to have strengthened their influence on loan lending. This can be brought back to the reasons for having imposed the filter in the first place. Clearly, mergers and failures result in a particular bank setting that is likely to be outside the pattern of a normal bank's day-to-day behavior which could antagonize that bank's lending[77]. Hence, removing the restriction on RB0 and RB100 growth rates is bound to bring out the effects of banks with peculiar LR and CR whose lending would suffer as a result.

On the other hand, we run the same regression for each bank SIZE category on its own. We find that for LARGE(_1&_2) banks, in all cases except the regression on TLN, almost all explanatory variables lose their significance. This confirms the result in Demirguc-Kunt et al. (2010) and is probably due to the fact that a large bank is more immune to risk than smaller, more fragile ones.

[73] Demirguc-Kunt et al. (2010) find a similar result for large banks. However, these are a more restricted sample as they are defined with respect to a minimum five-times higher threshold than the one we used for LARGE banks.

[74] We verify this statement by conducting Wald tests on these coefficients. In all regressions, the null of equality cannot be rejected.

[75] Tier 2$\leq$ 0.5$\times$Tier 1

[76] Comparing for instance with that in Furfine (2000).

[77] The other two reasons for using the filter are data and estimation errors whose impact is clear intuitively.

Not to mention the ability of large banks to have more diversified positions which protect them from particularly sensitive market fluctuations. This is true since although some major banks had to be rescued after the crisis, the majority of buyouts and nationalizations had to do with smaller ones. Still, spreads kept their critical impact on lending probably because what mattered the most to these banks was profit maximization. MEDIUM and SMALL banks, on the other hand, were more reflective of the overall regression not only because of the sample composition[78], but because such banks are essentially more sensitive to both macro-economic conditions and idiosyncratic risk which is inherent in CRs.

Similarly, we run the regression focusing only on SW banks. Although we would have expected state-related factors to be of importance, we are reminded that the dire conditions in this region did not stem from any specific macroeconomic factor[79]. Yet, NPFRAT1 is widely significant in these states which follows from the construction of the SW variable. We also run the regression using only OTS regulated banks as a sample space. Except for the loss in significance for the SW variable owing to the dispersion of such banks on U.S. soil, the main findings of our regression are mostly the same. As a matter of fact, national macroeconomic factors erase almost any state related impact at this level.

Finally, we are reminded that, in order to motivate the use of the second liquidity ratio LIQRAT, we started with the dummy liquidity variable LCR. As the latter is not a quantitative variable, it was unable to portray any impact at the loan type level with RSLN. Yet it revealed an important significance with regard to the composite loan category, TLN. This makes sense since the LCR is a proxy measure of liquidity. Of course, for reasons outlined earlier, the effects would have been magnified had we had the stress scenarios to construct the actual LCR. Still, this suggests that even in these circumstances, lack of liquidity can have an undesirable effect on lending.

Conclusion

In this research, we sought to expose a new facet of the Basel capital requirements regulation in light of the new crisis. Since its introduction, the perception of Basel I was that it could induce banks to cut down on lending in order to meet their target requirements; i.e. a supply-side "capital" crunch. Yet under Basel II, the second lowering of the RW on residential mortgages pushed banks initially toward further lending in this asset category. The reason being that mortgage lending, in terms of bearing credit risk, became closer to investing in Treasuries than in C&I loans. In other words, for the second crisis, banks were inclined towards real-estate lending should they have felt the need to economize on capital. In fact, the two crises were diametrically opposed with regards to loan-type riskiness in terms of portfolio composition as shown in our reported statistics.

Still, as most banks were more than adequately capitalized during the second crisis, it no longer became an issue of having enough capital but rather having good quality capital to cover the losses emanating from loan portfolios. As exemplified in our model, the - quality component of - capital was insufficient to wipe out these NPLs which turned out highly significant. This forced banks to cut down on their lending.

[78] MEDIUM was on average a few percentage points above SMALL but they both accounted for around 93% of the overall sample. Owing to the static nature of our choice of SIZE thresholds dating back to the first crisis, we do not account for survivorship bias in our sample as many banks were either removed or merged with other MEDIUM/LARGE banks.

[79] The consequences, however, were more severe than the average U.S. state (around 0.6% higher unemployment according to our calculations).

