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November 2012

n. 106

V&P VITA E PENSIERO

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www.vitaepensiero.it

ISBN 978-88-343-2367-0

Abstract

This paper investigates the role of off-balance sheet securitization on bank leverage pro-cyclicality. The interest in substantial leverage (taking into account off-balance sheet securitization), rather than formal leverage (measured by balance sheet data), accords well with Basel III, which aims at adopting leverage requirements incorporating off-balance sheet activities. This is especially important for the US, where GAAP accounting rules for securitization allowed until 2009 an underestimation of on balance sheet items, thanks to loose rules for the de-recognition of securitized assets. For a sample of the 73 largest US BHCs over 2001-2010, we document pro-cyclicality when we take into account securitization. Furthermore, we observe that in the pre-crisis period securitization was an important driver of leverage pro-cyclicality not only for investment banks but also for commercial banks highly involved in securitization.

JEL codes: G21, E3
Keywords: Banks, Pro-cyclicality, Securitization

Introduction[♣]

In the aftermath of the 2007 financial crisis, the high level of leverage of financial intermediaries has commonly been identified as the main source of weakness in the financial system and, consequently, as one of the major causes of the crisis (Financial Stability Forum, 2009). Many observers pointed at leverage pro-cyclicality – i.e. the increase (decrease) of leverage following an increase (decrease) of total assets value – as an amplification mechanism of business cycles upturns and downturns (Adrian and Shin, 2010b)[1]. The pro-cyclicality of leverage may fuel a supply side financial accelerator complementing (or substituting for) the demand side financial accelerator pioneered by Bernanke and Gertler (1989); Kiyotaki and Moore (1997) in explaining business cycle's booms and recessions.

Formally, leverage (L_t, defined as the ratio of total assets A_t to total equity E_t) is pro-cyclical if:

$$\Delta L_t = f(\Delta A_t)$$
$$f' > 0$$

Adrian and Shin (2010a) argue that pro-cyclicality of leverage is a consequence of banks targeting their capital to a fixed proportion of their own VaRs[2], joined with the widespread practice of market value accounting, which makes the value of banks assets strongly depend on the price changes of assets traded in financial markets. In short, the mechanism may be described as follows: ensuing an increase in the price of securities – for a given value of debt – leverage goes down. However if banks perceive that their value at risk (VaR) has also decreased they have room for increasing their holdings of

♣ We wish to thank Angelo Baglioni, Barbara Casu, Andrea Monticini for very helpful detailed suggestions on a previous version of the paper.

[1] Notice that a different notion of pro-cyclicality is adopted by Piffer (2010), as he investigates the existence of statistically significant positive co-movements between leverage and a measure of the business cycle such as aggregate output.

[2] This may be justified by considering the solvency regulation (1996 Market Risk Amendment to the Basel Accord).

securities more than needed to just restore the initial leverage. An upward pressure on asset prices follows, which in turn feeds back in higher leverage, generating an upward spiral. To the opposite, any negative shock to banks' balance sheets would trigger a downward spiral of leverage and asset prices.

Adrian and Shin (2010a) find that US commercial banks had an a-cyclical leverage between 1997 and 2008, whilst the five major "pure" investment banks have a strongly pro-cyclical leverage. Those banks account only for 11.7% of total equity of US banks. One might argue that – given the high degree of interconnectedness of today's banking systems – even a small fraction of banks with a pro-cyclical leverage can have such a large systemic impact as to give rise to a supply side accelerator. It may reasonably be said, however, that any kind of supply side financial accelerator may be better justified if a large proportion of a country's banking sector does substantially react to fluctuations in asset prices, making leverage pro-cyclical[3]. It is thus interesting to check whether it is possible to prove that pro-cyclical leverage characterizes a broader set of US financial institutions.

A burgeoning literature has attempted at verifying pro-cyclicality along different lines. Kalemli-Ozcan*et al.*(2011) document that the leverage ratio is pro-cyclical not only for US investment banks but also for *large* commercial banks (over the period 2000-2009). Damar *et al.*(2011) highlight the interaction of leverage pro-cyclicality with the use of wholesale funding, using Canadian data. They show that the degree of pro-cyclicality is not constant across different types of financial institutions and with respect to the changes in macroeconomic and market environments. Financial institutions that use wholesale funding display high degrees of pro-cyclicality as these market-based funds are readily available at short notice for quick adjustments to leverage. Gropp and Heider (2010), for a large sample of US and European banks between 1991 and 2004, focus on the behaviour of bank leverage through time and find that banks' target

[3] As Hanson, Kashyap and Stein (2011) write "If a large fraction of the financial system is in difficulty, a simultaneous attempt by many institutions to shrink their assets is likely to be more damaging to the economy" (p. 5).

leverage is time-invariant and bank specific. Instead Baglioni*et al.*(2012), for a sample of 77 European banks over 2000-2009, show that pro-cyclical leverage appears to be well entrenched in the behaviour of those European universal banks for which the investment banking activity prevails over the more traditional commercial banking activity.

In the present paper we move one step further by focusing on the role of off-balance sheets and securitization on leverage. This research, therefore, accords well with Basel III, which aims at adopting leverage requirements that incorporate off-balance sheet activities. The literature on securitization prior to the outbreak of the financial crisis (see for an extensive discussion: Wilson *et al.*, 2010) emphasized the positive role played by securitization in dispersing credit risk[4], in reducing reserve and capital requirements (Minton *et al.*, 2004), and in reducing the cost of funding (Rosenthal and Ocampo,1988a, 1988b; Jones, 2000). The recent financial crisis has tarnished such a positive image showing that securitization enables credit expansion through higher leverage of the financial system as a whole and drives down lending standards[5]. Rather than dispersing credit risk into the hands of final investors, securitization led to a concentration of the credit risk in the banking sector itself[6]. Specifi-

[4] Greenbaum and Thakor (1987); Pavel and Phillis (1987); Hess and Smith (1988). Franke and Krahnen (2005) argue however that if banks use the proceeds from securitization to issue new loans, and most banks active in the securitization markets do so, their default risk increases. Therefore, the authors conclude that securitization leads to a higher default probability and a higher equity beta for issuing banks.

[5] Specifically, the literature developed after the crisis pertain to how securitization affects banks' stability through its impact on bank funding, bank risk management and bank profitability (Greenlaw*et al.*(2008); Altunbas*et al.*(2009); Adrian and Shin (2008); Uhde and Michalak (2010). Greenlaw*et al.* (2008) report that roughly two thirds of the losses from subprime mortgages were borne by financial institutions themselves: investment banks, hedge funds and also commercial banks.

[6] Calomiris and Mason (2004); Higgings and Mason (2004); Niu and Richardson (2006); Jiangli*et al.* (2007); Jiangli and Pritsker (2008); Chen *et al.*(2008); Vermilyea*et al.* (2008). Adrian and Shin (2010b) argue that the act-prime crisis originated from the increased supply of loans and this was caused by the usage of securitization and the search for new assets to fill banks' balance sheets. The practice that securitizers tends to retain the equity tranche also indicate that the largest part of the risk remains within the bank. Typically issuing banks retain first-loss contractual inter-

cally, Jiangli, Pritsker, Raupach (2007) and Jiangli and Pritsker (2008) investigate the importance of computing the off-balance sheet securitization in order to consider the whole effect of securitization on banks. Using US bank holding company data from 2001 to 2007, these studies document empirically how the insolvency risk, leverage and profitability of securitizers would change if banks had to take the securitized assets back onto their balance sheets. They find that, off-balance sheet mortgage securitization reduces bank insolvency risk, and increases bank leverage and profitability.

The research questions addressed in this paper may be summarized as follows: 1) does "formal" leverage, as measured by balance sheet data, underestimate "substantial" leverage, which takes into account off-balance sheet securitization?; 2) once off-balance sheets are considered, does US commercial banks' leverage become procyclical? and 3) is there any difference in the role played by securitization before and after the break up of the financial crisis in 2008? These three questions appear especially relevant for US banks because until the amendment of FAS No. 140 by the SFAS 166 in January 2010, US GAAP left US banks the possibility to put securitized assets off-balance sheet, if certain conditions were met, when these assets were transferred to Special Purposes Entities (SPEs). In accordance with SFAS 140, the bank recognized transfers of financial assets as sales providing that control has been relinquished over such assets. The majority of a bank's involvement with SPE was related to securitization transactions meeting the SFAS 140 definition of a *Qualifying Special Purpose Entity* ("QSPE"). In what follows we shall provide an operational measure of "substantial leverage" that includes off-balance sheet securitization items for US bank holding companies (BHC). Specifically, we add the "outstanding principal balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements" to the value of total assets taken from the balance sheet. This amount consists in

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ests or provide implicit recourse in securitization transactions. These arrangements mean that the risks inherent in the securitized assets have not been transferred to investors and are, in effect, still held by the issuing bank, but off-balance sheet because securitized assets are transferred to Special Purpose Vehicle.

the principal balance outstanding of loans, leases and other assets, which the bank has sold and securitized while retaining the right to service these assets, or when servicing has not been retained, retaining recourse or providing other seller-provided credit enhancements to the securitization structure[7]. In this way, we obtain the actual amount of total assets that US banks would have to account, were the US banks forced to carry securitized assets on their balance sheet, as European banks do.

When moving from "formal" to "substantial" leverage, several interesting results emerge. As for the first and second research questions, distinguishing between four groups of banks differing as for the degree of their involvement in securitization activities (major securitizers vs. minor securitizers) and on the basis of their nature (commercial vs. investment banks), we observe that in the pre-crisis period securitization was an important driver of leverage pro-cyclicality not only for investment banks but also for commercial banks highly involved in securitization. This analysis shows an important result at variance with that of Adrian and Shin (2010a): when off-balance sheet securitization is taken into account, commercial banks do not follow a policy of leverage targeting but they rather pursue, like investment banks, a pro-cyclical leverage. As for the third research question, the average degree of pro-cyclicality of US banks becomes even stronger than that found in the literature, especially when the pre-crisis period is considered in isolation. For both the crisis and post-crisis periods we observe a decreasing power of securitization in driving pro-cyclicality.

The paper is organized as follows. Section 2 motivates the sample used in the empirical analysis that follows. Section 3 is devoted to

[7] In order to avoid double counting, it excludes the principal balance of loans underlying seller's interests owned by the bank. Moreover, this item does not report mortgages sold to the Federal National Mortgage Association (Fannie Mae) or the Federal Home Loan Mortgage Corporation (Freddie Mac) that the government-sponsored agency in turn securitizes. Finally, this item also excludes securitizations that have been accounted for as secured borrowings because the transactions do not meet the criteria for sale accounting under generally accepted accounting principles. These securitized loans, leases and other assets should continue to be carried as assets on the reporting institution's balance sheet.

some preliminary graphic analysis that strongly points to the relevant role played by off-balance sheet securitization in enhancing the leverage pro-cyclicality of both investment and commercial US banks. Section 4 discusses the five different model specifications employed in our empirical study. Section 5 presents the empirical results and the robustness tests, whilst section 6 concludes and gives some policy recommendations.

1. *Sample and data sources*

In this study we focus on US bank holding companies (BHCs). This choice is first motivated by the fact that risk and capital management are usually managed at the highest level of the financial group (Casu*et al.*, 2011). In addition, securitization may involve several subsidiaries of a bank holding company and therefore may affect capital and liquidity planning for the whole group (Aggarwal and Jacques, 2001). Finally, loan sale and securitization within a BHC group may not be subject to the same informational and agency problem (Jiangli and Pritsker, 2008).

With regard to the period of analysis, being interested in the effects of securitization on bank leverage, with a specific interest about the effect of leverage on the financial crisis, we collect data from the second quarter of 2001 (since when greater disclosure about securitization activity has been imposed on US banks) to the last quarter of 2010. Unlike previous studies on securitization that were restricted to the pre-crisis period, we extend the sample period until the last quarter of 2010 in order to analyze the propagation phase of the financial crash and the post-crisis period.

The accounting data used in the study are taken from FR Y-9C provided by the Federal Reserve Bank of Chicago. This database, already used in previous studies[8], collects quarterly accounting information on balance sheet and income statement's data and detailed support schedules (including the one on off-balance sheet items)

[8] Jiangli*et al.*(2007), Ashcraft and Steindel (2008), Jiangli and Pritsker (2008), Sarkisyan et al (2010), Casu*et al.* (2011).

since 1986. Moreover since June 2001, it was required for US banks to provide detailed information on their securitization activities, which are shown in the Schedule HC-S (Servicing, Securitization, and Asset Sales Activities). This schedule includes information on assets that have been securitized or sold and are not reportable on the balance sheet (Schedule HC), except for credit-enhancing interest-only strips, subordinated securities and other enhancement, and seller's interest, that is bank's ownership interest in loans that have been securitized. A bank holding company should report information in this schedule for those securitization for which the transferred assets qualify for sale accounting or are otherwise not carried as assets on the bank holding company's consolidated balance sheet.

Table 1 (Panel A) refers to the sample of 2,809 US BHCs (as made available by the Fed). It shows the results of a comparison among securitizers and non-securitizers in terms of total assets. Although loan sales and securitization activities have grown in the aggregate, the number of US BHCs that engage in these activities is small. The number of securitizers in the sample is extremely limited (337): they represent only 12% of the total BHCs. Moreover it is important to note that securitizer BHCs are significantly larger than non-securitizer ones: their amount of total assets ($53.9 billion) is over 45 times higher than that of non-securitizers ($1.5 billion). These 317 securitizers account for 86.08% of the total US BHCs in terms of total assets. This finding is consistent with previous studies that document that larger banks are more likely to securitize[9]. Table 1 also shows summary statistics on securitization activity. The first index is the ratio of securitized assets to total loans. The 337 securitizers have a mean value of 15.43% over the whole period of analysis (note that is not an extremely high value overall). This panel also shows that most of securitized assets are residential mortgage: they represents almost 10.53% of total loans. The second index is the *ratio* of

[9] Minton *et al.* (2004) have shown that large US commercial banks have a greater propensity to securitize. Similar results have been documented for European banks by Bannier and Hansel (2006) and by Martin-Oliver and Saurina (2007) for Spanish financial institutions.

securitized assets to total assets: the mean value is almost 7.97% and about 5.56% is represented by mortgages.

As our focus is on the effects of securitization on leverage, we shall take into account only large banks: precisely the largest BHCs in terms of assets. Following the procedure in Jiangli*et al.* (2007)[10], we have created an open sample, including banks that, between 2001 and 2010, appeared at least once among the top 50 BHCs in terms of total assets.[11] As reported in Table 1 (Panel B), the sample consists of 73 US BHCs, observed quarterly between 2001 2Q and 2010 4Q, for a total of 2,211 panel observations[12].

Focusing on the largest BHCs, the percentage of securitizers in the sample is higher than in the total sample[13]: about 80% (57 securitizers and 16 non-securitizers). This sample is more representative of banks that are engaged in securitization, and also contains a control group of banks not involved in securitization. However not all securitizers are substantially involved in these activities: for some of them the amount of securitized assets is very small. It is because of this difference among large banks that we can assess the influence of securitization on leverage. In order to differentiate among banks for

[10] Jiangli*et al.*(2007) sorted the US BHCs into seven size-buckets, based on the quantiles of Ln(assets), with bucket seven containing the 22 largest bank holding companies, and each succeeding size-bucket containing increasingly smaller BHCs. The authors show an upward jump in the fraction of securitizers as the size of BHCs increases. For example, among the smallest BHCs, only 1% are securitizers but this fraction jumps to almost 100% in the last bucket of largest banks. This shows that large US BHCs are more likely to securitize, while smaller banks are less likely to securitize.