Nevertheless, there is only so much quality capital that a bank can hold and remain competitive if it is taking on more risk than it should. Being so highly leveraged and engaging vastly in securitization whilst not having sufficient liquidity meant that the banks could not measure up to a wave of defaults that was, predatory lending set aside, exogenous to the banks. This can be summed up as a demand-side - quality - "capital" crunch. Our results inherently validated, as a first step, the coercive risk-retrenchment and liquidity CCHs. This proved to be a fruitful addition to B&U's framework.

The advantage of our procedure is that it illustrates the various factors that contributed to the crisis in a holistic approach showcasing the relative impact of each on the downfall that lead to the recession. In fact, the crisis brought a systematic decrease in lending for all categories as shown by the sign relationship between the intercept of our random-effects model and the crunch variable. While the approach is based on B&U's model for the first crisis, the conclusions we obtain are at odds with theirs. As a matter of fact, we can adjust some of their findings based on the amendment we introduce to their assumption of uniform behavior. Specifically, we try to understand a bank's behavior from the standpoint of the bank's managers rather than that of regulators. This can potentially allow for their findings to be reconciled with the mainstream literature related to the impact of Basel I on the first crisis.

Obviously, the model had to be adapted in order to simultaneously incorporate the additional factors we mentioned. This allowed for a six-fold increase in R^2, albeit for different individual loan and RW categories from those used in B&U's original regression. To our knowledge, this is the first study to do so as various authors have tackled the crisis from seemingly distinct angles.

So where does this leave us on the role RBC played during the second crisis? The fact that the coefficients on Tier 1 and Total capital turned out insignificant can be interpreted in various ways. If we try to understand matters from the perspective of a transformation from a direct causal link into an indirect one, the first impact of the change in RW was to encourage lending. This trend was reversed at the time that coincided with banks' inability to write off loan losses using Tier 2 capital as exemplified by our robustness test. In short, what started as a positive impact of RBC due to quantity quickly changed to a negative one due to quality. As a matter of fact, the first impact occured sometime prior to the onset of the crisis and continued for a while before the second impact was perceived during the crisis. Hence since lending did not directly contract at the exact point where we chose the beginning of the crisis, the fact that the coefficients are insignificant could suggest an overlap between the two effects resulting in their cancellation.

Note that Calem and Rob (1999) found a U-shape function between capital and risk while the surveyed literature has already given evidence of an inverse trend between capital and growth for capital constrained banks. Combined with the latter finding, we uncover the existence of an inverted U-shape between capital and growth by supplementing the missing part for non-capital constrained banks.

From a different angle, the combination of RBC with other capital RISK factors such as leverage may well have been detrimental as the latter could have overshadowed the effects of the former. Therefore, the hindsight of working with a proven-to-be-faulty LR should be the main priority of regulators before engaging in more complex directives which would repudiate the essence behind having simple RBC guidelines. Moreover, the fact that removing the lag from our RISK factors made the CRs significant means RBC has no predictive power like other RISK factors but is rather important at the point of measurement during the crisis. We also shed light on the peculiar opposite signs regarding Tier 1 and Total capital which occured during both crises.

Other seemingly odd features between the two crises such as the opposite sign on USTR/USTRA allowed us to unveil decisive factors in the crisis such as the role of GSEs. Still, more work is needed to explain differences in growth-related behavior between an instrument (e.g. USTREAS/USTA/FGNMA) and its corresponding RW class (RB0/RB20) which were revealed by our analysis. This could hint to the possible existence of a kink, a.k.a. regulatory loophole, in the RW scheme. Not to mention that the sensitivity of an instrument and the CR to a change in its RW is crucial to setting the RW in the first place. Unfortunately, aside from two historical crises data points where such changes have occurred, the characteristics of this sensitivity remain virtually unknown. We try to address this matter from a mathematical viewpoint in a companion paper. In the meantime, the policy implications with regard to capital adequacy should be, in line with the Bank of England's recent FSR recommendations, the re-assessment, from a microprudential perspective, of the instrument categorization process within the RW scheme by the Basel III committee. That is because the riskiness of a particular instrument and its belonging to a certain RW class seem to be subject to change depending on the business cycle (dynamic VS static RW).

Finally, we tested for the effects of liquidity on lending by introducing a LCR-proxy which has demonstrated that fortifying RBC with a liquidity threshold is highly commendable. Still, the Basel III liquidity measures, LCR and NSFR, will need further backtesting before they are introduced as the missing elements to the regulation. They are nonetheless the right way forward. Also, while the benefits of securitization should not be dismissed, it is important that SPVs which escape the regulation itself are subject to a compatible set of guidelines; or at least a threshold on securitization activity should be imposed that complies with the Basel safety goal.

In sum, no matter how the scenario could change between credit crunches in terms of supply/demand triggers, direct/indirect effects, different states NE/SW, new players FDIC/OTS, the essence of capital adequacy will always be to delay rather than completely absorb shocks; that is, if used properly in conjunction with the remaining guidelines (Pillars 2 and 3). This idea has lead some analysts to reverse the title of our research and ask about the impact of the crises on the Basel Accords. The promising part is that there is still time until 2019 for the Basel III regulation to be fully phased in. As a matter of fact, with the ongoing European turmoil which is seemingly unrelated to the Basel regulation, efforts are being directed towards continued deleveraging and sustained increases in CRs. Hopefully, this will catalyze efforts to promote healthy banking discipline in the future.

Appendix A. RB0 Breakdown

Table Appendix A.1: RISK-factor model applied to the 2007-2009 subprime crisis (RB0 Breakdown)

	USTRA		USTA		USTREAS		CURR		mFGNMA	
	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat
INTERCEPT	-0.426	-1.521	0.305	0.781	-0.786***	-2.725	-0.495***	-4.639	-0.161	-0.935
CRUNCH	-0.163**	-2.433	0.027	0.288	-0.091	-1.361	-0.021	-0.622	-0.033	-0.712
L_T1RAT	0.266	0.294	2.344	1.612	-1.895	-1.482	-0.650*	-1.788	0.712	1.155
L_TOTRAT	-0.262	-0.289	-2.343	-1.608	1.911	1.492	0.856**	2.145	-0.708	-1.148
L_LEVRAT	-0.048	-0.247	-0.196	-0.735	-0.058	-0.302	-0.227	-1.154	-0.202	-1.146
L_NPFRAT1	1.771*	1.848	1.727	1.139	-0.229	-0.184	1.915	0.748	-2.197**	-2.408
L_CRRAT	-0.041	-0.396	0.134	0.939	-0.051	-0.473	-0.049	-0.534	0.090	0.960
SQ_L_T1RAT	0.309	0.263	2.657	1.428	-1.979	-1.309	-2.258*	-1.796	0.747	0.977
SQ_L_TOTRAT	-0.309	-0.263	-2.657	-1.428	1.980	1.310	2.314*	1.829	-0.747	-0.977
SQ_L_LEVRAT	0.081	0.205	-0.393	-0.753	0.155	0.415	0.210	0.394	-0.376	-1.024
SQ_L_NPFRAT1	-12.793	-0.513	-4.590	-0.083	-6.030	-0.124	-146.311	-1.298	60.957*	1.897
SQ_L_CRRAT	0.696	1.605	-0.343	-0.611	0.458	1.136	0.126	0.489	0.005	0.013
CR_L_T1RAT	4.581**	1.997	-1.561	-0.443	2.289	0.832	0.886*	1.910	1.268	1.103
CR_L_TOTRAT	-4.579**	-1.993	1.565	0.443	-2.317	-0.839	-0.948**	-2.019	-1.291	-1.119
CR_L_LEVRAT	-1.185***	-3.070	-1.075**	-2.064	0.102	0.311	-0.078	-0.277	-0.162	-0.540
CR_L_NPFRAT1	-1.796	-1.113	-3.983*	-1.778	2.253	1.376	-2.649	-0.949	0.973	0.746
CR_L_CRRAT	-0.119	-0.475	-0.013	-0.044	-0.381*	-1.953	0.104	0.811	0.106	0.710
SQ_CR_L_T1RAT	0.734	0.245	-3.660	-0.854	2.627	0.918	2.902***	2.869	-0.325	-0.158
SQ_CR_L_TOTRAT	-0.734	-0.245	3.660	0.854	-2.628	-0.918	-2.914***	-2.896	0.324	0.158
SQ_CR_L_LEVRAT	-1.967**	-2.553	-1.706	-1.524	-0.195	-0.261	-0.465	-0.900	-0.678	-0.977
SQ_CR_L_NPFRAT1	2.313	0.066	31.818	0.493	-25.414	-0.480	151.024	1.332	-65.340*	-1.876
SQ_CR_L_CRRAT	-1.144	-1.032	-0.949	-0.771	0.835	1.130	-0.322	-0.976	-0.764	-1.388
GNPGROW	-0.106***	-5.085	-0.027	-0.953	-0.082***	-3.831	0.012	1.100	0.009	0.659
UNEMP	0.136***	4.859	0.077**	2.069	0.056**	2.128	0.061***	7.435	-0.062***	-3.821
STGROW	-1.833***	-3.581	-2.322***	-3.418	0.741	1.489	-1.891***	-8.228	1.059***	2.595
STUNEMP	0.008*	1.681	-0.014**	-2.204	0.023***	4.885	0.000	0.172	-0.000	-0.066
NE	-0.005	-0.252	-0.062**	-2.075	0.063***	2.649	-0.013**	-2.059	-0.040**	-2.170
BAA-AAA	-0.230***	-4.543	-0.125*	-1.797	-0.115**	-2.223	-0.089***	-3.618	0.042	1.351
RF3MO	-0.055	-0.863	-0.145*	-1.684	0.086	1.368	0.036*	1.729	0.085**	2.053
SQ_RF3MO	0.038**	2.127	0.045*	1.788	-0.000	-0.010	0.010	1.433	-0.016	-1.280
TIME	-0.010**	-2.081	-0.021***	-3.065	0.011**	2.191	0.008***	4.020	0.010***	3.084
SEAS1	-0.094***	-4.849	-0.085***	-3.204	0.001	0.030	-0.066***	-4.548	0.039***	2.873