[11] In order to avoid double counting we have excluded the subsidiaries of BHCs included in the sample, although present in FR Y-9C. Moreover we have included in the sample not only active banks but also banks that have ceased to exist over time or that have been involved in mergers or acquisitions. In the latter case, as for the full sample, we maintain the code of the acquiring BHC while the acquired bank is eliminated from the sample.

[12] This sample included both listed and non-listed BHCs, typically subsidiaries of foreign listed bank holding companies but included in the sample because they are considered US BHCs by the Federal Reserve Bank of Chicago.

[13] We define here as securitizers BHCs that have conducted at least a securitization transaction during the period of analysis, regardless of the weight of operation in terms of assets.

which the ratio of securitized assets on total assets is not significant and banks that recourse heavily to this practice, we introduce a further distinction between major securitizers and minor securitizers, on the basis of average weight that asset securitization has had for each bank over time. When the ratio between securitized assets and total assets, for each bank, is higher than the median value of the same ratio for all banks in the sample (2.47%) the bank is considered major securitizer.

In this sample of the largest BHCs, among the 57 securitizers, 32 are major securitizers, which represent 44% of the sample. Moreover, major securitizers represented almost 76.81% of the US banking system in terms of total assets over the whole period, and this weight has been increasing over time. This explains the importance to focus specifically also on this group of banks. Turning to the comparison on total assets, in the largest banks sample, securitizers have, on average, a value of total assets that is about three times higher than that of non-securitizers ($214.06 billions vs. $62.31 billions); and this difference is even bigger considering major securitizers that are more than four times bigger than minor securitizers ($316.81 billions vs. $74.64 billions). As for ratios on securitization, as we focus here on banks that have on average a deeper involvement in securitization, the value of securitized assets to loans ratio is much higher: off-balance sheet securitized assets account for 78.03% of on-balance sheet loans (against 44.53% in the largest bank sample and 15.43% for the overall sample). Same finding comparing securitized assets with total assets: 32.09% (against 18.37% in this largest bank sample and 7.97% in the overall sample). This result gives further evidence that securitization is a phenomenon which has interested a limited subset of US BHCs but some of the larger banks have used it heavily. Also, the focus on major securitizers reveals that the impact of securitization is even greater: the securitized assets to loans ratio is 78.03% while the percentage of securitized assets on total assets is about 32.09%.

Table 2 reports the substantial leverage, in addition to the formal leverage, and clearly shows an increase in the value of leverage when securitization is taken into account, and therefore an increasing dif-

ference in the comparison between securitizers and non-securitizers. The increase of leverage is much more consistent on the smaller sample: focusing on major securitizers, that are banks most involved in securitization transactions, the increase of leverage, considering securitization, is about 25%.

2. *A preliminary graphical analysis*

In order to get some preliminary evidence on the relationship between total assets and leverage for US large BHCs, we perform a graphical analysis by reporting scatter plots of the log difference (i.e. the rate of change between time *t* and *t+1*) of total assets and leverage. Specifically, on the *x-axis* there is the percentage change of total assets and on the *y-axis* the percentage change of leverage.

Figures 1 and 2 are quite informative. For the sample of large US BHCs there is a positive relationship between total assets and leverage, indicating pro-cyclicality. Moreover, pro-cyclicality becomes even stronger when we augment the value of total assets by the amount of off-balance sheet assets that have been securitized or sold with servicing retained or with recourse or other seller-provided credit enhancements. The comparison of the two scatter plots reveals that the positive relationship is stronger considering securitization.

We then examine whether the degree of US banks pro-cyclicality depends on their specialization (as in Europe) and whether securitization has a different impact in driving pro-cyclicality for commercial and investment BHCs. This interest comes from previous evidence in Baglioni*et al.* (2012) that for European banks point out a stronger pro-cyclicality for banks involved in investment banking activity, and a lower one for more traditional commercial banks. This seems relevant also for the US because the period under analysis is follows the repeal of the Glass-Steagall Act in 1999; hence US bank holding companies are allowed to be engaged in both investment and commercial activities. We therefore distinguish between BHCs with predominant commercial banking activity (mainly commercial

banks) and BHCs more oriented on investment banking (mainly investment banks). More precisely, following Baglioni*et al.* (2012), a bank is considered a "mainly commercial" BHC if the loan ratio is above the median value for the whole sample (that is, 62,5) and a mainly investment BHC otherwise. Coherently with the repeal of the Glass-Steagall Act, the sample of large US BHCs is composed from both banks that are more traditional and focused primarily on commercial activities and banks for which, instead, the investment banking activity is prevalent.

Figure 3 provides preliminary evidence for the different time pattern of leverage in the two act-samples (mainly commercial and mainly investment banks). It shows that the two groups of banks follow clearly different patterns. For banks with a predominance of traditional commercial banking activity the leverage trend has been roughly constant since 2001, and slightly higher to a level of 10 until the outbreak of the financial crisis. But even with the burst of the crisis, the reduction in the leverage was limited. Instead, the pattern of leverage for the banks with a predominance of investment banking is completely different. It has remained nearly constant up to mid-2004, albeit at a higher level of that of mainly commercial banks. After 2004 these banks were characterized by a continuous rise in the level of indebtedness, until the third quarter of 2008 (except for a slight decrease in 2007, during the early stages of the crisis).

Figures 1.a, 1.b and 2.a, 2.b point to a stronger pro-cyclicality for BHCs oriented to investment banking activity and a larger role of securitization. For mainly commercial banks the degree of pro-cyclicality seems low, the slope is close to zero, suggesting a policy of constant leverage targeting. The impact of securitization on leverage pro-cyclicality is very weak, albeit positive.

A different picture emerges, however, when focusing only on major securitizers, that is on banks for which securitization is a large proportion to total assets (figures 4.a, 4.b and figures 5.a, 5.b). These figures show that the slope of the trend line is much steeper when considering securitization and this is preliminary evidence that securitization that banks use this activity in order to increase their leverage during upturns and vice versa. Notice that this is true not only for

mainly investment banks but also for mainly commercial banks: focusing on banks involved in securitization activity and considering the "substantial" level of leverage (with off-balance securitization), commercial banks too seem to manage pro-cyclically their leverage. This intriguing preliminary evidence of pro-cyclicality for US commercial banks is at variance with Adrian and Shin (2010a) evidence and it will be further studied in sections 4 and 5 below.

3. *Methodology*

To empirically examine the relationship between the change in leverage and the change in total assets, that is the pro-cyclicality of leverage, we first run the following two-ways fixed effects panel data regression[14]:

$$\Delta Leverage_{i,t} = \beta_0 + \beta_1 \Delta Assets_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where:

$\Delta Leverage_{i,t}$= quarterly log-differenced leverage of bank*i* at time*t*, where leverage is defined as total assets over bank equity capital;

$\Delta Assets_{i,t}$= quarterly log-differenced total assets' value of bank i at time *t*. Obviously, regression (1) will give evidence of leverage pro-cyclicality if the sign of β_1 results positive and statistically significant;

$\varepsilon_{i,t} = \propto_i + \propto_t + e_{i,t}$= error term, where $e_{i,t} \sim i.i.d.(0, \sigma^2_{i,t})$with $\sigma^2_{i,t} \neq \sigma^2_{j,s}$ for$t \neq s$, in general.

The second step of our empirical research is testing how differences in the banks' business model affect the leverage management of banks. By so doing we are in the position to further test on a large

[14] This model explores fixed effects of one group and one time variable. This model thus needs two sets of group and time dummy variables (i.e. bank and quarter). It is characterized by a three-part error structure: $\propto_i$: group fixed-effects, which controls for permanent differences between groups; $\propto_t$: time fixed-effects, which is common to all groups but vary by time period (e.g. quarter); $e_{i,t}$: idiosyncratic error.

sample of US BHCs the evidence in Adrian and Shin (2010a) according to which commercial banks follow a policy of constant leverage targeting. Formally, the regression model becomes:

$$\Delta Leverage_{i,t} = \beta_0 + \beta_1 \Delta Assets_{i,t} + \beta_2 Commercial_i * \Delta Assets_{i,t} + \beta_3 Leverage_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

where:
$Commercial_i$= a dummy variable taking value 1 for "mainly commercial" banks where the ratio between loans and total assets is above the median ratio of the whole sample (0.625), and zero for "mainly investment" banks, as done in Baglioni*et al.* (2012);
$Leverage_{i,t-1}$= (log) leverage lagged by one quarter. This variable is included in order to capture bank's reaction to the leverage level in the previous quarter.

In regression (2), β_1 has to be interpreted as the slope of the regression line for the group of "mainly investment" banks, while ($\beta_1 + \beta_2$) represents the coefficient for the group of "mainly commercial" banks. Thus, the expected sign of β_1 is positive, reflecting the pro-cyclical pattern of investment banks' leverage, while the expected sign of β_2 is negative. As suggested by previous preliminary analysis, the idea is that pro-cyclicality in leverage characterize especially BHCs that are involved consistently in investment banking activity, so the sum ($\beta_1 + \beta_2$) should be close to zero, indicating a policy of leverage targeting by mainly commercial banks. β_3 is expected to be negative as it should reflect the behavior of banks that try to correct deviations from some target levels.

With the third model we introduce the core analysis of the present paper, i.e. we test the impact of off-balance sheet securitization on the pro-cyclicality of bank leverage, by moving to the substantial leverage. Specifically, we develop three levels of analysis on substantial leverage, focusing on the business model, on the degree of involvement in securitization and on the interplay between business model and off-balance sheet securitization. First, we test the impact of securitization on the pro-cyclicality of bank leverage with reference to different business models; formally:

$$\Delta SubstantialLeverage_{i,t} =$$

$$= \beta_0 + \beta_1 \Delta SubstantialAssets_{i,t} +$$

$$+ \beta_2 Commercial_i * \Delta SubstantialAssets_{i,t} +$$

$$+ \beta_3 SubstantialLeverage_{i,t-1} + \varepsilon_{i,t} \qquad (3)$$

where:

$\Delta SubstantialLeverage_{i,t}$= quarterly log-differenced substantial leverage of bank *i* at time *t* (i.e. value of formal leverage corrected to consider the assets sold or securitized that are carried off-balance sheet);

$\Delta SubstantialAssets_{i,t}$= quarterly log-differenced total assets' value of bank *i* at time *t*, where the amount of total assets has been corrected to consider off-balance sheet securitization;

$SubstantialLeverage_{i,t-1}$= (log) substantial leverage lagged by one quarter.

Indeed, if the securitization is an important phenomenon that must be taken into consideration when investigating the pro-cyclicality of bank leverage, regression (3) should show a higher explanatory power than that of regression (2). Moreover, if securitization determines a stronger pro-cyclicality, it is expected an increase in coefficient β_1 .

We then test the impact of securitization on the pro-cyclicality of bank leverage with reference to different levels of exposure to securitization. We thus distinguish, through the use of a dummy variable, between banks with a major involvement in securitization and banks with a minor involvement, regardless of whether they are commercial or investment banks. Formally:

$$\Delta SubstantialLeverage_{i,t} =$$

$$= \beta_0 + \beta_1 \Delta SubstantialAssets_{i,t} +$$

$$+ \beta_2 Major * \Delta SubstantialAssets_{i,t}$$

$$+ \beta_3 SubstantialLeverage_{i,t-1} + \varepsilon_{i,t} \qquad (4)$$

where:

$Major_i$ = dummy variable taking value 1 for major securitizers, that isbanks for which the ratio between securitized assets off-balance sheet and total assets is above the median value of the whole sample, and zero otherwise.

The base group is, consequently, minor securitizers: β_1 is the coefficient for minor securitizers and (β_1+ β_2) is the coefficient for major securitizers. We expect that the coefficient of β_2 is positive and statistically significant before the crisis and not statistically significant during the crisis, indicating a decreasing role of securitization in driving leverage pro-cyclicality.

Finally, we investigate the impact of securitization on the pro-cyclicality of bank leverage by combining the two dimensions: business model(i.e. mainly commercial vs. mainly investment banking) and level of exposure to securitization (i.e. major vs. minor securitizers). Specifically, the model disentangles four different groups of banks: banks with mainly investment banking activities with a high involvement in securitization; banks with mainly investment banking activities with a low involvement in securitization; banks with mainly commercial activities with an high involvement in securitization; banks with mainly commercial activities with a low involvement in securitization (see Box 1 for a description of the number of banks in each group). By so doing, we are able to examine if, indeed, banks involved to an appreciable extent in securitization activities are more oriented towards an active pro-cyclical management of their leverage. In addition, we are able to appreciate whether the involvement in securitization affects the level of pro-cyclicality commercial as well as for investment banks. By using dummy variables that interact with the quarterly change in assets, we investigate the different degree in pro-cyclicality for the four groups of banks. Formally:

$$\Delta SubstantialLeverage_{i,t} =$$

$$= \beta_0 + \beta_1 \Delta SubstantialAssets_{i,t} +$$

$$+ \beta_2 InvMaj_i * \Delta SubstantialAssets_{i,t}$$

$$+ \beta_3 InvMin_i * \Delta SubstantialAssets_{i,t}$$
$$+ \beta_4 ComMaj_i * \Delta SubstantialAssets_{i,t}$$
$$+ \beta_5 SubstantialLeverage_{i,t-1} + \varepsilon_{i,t} \quad (5)$$

where:
$InvMaj_i$ = a dummy variable taking value 1 if a bank is both investment bank and major securitizers, and zero otherwise;
$InvMin_i$= a dummy variable taking value1 if a bank is an investment bank but that is not highly involved in securitization (minor securitizers), and zero otherwise;
$ComMaj_i$= a dummy variable taking value 1 if a bank is a commercial bank and a major securitizer, and zero otherwise.

The base-group is the category of commercial banks that are not highly involved in securitization. Consequently, $\beta_1$is the estimated coefficient of the base-group and its expected sign is around zero, indicating a policy of leverage targeting since it refers to commercial banks that do not have a significant exposure on securitization. The estimated coefficient for the group of commercial banks that are, however, highly involved in securitization is (β_1+ β_4); consequently the expected sign of β_4 is positive, reflecting a positive impact of securitization on the relation between changes in leverage and changes in assets. In other words, we expect that, when considering securitization, also commercial banks show some pro-cyclicality. Turning to investment banks, the coefficient for the group of investment banks not considerably involved in securitization transaction is (β_1+ β_3). The expected sign of β_3 is positive because, even if they are not involved in securitization, it is expected that investment banks are characterized by a greater degree of pro-cyclicality than minor securitizers commercial banks (that represents the base group). Finally, the estimated coefficient for investment banks highly involved in securitization is (β_1+β_2) and the expectation is that β_2 is positive and higher thanβ_3, reflecting, once again a positive impact of securitization on leverage pro-cyclicality. Specifically, we expect that investment banks show a greater pro-cyclicality than commercial banks and, within each category, banks involved in securitization transac-

tions are expected to be more pro-cyclical than minor securitizers. That is: $(\beta_1+\beta_2) > (\beta_1+\beta_3) > (\beta_1+\beta_4) > \beta_1$.