Table Appendix A.1: (continued)

SEAS2	-0.012	-0.717	0.014	0.562	-0.025	-1.248	-0.061***	-5.357	-0.018	-1.480
SEAS3	0.004	0.240	0.004	0.179	-0.002	-0.117	-0.100***	-9.006	-0.032***	-2.854
SLOPE+	0.099	1.088	-0.067	-0.481	0.213*	1.937	0.105**	2.059	0.097	1.460
SLOPE-	13.421***	6.037	7.510**	2.315	5.635**	2.253	-6.741***	-7.190	-3.504*	-1.874
SQ_SLOPE+	-0.087**	-2.156	-0.026	-0.443	-0.077	-1.636	-0.023	-0.973	-0.009	-0.319
SQ_SLOPE-	147.248***	5.842	82.773**	2.262	60.849**	2.161	-79.802***	-7.395	-41.373*	-1.956
MEDIUM	0.015*	1.649	0.043***	3.537	-0.033***	-3.642	-0.020	-0.403	0.008	0.850
LARGE_1	-0.024	-1.063	0.074**	2.335	-0.118***	-4.227	-0.027	-0.558	-0.011	-0.734
LARGE_2	0.023	0.400	0.163*	1.751	-0.082	-0.930	-0.028	-0.596	-0.007	-0.234
HHIA	0.059	0.703	0.040	0.335	-0.004	-0.043	-0.004	-0.110	0.040	0.678
HHID	-0.108	-1.185	-0.164	-1.291	0.083	0.863	-0.000	-0.011	-0.037	-0.556
OCC	0.038***	3.194	0.007	0.342	0.012	0.714	-0.004	-0.538	0.022**	2.038
FDIC	0.033***	3.142	-0.034*	-1.933	0.046***	3.242	0.008	1.485	0.021**	2.222
R^2	0.006		0.003		0.001		0.022		0.003	
Num Obs	119679		107404		107404		25424		119679	

Appendix B. Securitization Effect

Table Appendix B.1: Enhanced RISK-factor model applied to the 2007-2009 subprime crisis (Securitization Effect)