All the above regression are tested for different periods: pre-crisis period, crisis period and post-crisis period, in order to check if the management of leverage has followed a constant pattern over time or whether the outbreak of the crisis has put a brake on the use of securitization as a driver of leverage pro-cyclicality. For this reason we first test the models on the whole period (2001 2Q – 2010 4Q) and then on the three sub-periods (pre-crisis period: 2001 2Q – 2007 2Q, crisis period: 2007 3Q – 2009 Q1, post-crisis period: 2009 2Q – 2010 4Q), based on the classification of the Bank for International Settlements (2010).

4. *Empirical results*

4.1. Regression results

Regression results for the full period are reported in Table 3. In the base regression (1), the estimated β_1 is positive and highly statistically significant, indicating pro-cyclicality of leverage for US bank holding companies. In the more complete regression (2), several results emerge. First, β_1 remains positive and statistically significant, which indicates a clear pro-cyclicality of leverage especially for those BHCs whose business is more oriented to investment banking activities. Mainly investment banks seem to respond to a change in their asset value by changing their leverage in the same direction. If we compare our results with those in Baglioni*et al.* (2012), we observe a greater pro-cyclicality for US banks than for European banks (β_1 is higher here). Second, $\beta_2$is negative and statistically significant so that the estimated slope coefficient for commercial banks ($\beta_1+\beta_2$) is still positive but very low. The active pro-cyclical management of leverage concerns not only pure investment banks (as maintained by Adrian and Shin, 2010a) but also US BHCs mainly oriented to commercial banking. Despite this, it is true that the pro-cyclicality concerns, above all, those banks for which the investment banking activ-

ity is prevalent. Third, the estimated value of β_3 is negative and significant, confirming that banks react to the previous quarter leverage by correcting levels that deviate from some target levels. Finally, the result of the F-test, which controls for the effective presence of unobserved factors, is 1.91 that corresponds to a statistical significance at the one per cent level. We can therefore reject the null hypothesis that the unobserved factors are equal to zero and, therefore, the estimated model is consistent[15].

When we take into account off-balance sheet securitization (regression 3) the pro-cyclicality of leverage becomes stronger, above all for mainly investment banks, although it remains positive also for mainly commercial banks. The remarkable rise of the R^2 (from 22 percent to 34 percent moving from regression 2 to regression 3 without adding any explanatory variable) confirms the need to consider securitization when interested in investigating the possible existence of a positive relationship between change in assets and change in leverage.

In order to investigate the impact of securitzation on leverage pro-cyclicality, we perform regression 4. The value of β_1 is roughly zero (0.009) pointing out that minor securitizers are more inclined to a policy of constant leverage targeting, whereas the value of β_2 is positive (0.502) and statistically significant showing that major securitizers have a high degree of leverage pro-cyclicality.

In order to directly catch the impact on leverage pro-cyclicality of being involved is securitization for both mainly commercial and mainly investment banks, we perform regression 5. What emerges here is that mainly commercial banks not involved in securitization show a very low degree of pro-cyclicality: the value of β_1 is roughly zero (0.075), showing that these banks are more inclined to a policy of constant leverage targeting, confirming previous findings by Adrian and Shin (2010a). In short: being both mainly investment banks and major securitizers strengthen the pro-cyclicality of leverage.

However, for mainly commercial banks involved in securitization the situation changes dramatically when off-balance sheet items re-

[15] We perform this tests also for the subsequent regression models and we are always able to reject the null hypothesis that the unobserved factors are equal to zero.

lated to securitized assets are taken into account: the coefficient β_4 is positive (0.411) and statistically significant. This proves a high degree of pro-cyclicality also for commercial banks, when off-balance sheet securitization is considered. Turning to mainly investment banks, the pro-cyclicality is even higher. The coefficient β_3 is positive (0.49) and highly statistically significant for investment banks not involved in securitization. The pro-cyclicality is even higher focusing on investment banks major securitizers: $\beta_2$is positive (0.77) and significant. These results show a strong impact of off-balance sheet securitization for both commercial and investment banks. This finding is in contrast with those of Adrian and Shin (2010a), whilst it is consistent with the resulkts of Kalemli-Ozcan*et al.* (2011). Finally, the coefficient $\beta_5$is negative and statistically significant, indicating that leverage is mean reverting.

In short, Table 3 reveals that the active management of leverage concerns not only the small category of pure investment banks but, as for European banks, it is a phenomenon extended to a broader class of financial institutions. There is a positive relationship between change in assets and change in leverage for the whole category of large bank holding companies when securitization is taken into account. This relationship is however more pronounced for those that focus primarily on investment banking activities and for all those involved in securitization (either commercial or investment banks).

We then move to the investigation of the differences among the pre-crisis, crisis and post-crisis periods. Table 4 presents the result for the pre-crisis period, considering all the five regression models. In the pre-crisis period all previous results are basically confirmed. There is evidence of pro-cyclicality of substantial leverage, which is particularly strong for mainly investment banks but also for mainly commercial banks that are involved in securitization, when taking into account the off-balance sheet items. Also, the explanatory powers of the regression is especially high before the crisis: in the last model the R^2 is about 50%.

As for the crisis period (Table 5), not all previous results are confirmed. In particular we document a change as for the impact of securitization. By looking at regressions 1 and 2 (that do not account

for securitization), previous results are still valid. Specifically, pro-cyclicality remains strong also during the crisis: coefficient β_1 in regression 2 during the crisis period is even higher than in the pre-crisis period. However, during the crisis only mainly investment banks show leverage pro-cyclicality. The value of $\beta_1 + \beta_2$, indeed, is close to zero, pointing that mainly commercial banks follow a policy of leverage targeting in the crisis period. The coefficient β_3 in regression 2 has remained negative and statistically significant, like in the pre-crisis period, but now it has a higher negative value. That is, the adjustment mechanism of banks' leverage to some target levels has become stronger. By including off-balance sheet securitization (regression 3), conclusions for the crisis period are different from those for the pre-crisis period: securitization does not contribute any more to explain the relationship between the change in total assets and the change in leverage. Passing from regression 2 to regression 3, β_1(the coefficient of the change in assets) remains essentially unchanged whereas before the crisis by including off-balance sheet assets the level of pro-cyclicality increased substantially (essentially more than doubled). Moreover, the R^2 remains roughly unchanged from regression 2 to regression 3. Next, in regression4, the results reveal a decreasing role of securitization in driving leverage pro-cyclicality. The statistical insignificance of β_2 in model 4 points out that, after the outbreak of the crisis, being involved in securitization is not any more a discriminating factor in determining the degree of leverage pro-cyclicality. Finally, turning to regression5, the coefficients for the different groups of banks are not statistically significant, thus suggesting that securitization in the crisis period is no longer able to determine a higher degree of pro-cyclicality. However, coefficients β_1 and β_2 in model 2 remain however statistically significant. This means that the predominant type of business activity (commercial vs. investment banking) is still able to discriminate the level of pro-cyclicality, whereas securitization seems not to be any more a relevant factor during the crisis period.

As for the post-crisis period (Table 6), results substantially confirm those obtained for the crisis. We document the highest level of pro-cyclicality and an increase in this positive relationship also for

mainly commercial banks (regression2). Similarly to the crisis period, β_3 in regression 2 shows a further strengthening of the adjustment process performed by banks to bring leverage to the target level. In the post-crisis period, securitization seems to lose its relevance in explaining the evolution of leverage in relation to changes in the value of total assets. Moving from regression2 to regression3, coefficient β_1 decreases and the R^2 remains roughly unchanged. Turning to regression5, securitization seems to have even a negative effect on pro-cyclicality since the coefficient for minor securitizers is higher, both in the case of commercial and investment banks. However, coefficient β_4 (relative to commercial banks involved in securitization) is not statistically significant and, when correcting for autocorrelation in residuals (see Table 10) the coefficient for the group of investment banks involved in securitization becomes not significant. This seems to suggest once again the decreasing role of securitization in explaining the relationship between changes in assets and changes in leverage. With the outbreak of the crisis, and the reduction in securitization activities implemented by financial institutions, the unique factor that seems to remain relevant in determining the different degree of pro-cyclicality is the business model (commercial vs. investment banking).

Summarizing, the breakdown of the analysis into the three act-periods shows a permanence over time of a strong pro-cyclicality of US banks' leverage, regardless of the outbreak of the recent financial crisis. Indeed, in the post-crisis period, we document a more pro-cyclical leverage than before. However, the role of securitization has changed markedly. In the pre-crisis period by considering off-balance sheet securitization, we observe an active management of leverage by all banks (both mainly investment and mainly commercial) and greater pro-cyclicality for those financial institutions more involved in securitization. In the subsequent periods securitization seems to lose its relevance. This can be explained as follows: i) the growth of securitization transactions has slowed down since the outbreak of the crisis, ii) those banks hardest hit by the crisis were just the ones heavily involved in securitization; iii) the change in the US accounting standards, which since 2010 have significantly reduced

the possible circumstances in which securitized assets could be placed off-balance sheet.

4.2 Robustness tests

We test for serial correlation in residuals (Tables 7-10). This test delivers, for model 1 and over the whole period, a value of LM of 3,761 and this confirms the presence of serial correlation in residuals because we can reject the null hypothesis of absence of serial correlation in residuals. On the basis of this result, the following tables show results obtained correcting all models for the presence of autocorrelation in residuals. All previous conclusions are confirmed, and some become even stronger.

For the pre-crisis period, for example, coefficient β_2 in model 2 is not statistically significant (Table 3), but by correcting for autocorrelations in residuals, it turns to be highly significant (Table 8). Similarly, coefficient β_3 in model 4 is not statistically significant (Table 3), but it turns to be significant correcting for autocorrelation (Table 8). This indicates that, during the pre-crisis period, when the use of securitization was maximum, the degree of pro-cyclicality was even higher for commercial banks involved in securitization transactions than for investment banks not involved in these activities. Securitization was thus even more important than the predominant business (commercial or investment banking) in driving pro-cyclicality. This confirms the importance to take account off-balance sheet securitization activities, when we aim to investigate the level of pro-cyclicality in the financial system.

Conclusions

The 2007 financial crisis has shown the disruptive effects of the mutually reinforcing interactions between the financial system and the real economy that tend to amplify business cycle fluctuations, thus exacerbating financial instability. In this paper we focused on leverage pro-cyclicality, i.e. the existence of a positive relationship be-

tween assets growth and leverage growth, which is a possible driving factor of a supply side financial accelerator. For a sample of the 73 largest US BHCs over 2001-2010, by using a panel regression with time and group fixed effects, we document leverage pro-cyclicality for US BHCs. Furthermore, the degree of pro-cyclicality is different among banks depending on the nature of their business and on the degree of involvement in off-balance sheet securitization. Since the starting point of sample period is after the repeal of the Glass-Steagall Act in 1999, US BHCs under analysis may have carried out both commercial and investment banking activities. By disentangling the sample in two groups (mainly commercial and mainly investment banks), we observe that the degree of pro-cyclicality (on the basis of formal leverage) is higher for banks predominantly involved in investment banking activities, while banks more oriented to traditional activities seem to follow a policy of leverage targeting (as in Adrian and Shin, 2010a).

The main contribution of the paper is the analysis of substantial leverage rather than on formal leverage. The interest in substantial leverage is twofold. First, the true level of pro-cyclicality does not emerge from the balance sheet at first sight because US GAAP accounting rules allow an underestimation of on-balance sheet items, thanks to loose rules for the recognition of securitized assets. Accounting or formal leverage may therefore be significantly lower and less pro-cyclical than substantial leverage. Moreover, the Basel Committee (2010a, 2010b) has pointed out that one of the main reasons the economic and financial crisis became so severe was that the banking sector of many countries had built up excessive on- and off-balance sheet leverage.

Once substantial leverage is appropriately defined and accounted for, several interesting results emerge. First, the degree of pro-cyclicality becomes even stronger especially during the pre-crisis period. However during the crisis and post-crisis periods, we observe a decreasing power of securitization in driving pro-cyclicality, which may be due either to "spontaneous" lower securitization activity or to changes in accounting standards. Second, when we distinguish between four different groups of banks on the basis of the weight of

their involvement in securitization activities (major securitizers vs. minor securitizers) and on the basis of their business nature (mainly commercial vs. mainly investment banks), we observe that in the pre-crisis period securitization was an important driver of leverage pro-cyclicality not only for investment banks but also for commercial banks highly involved in securitization. This analysis shows an important result that contrasts those of Adrian and Shin (2010a): when off-balance sheet securitization is taken into account, commercial banks do not follow a policy of constant leverage targeting but they rather pursue, like investment banks, a pro-cyclical leverage. Our result may support the view that some sort of supply-side financial accelerator has been at work in the US (especially in the pre-crisis period) due to the pro-cyclical management of leverage by a share of US banks larger than that made of purely investment banks.

The destabilizing economic effects of leverage pro-cyclicality are apparent during downturns, when financial firms react to a common negative shock to the value of their assets by excessively shrinking their balance sheet, by means of fire-sales and credit crunch. The externalities associated with this individually rational behaviour call for macro-prudential regulation, aimed at preventing excessive leverage building during booms by means of higher (possibly time varying) capital requirements and "higher quality" capital, as forcibly argued by Hanson, Kashyap and Stein, 2011.

The steps recently taken by the Basel III Committee on Banking Supervision must be welcome. Such steps are aimed at introducing a simple, non-risk based leverage ratio that is calibrated to act as supplementary requirement to the risk based capital requirements. The evidence of this paper about the strong implications of off-balance sheet securitization on pro-cyclicality support the Basel III view according to which an important further step towards a sounder and safer regulation of banks requires leverage constraints including off-balance sheet items.

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Table 1. *Descriptive statistics*

Panel A: Whole sample															
	All banks				**Securitizers**				**Non securitizers**				**Securitizersvs Non securitizers**		
	N.	Mean	Median	StD	N.	Mean	Median	StD	N.	Mean	Median	StD	Mean diff.	Median diff.	T-test
Total assets ($ billions)	2809	7.509	0.375	65.8	337	53.876	1.468	181.7	2472	1.187	0.329	9.7	52.689	1.139	22.353***
Securitized assets/Loan Ratio					337	15.43%									
Mortgage/Loan ratio					337	10.53%									
Securitized assets/Assets Ratio					337	7.97%									
Mortgage/Loan ratio					337	5.56%									
N. BHC securitizers/ N. BHC					337	12.00%									
Assets securitizer/Assets BHC					337	86.08%									
Panel B: Large banks															
	All banks				**Securitizers**				**Non securitizers**				**Securitizersvs Non securitizers**		
	N.	Mean	Median	StD	N.	Mean	Median	StD	N.	Mean	Median	StD	Mean diff.	Median diff.	T-test
Total assets ($ billions)	73	180.8	56.6	315.5	57	214.06	94.50	346.41	16	62.31	32.95	103.65	151.7	61.5	11.154***
Securitized assets/Loan Ratio					57	44.53%									
Mortgage/Loan ratio					57	30.83%									
Securitized assets/Assets Ratio					57	18.37%									
Mortgage/Loan ratio					57	12.54%									
N. BHC securitizers/ N. BHC						78.08%									
Assets securitizer/Assets BHC						92.45%									
	All banks				***Major securitizers***				***Non major securitizers***				***Major vs. non major securitizers***		
	N.	Mean	Median	StD	N.	Mean	Median	StD	N.	Mean	Median	StD	Mean diff.	Median diff.	T-test
Total assets ($ billions)	73	180.8	56.6	315.5	32	316.81	137.74	432.65	41	74.64	45.89	88.34	242.2	91.9	16.270***
Securitized assets/Loan Ratio					32	78.03%									
Mortgage/Loan ratio					32	54.26%									
Securitized assets/Assets Ratio					32	32.09%									
Mortgage/Loan ratio					32	22.11%									
N. BHC major/ N. BHC						43.84%									
Assets securitizer/Assets BHC						76.81%									

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test).