	RSLN		TLRE		TLN		RMBS		RB20		RB50	
	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat	Parms	t-stat
INTERCEPT	-7.438	-1.330	-7.437	-1.347	-3.223***	-5.324	33.346**	2.152	12.216***	3.006	2.764	0.207
CRUNCH	-0.081	-1.253	-0.039	-0.656	-0.014*	-1.827	0.197	1.441	0.029	0.779	-0.066	-0.830
L_T1RAT	-1.245	-0.652	-1.296	-0.718	-0.678**	-2.518	2.121	0.740	1.402**	1.980	-0.166	-0.078
L_TOTRAT	0.849	0.419	0.948	0.520	0.513*	1.782	-2.343	-0.753	-0.660	-0.863	-0.606	-0.272
L_LEVRAT	0.915	0.987	0.733	0.863	-0.032	-0.283	0.362	0.424	-1.005***	-4.628	1.137	1.291
L_NPFRAT1	-1.016***	-2.639	-1.303***	-4.808	-1.295***	-9.500	-2.451	-1.169	0.040	0.103	-1.584**	-2.136
L_CRRAT	0.024	0.638	0.009	0.301	0.038	1.540	0.102	0.587	-0.032	-0.780	0.003	0.042
SQ_L_T1RAT	-8.052	-0.583	-8.760	-0.676	-3.490*	-1.936	4.476	0.258	4.927	0.985	1.771	0.116
SQ_L_TOTRAT	5.191	0.377	6.041	0.486	3.167*	1.706	-4.890	-0.277	-4.113	-0.807	-4.955	-0.335
SQ_L_LEVRAT	6.882	1.019	5.727	0.954	-0.004	-0.007	1.157	0.472	-1.553**	-1.991	6.146	1.037
SQ_L_NPFRAT1	24.203*	1.828	18.818*	1.790	15.894***	3.353	41.017	0.663	18.022	1.294	53.771	1.437
SQ_L_CRRAT	-0.040	-0.316	0.018	0.228	-0.162*	-1.928	0.116	0.195	0.174	1.246	0.093	0.385
CR_L_T1RAT	-0.121	-0.040	-1.488	-0.508	-0.293	-0.735	-9.869*	-1.654	0.900	0.656	0.349	0.165
CR_L_TOTRAT	0.476	0.157	1.961	0.670	0.259	0.585	9.979	1.617	-0.990	-0.665	0.550	0.245
CR_L_LEVRAT	-0.988	-1.093	-0.819	-0.905	0.063	0.689	0.865	0.549	-0.165	-0.536	-1.502	-1.464
CR_L_NPFRAT1	1.318**	2.311	0.474*	1.665	0.394***	2.639	2.480	0.776	0.151	0.306	0.933	0.902
CR_L_CRRAT	0.099	1.068	0.038	0.491	0.004	0.237	-0.087	-0.254	-0.039	-0.608	0.041	0.427
SQ_CR_L_T1RAT	8.274	0.525	-4.657	-0.295	-1.878	-0.583	-49.681	-1.356	10.922	1.114	2.442	0.158
SQ_CR_L_TOTRAT	-5.703	-0.379	7.532	0.494	2.032	0.623	50.232	1.359	-10.847	-1.088	0.458	0.030
SQ_CR_L_LEVRAT	-5.957	-1.044	-6.030	-1.014	-0.405	-1.039	0.627	0.151	-1.618	-1.575	-5.235	-0.807
SQ_CR_L_NPFRAT1	-14.977	-1.000	-12.984	-1.177	-9.659*	-1.769	-70.617	-0.986	-17.682	-1.160	-43.456	-1.115
SQ_CR_L_CRRAT	-0.162	-0.639	-0.108	-0.538	-0.002	-0.034	-0.115	-0.108	0.036	0.159	-0.232	-0.754
LIQRAT	-0.027	-1.210	-0.053***	-4.243	-0.180***	-18.451	0.366***	2.707	0.562***	19.163	0.031	0.710
GNPGROW	0.028*	1.687	0.023	1.421	0.012***	4.970	-0.103	-1.459	-0.042***	-3.106	-0.000	-0.013
UNEMP	0.044	1.045	0.056	1.334	0.022***	4.455	-0.313**	-2.475	-0.084**	-2.253	-0.013	-0.119
STGROW	-0.131	-0.406	-0.066	-0.219	0.017	0.501	-0.421	-0.422	-0.114	-0.630	-0.288	-0.899
STUNEMP	0.000	0.042	-0.001	-0.615	-0.001	-1.464	0.000	0.061	0.000	0.250	-0.004*	-1.832
DM3GDP	-0.044	-0.124	0.207	0.678	0.051	0.666	1.398	0.581	1.365***	2.957	-0.904	-0.819
INFL	-0.009	-1.138	-0.008	-1.032	-0.003***	-3.459	0.040	1.461	0.020***	3.458	-0.005	-0.330
GDPCAP	0.000	1.362	0.000	1.365	0.000***	5.528	-0.001**	-2.202	-0.000***	-3.155	-0.000	-0.214
NE	0.001	0.238	-0.005*	-1.657	-0.006***	-3.179	-0.032	-1.542	0.000	0.045	-0.004	-0.726
SW	0.006	0.316	-0.007	-0.831	0.008	1.489	0.030	0.785	-0.009	-1.170	-0.004	-0.168