Table 2. *Formal versus substantial leverage*

Whole sample															
	All banks				**Securitizers**				**Non securitizers**				**Securitizersvs Non securitizers**		
	N.	Mean	Median	StD	N.	Mean	Median	StD	N.	Mean	Median	StD	Difference in Mean	Difference in Median	T-test
Formal leverage	2809	12.676	11.711	7.5	337	12.974	11.615	9.7	2472	12.636		7.2	0.339	-0.131	3.3***
Substantial leverage	2809	12.785	11.769	7.7	337	13.883	11.897	10.4	2472	12.636		7.2	1.247	0.152	3.3***
Large banks															
	All banks				**Securitizers**				**Non securitizers**				**Securitizersvs Non securitizers**		
	N.	Mean	Median	StD	N.	Mean	Median	StD	N.	Mean	Median	StD	Difference in Mean	Difference in Median	T-test
Formal leverage	73	14.439	11.033	15.1	57	14.264	11.099	15.4	16	15.066	11.746	14.4	-0.803	0.395	-4.3***
Substantial leverage	73	16.078	11.999	16.0	57	16.362	11.999	16.6	16	15.066	10.704	14.4	1.296	1.294	3.4***
	All banks				**Major securitizers**				**Non major securitizers**				**Major vs. Non major securitizers**		
Formal leverage	73	14.439	11.033	15.1	32	14.660	11.364	15.3	41	14.267	11.746	15.1	0.393	0.671	3.3***
Substantialleverage	73	16.078	11.999	16.0	32	18.312	13.500	17.1	41	14.335	10.693	15.1	3.976	2.807	3.3***

Box 1. *Types of banks in the sample*

Number of banks	*2010 2Q – 2010 4Q*	*Pre-crisis*	*Crisis*	*Post-Crisis*
Investment banks (IB)major sec.	18	14	12	10
Investment banks (IB)minorsec.	16	14	13	12
Commercial banks (CB)major sec.	14	14	11	11
Commercial banks (CB)minorsec.	25	14	22	20

Figure 1. *Relationship between total assets and formal leverage (on-balance sheet data)*

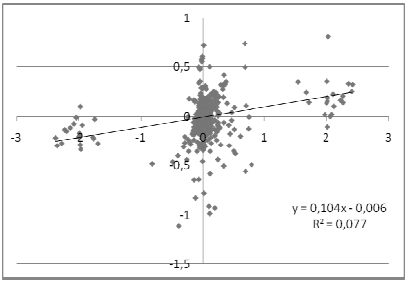

Figure 2. *Relationship between total assets and substantial leverage (with off-balance sheet securitization)*

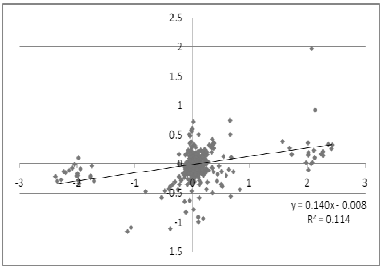

Figure 3. *Leverage of mainly commercial vs. mainly investment banks*

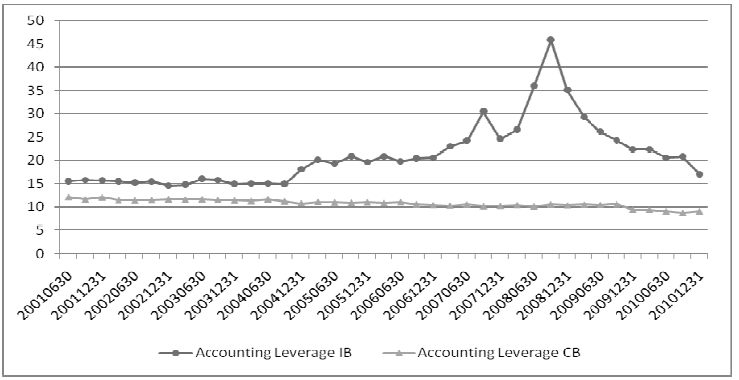

Figure 1.a *Total assets and formal leverage for CB (on-balance sheet data)*

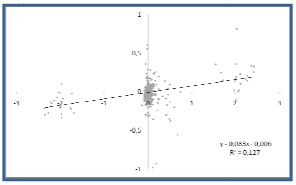

Figure 1.b *Total assets and formal leverage for IB*

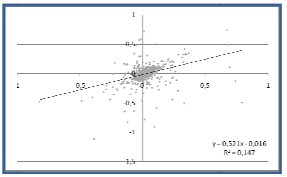

Figure 4.a *Total assets and formal leverage for CB major securitizers*

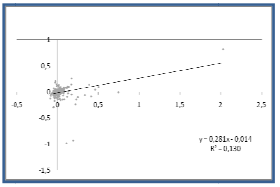

Figure 4.b *Total assets and formal leverage IB major securitizers*

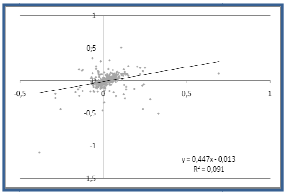

Figure 2.a *Total assets and substantial leverage for CB (with off-balance sheet securitization)*

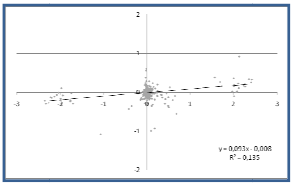

Figure 2.b *Total assets and substantial leverage for IB*

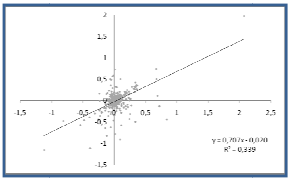

Figure 5.a *Total assets and substantial leverage CB major securitizers*

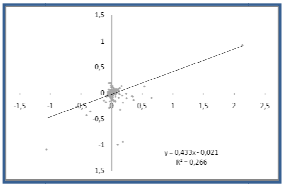

Figure 5.b *Total assets and substantial leverage IB major securitizers*

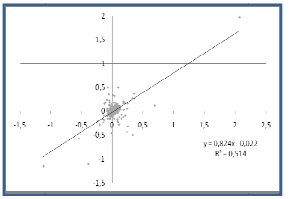

Table 3. *Regression results: full period*

ΔLeverage	Constant	ΔAssetsβ_1	CB*ΔAssetsβ_2	LagLeverageβ_3	Time dummies			F	R^2
Regression (1)	0.017 (0.015)	0.104*** (0.012)			yes			5.61***	13%
Regression (2)	0.233*** (0.082)	0.467*** (0.112)	-0.387*** (0.113)	-0.101*** (0.033)	yes			7.14***	22%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression (3)	0.264*** (0.081)	0.643*** (0.112)	-0.554*** (0.113)	-0.109*** (0.031)	yes			7.19***	34%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression (4)	0.207*** (0.063)	0.009*** (0.012)	0.502*** (0.142)			-0.110*** (0.022)	yes	37.54***	32%
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔASubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression (5)	0.233*** (0.080)	0.075*** (0.009)	0.695*** (0.104)	0.411*** (0.137)	0.337*** (0.092)	-0.010*** (0.031)	yes	10.0***	37%

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors (in parenthesis).