Table Appendix B.1: (continued)

BAA-AAA	0.078	1.395	0.069	1.287	0.028***	4.883	-0.192	-1.294	-0.070**	-2.100	-0.055	-0.453
RF3MO	-0.247	-1.559	-0.226	-1.472	-0.116***	-6.543	1.407***	2.639	0.456***	4.083	0.094	0.259
SQ_RF3MO	0.050	1.590	0.045	1.498	0.024***	6.562	-0.304***	-2.732	-0.100***	-3.892	-0.020	-0.260
TIME	-0.022	-1.384	-0.023	-1.415	-0.010***	-6.086	0.117**	2.539	0.035***	3.347	0.016	0.428
SEAS1	-0.041**	-2.546	-0.038**	-2.438	-0.024***	-7.029	0.231***	2.815	0.064***	3.964	0.018	0.425
SEAS2	-0.020**	-2.496	-0.014**	-2.192	-0.005**	-2.113	0.107	1.363	0.044***	2.837	-0.026	-1.411
SEAS3	-0.000	-0.086	0.002	0.835	0.003**	2.427	-0.018	-0.652	0.003	0.528	0.015	1.341
SLOPE+	-0.011	-0.671	-0.015	-0.990	-0.009*	-1.830	0.069	0.460	-0.014	-0.257	0.042	0.765
SLOPE-	0.932	1.263	1.422**	2.003	0.531***	3.643	-5.721	-1.272	-2.178**	-2.437	-3.662*	-1.697
SQ_SLOPE+	-0.039	-1.347	-0.034	-1.242	-0.018***	-4.793	0.262**	2.286	0.088***	2.604	-0.004	-0.051
SQ_SLOPE-	14.301	1.278	20.037*	1.830	7.467***	4.029	-86.689	-1.563	-30.200***	-2.667	-44.895	-1.462
MEDIUM	0.007**	2.227	0.004*	1.838	0.002	0.853	0.043**	2.119	0.016***	4.346	0.000	0.063
LARGE_1	-0.001	-0.281	0.001	0.526	-0.001	-0.460	0.013	0.511	0.022***	4.526	-0.002	-0.242
LARGE_2	-0.005	-0.627	-0.012	-1.237	0.001	0.148	0.060*	1.785	0.007	0.750	-0.005	-0.337
HHIA	0.004	0.110	0.005	0.187	-0.007	-1.064	0.110	1.345	0.019	1.238	0.002	0.064
HHID	-0.066	-1.065	-0.046	-1.047	-0.000	-0.003	-0.100	-1.028	0.009	0.445	0.005	0.064
OCC	-0.006*	-1.878	-0.005**	-2.016	-0.005**	-2.482	-0.011	-0.565	0.002	0.555	0.002	0.436
FDIC	0.004	1.517	0.003*	1.713	-0.000	-0.127	0.014	0.855	0.008**	2.198	0.009**	2.575
o.OTS	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.	0.000	.
S_CILN	0.009	0.439	0.039	1.340	-0.029*	-1.823	1.994**	2.419	0.025	0.733	0.043	0.964
S_LNRE	-0.266**	-2.225	-0.237*	-1.889	-0.163**	-2.564	0.615	1.343	0.167	1.078	-0.274	-1.273
S_INLN	0.039*	1.782	0.033**	2.269	-0.014	-0.652	-0.457	-1.533	0.044	1.200	0.013	0.512
S_RMBS	-0.000	-0.793	-0.000	-0.912	-0.000	-1.522	-0.087***	-5.218	-0.005**	-2.029	-0.001	-0.803
S_USTR	0.177**	2.270	0.137	1.561	0.121**	2.436	-0.237	-0.763	-0.133	-1.007	0.085	0.587
S_EQ	0.002	0.180	0.012	1.304	0.023***	4.161	-0.021	-0.431	0.011	0.481	0.036*	1.700
NINCRAT	-0.193	-0.924	-0.073	-0.832	-0.192	-0.877	0.358	0.733	-0.347**	-2.511	0.354*	1.820
XRERAT	-0.013***	-3.054	-0.008***	-2.700	-0.007***	-3.172	-0.032	-1.395	0.007	1.622	-0.013*	-1.955
R^2	0.024		0.033		0.098		0.011		0.057		0.003	
Num Obs	24121		24121		24121		24121		24121		24121	

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