Table 4. *Regression results: pre-crisis period*

ΔLeverage	Constant	ΔAssetsβ_1	CB*ΔAssetsβ_2	LagLeverageβ_3	Time dummies			F	R^2
Regression(1)	0.019**	0.103***			yes			7.20***	17%
	(0.008)	(0.013)							
Regression(2)	0.337***	0.306*	-0.216	-0.131***	yes			8.00***	24%
	(0.097)	(0.169)	(0.169)	(0.040)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression(3)	0.370***	0.651***	-0.550***	-0.149***	yes			8.24***	43%
	(0.100)	(0.143)	(0.143)	(0.039)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression(4)	0.299***	0.086***	0.550***			-0.119***	yes	41.09***	47%
	(0.070)	(0.008)	(0.150)			(0.027)			
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression(5)	0.208***	0.082***	0.701***	0.243	0.403***	-0.113***	yes	15.14***	50%
	(0.089)	(0.008)	(0.094)	(0.242)	(0.105)	(0.035)			

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors (in parenthesis).

Table 5. *Regression results: crisis period*

ΔLeverage	Constant	ΔAssets β_1	CB*ΔAssets β_2	LagLeverageβ_3	Time dummies			F	R^2
Regression (1)	0.026**	0.070*			yes			3.61***	9%
	(0.012)	(0.036)							
Regression (2)	0.795***	0.437***	-0.417***	-0.329***	yes			7.67***	36%
	(0.211)	(0.142)	(0.145)	(0.086)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression (3)	0.854***	0.452***	-0.433***	-0.341***	yes			8.31***	38%
	(0.218)	(0.143)	(0.145)	(0.087)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression (4)	0.105***	0.074**	0.026			-0.422***	yes	5.37***	28%
	(0.236)	(0.036)	(0.123)			(0.094)			
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression (5)	0.824***	0.021	0.208	0.48***	-0.111	-0.332***	yes	7.74***	38%
	(0.222)	(0.027)	(0.161)	(0.174)	(0.068)	(0.088)			

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors.

Table 6. *Regression results: post-crisis period*

ΔLeverage	Constant	ΔAssetsβ_1	CB*ΔAssetsβ_2	LagLeverageβ_3	Time dummies			F	R^2
Regression(1)	0.002 (0.020)	0.070*** (0.027)			yes			5.07***	13%
Regression(2)	1.147*** (0.276)	0.936*** (0.189)	-0.833*** (0.186)	-0.482*** (0.115)	yes			22.05***	48%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression(3)	1.204*** (0.301)	0.919*** (0.190)	-0.812*** (0.187)	-0.490*** (0.122)	yes			21.95***	49%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression(4)	1.399 *** (0.304)	0.115*** (0.022)	0.079 (0.110)			-0.565*** (0.124)	yes	14.78***	43%
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression(5)	1.202*** (0.299)	0.109*** (0.022)	0.612*** (0.211)	0.937*** (0.242)	-0.053 (0.081)	-0.489*** (0.121)	yes	20.48***	49%

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors.

Table 7. *Robustness tests: full period*

ΔLeverage	Constant	ΔAssets β_1	CB*ΔAssets β_2	LagLeverageβ_3	Time dummies			F	R^2
Regression (1)	-0.064***	0.105***			yes			8.21***	13%
	(0.014)	(0.008)							
Regression (2)	0.360***	0.470***	-0.390***	-0.151***	yes			18.12***	27%
	(0.029)	(0.033)	(0.034)	(0.013)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression (3)	0.404***	0.527***	-0.441***	-0.163***	yes			22.67***	31%
	(0.302)	(0.316)	(0.032)	(0.130)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression (4)	0.424***	0.086***	0.416***			-0.173***	yes	22.66***	32%
	(0.028)	(0.007)	(0.031)			(0.013)			
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression (5)	0.401***	0.074***	0.547***	0.404***	0.374***	-0.162***	yes	26.65***	36%
	(0.029)	(0.006)	(0.049)	(0.039)	(0.037)	(0.013)			

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors (in parenthesis).

Table 8. *Robustness tests: pre-crisis period*

ΔLeverage	Constant	ΔAssetsβ_1	CB*ΔAssetsβ_2	LagLeverageβ_3	Time dummies			F	R^2
Regression(1)	0.003 (0.010)	0.106*** (0.007)			yes			13.51***	19%
Regression(2)	0.344*** (0.036)	0.300*** (0.044)	-0.209*** (0.045)	-0.142*** (0.015)	yes			17.56***	26%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression(3)	0.453*** (0.038)	0.469*** (0.039)	-0.369*** (0.039)	-0.179*** (0.016)	yes			26.91***	35%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression (4)	0.457*** (0.035)	0.085*** (0.007)	0.462*** (0.028)			-0.174*** (0.017)	yes	39.23***	45%
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression(5)	0.401*** (0.035)	0.082*** (0.007)	0.538*** (0.047)	0.241*** (0.053)	0.432*** (0.033)	-0.160*** (0.016)	yes	38.08***	45%

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors (in parenthesis).

Table 9. *Robustness tests: crisis period*

ΔLeverage	Constant	ΔAssetsβ_1	CB*ΔAssetsβ_2	LagLeverageβ_3	Time dummies			F	R^2
Regression(1)	-0.012 (0.020)	0.087*** (0.027)			yes			5.89***	13%
Regression(2)	1.381*** (0.126)	0.377*** (0.060)	-0.353*** (0.065)	-0572*** (0.070)	yes			26.89***	50%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression(3)	1.434*** (0.133)	0.388*** (0.061)	-0.364*** (0.066)	-0.577*** (0.069)	yes			27.90***	51%
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression(4)	1.764*** (0.135)	0.067*** (0.023)	0.033 (0.129)			-0.708*** (0.072)	yes	20.96***	44%
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression(5)	1.386*** (0.135)	0.025 (0.023)	0.17 (0.152)	0.404*** (0.071)	-0.091 (0.193)	-0.556*** (0.070)	yes	21.62***	51%

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors.

Table 10. *Robustness tests: post-crisis period*

ΔLeverage	Constant	ΔAssetsβ_1	CB*ΔAssetsβ_2	LagLeverageβ_3	Time dummies			F	R^2
Regression(1)	-0.015	0.143***			yes			10.43***	20%
	(0.011)	(0.020)							
Regression(2)	2.161***	0.542***	-0.458***	-0.926***	yes			51.81***	64%
	(0.131)	(0.149)	(0.148)	(0.075)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	CB*ΔSubAssetsβ_2	LagSubLeverageβ_3	Time dummies			F	R^2
Regression(3)	2.328***	0.481***	-0.397***	-0.977***	yes			56.36***	66%
	(0.136)	(0.147)	(0.146)	(0.077)					
ΔSubLeverage	Constant	ΔSubAssetsβ_1	Maj*ΔSubAssetsβ_2			LagSubLeverage	Time dummies	F	R^2
Regression(4)	2.445***	0.090***	-0.026			-1.027***	yes	50.81***	64%
	(0.131)	(0.016)	(0.107)			(0.070)			
ΔSubLeverage	Constant	ΔSubAssets β_1	InvMaj*ΔSubAssetsβ_2	InvMin*ΔSubAssetsβ_3	ComMaj*ΔSubAssets β_4	LagSubLeverage β_5	Time dummies	F	R^2
Regression(5)	2.333***	0.084***	0.178	0.535***	-0.055	-0.980***	yes	44.55***	67%
	(0.136)	(0.015)	(0.216)	(0.178)	(0.117)	(0.077)			

***, **, and * indicate a statistical significance at 1%, 5% and 10% respectively (two-tailed t test). The significance levels are based on robust standard errors.

Printed by
Gi&Gi srl - Triuggio (MB)
November 2012

ISBN 978-88-343-2367-0