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Leverage pro-cyclicality and securitization in US banking

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ABSTRACT

This paper investigates the role of off-balance sheet securitization on US bank leverage pro-cyclicality. Effective leverage (taking into account off-balance sheet securitization) is especially relevant for the US, where GAAP accounting rules for securitization allowed until 2009 a underestimation of on balance sheet items. Over 2001–2010, we document that US BHCs which are more involved in securitization have a more pro-cyclical leverage. We also show that in the pre-crisis period securitization dominates the business model in determining the leverage pro-cyclicality to the point that even commercial banks highly involved in securitization had a pro-cyclical behavior. We document that the period-long relation between securitization and capital ratios was week. The effect on leverage pro-cyclicality of the 2004 changes in regulation (the new SEC net capital rule and the exemption from the FASB directive on consolidation of SPVs) was absent for investment banks, and mixed for commercial banks highly involved in securitization. The evidence of this paper supports the view of the Basel III committee that macro-prudential regulation must include constraints on effective leverage.

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1. 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). 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,[1] 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 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.[2] 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. (2012) 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). Huang and Ratnovski (2011) attempt at theoretically highlighting the dark side of bank wholesale funding in the presence of costless but noisy signals on the quality of bank projects. Damar et al. (2013) 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 behavior of bank leverage through time and find that banks' target leverage is time-invariant and bank specific. Instead Baglioni et al. (2013), for a sample of 77 European banks over 2000–2009, show that pro-cyclical leverage appears to be well entrenched in the behavior of those European universal banks for which the investment banking activity prevails over the more traditional commercial banking activity.

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

[2] As Hanson et al. (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).

In the present paper we move one step further by focusing on the role of off-balance sheets and securitization on leverage. The massive use of securitization for conforming loans (well before than for subprime mortgages) deeply transformed the banking activity. In particular, securitization allowed banks highly involved in traditional loans (commercial banks that have a high ratio of loans to total assets) to move from the "originate to hold" model of business to the "originate to distribute" model. Hence, the diffusion of securitization may have changed the attitude of commercial banks towards leverage, blurring the traditional distinction between leverage a-cyclical commercial banks and leverage pro-cyclical investment banks. In fact, it may be argued that the distinction based on the asset side business model (as defined by the ratio between loans and total assets) has gradually lost importance in favor of a distinction based on the degree of securitization. The role of off-balance sheet securitization by means of "conduits" sponsored by commercial banks is well documented. It can indeed be argued that off-balance sheet securitization is a powerful means to profitably arbitrage capital requirement regulations, hence to increase "off-stage" leverage whilst being "on-stage" compliant.[3] Moreover, securitization may be regarded as one of the market based sources of funding, which – due to its liquidity – can contribute to the active management of leverage alongside other wholesale funding sources such as repos.

In order to properly examine the links between securitization, off-balance sheets and leverage we introduce the distinction between "formal" leverage, as measured by balance sheet data, and "effective" leverage, which takes into account off-balance sheet securitization. This research, therefore, accords well with Basel III, which aims at adopting leverage requirements that incorporate off-balance sheet activities.[4]

The research questions addressed in this paper may be summarized as follows: (1) does formal leverage underestimate effective leverage?; (2) once off-balance sheets are considered, does US commercial banks' leverage become pro-cyclical?; (3) is there any difference in the role played by securitization before and after the break-up of the financial crisis in 2008?; (4) which kind of relation can be detected between securitization and regulatory mandated minimum capital requirements and between actual capital ratios and the availability of alternative financial sources such as repos and (5) have changes in regulation (such as the 2004 SEC reform of the net capital rule and the 2004 exemption from the FASB directive on consolidation of SPVs) played a major role in explaining US banks' behavior as for leverage pro-cyclicality? This set of 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 "effective" 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 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

[3] Specifically, Jiangli et al. (2007) and Jiangli and Pritsker (2008), using US bank holding company data from 2001 to 2007, find that off-balance sheet mortgage securitization reduces bank insolvency risk, and increases bank leverage and profitability.

[4] 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, 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 (Greenlaw et al., 2008; Altunbas et al., 2009; Adrian and Shin, 2008; Uhde and Michalak, 2010). 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.

securitization structure.[5] 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 effective 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 business (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. As for the fourth research question, we are able to show that the relation between securitization and mandated and actual capital ratios are week, whilst the increase in repos did actually influence negatively the change of total capital ratios, confirming that repos to some extent arbitraged off equity in US banks' choices. Finally, when analyzing changes in regulation, on the one hand our data confirm the common view that the 2004 SEC new net capital rule strongly increased the *level* of formal leverage of investment banks. Interestingly, however, the consequential implementation of the internal-model portion of Basel II actually decreased the leverage pro-cyclicality of investment banks. On the other hand, the 2004 exemption from the FASB directive on consolidation of SPVs had no effect on the *level* of formal leverage of major securitizer commercial banks whilst their formal leverage pro-cyclicality increased and the effective one unexpectedly decreased.

The paper is organized as follows. Section 2 motivates the sample used in the ensuing empirical analysis. Section 3 is devoted to 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 different regression specifications employed in our empirical study. Section 5 presents the empirical results and the robustness tests, whilst Section 6 concludes and gives some tentative policy recommendations.

2. 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.

[5] In order to avoid double counting, we exclude 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.

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,[6] collects quarterly accounting information on balance sheet and income statement's data and detailed support schedules (including the one on off-balance sheet items) 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 2809 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 337 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.[7] 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 this 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 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),[8] 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.[9] 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 2211 panel observations.[10]

Focusing on the largest BHCs, the percentage of securitizers in the sample is higher than in the total sample[11]: 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 which the

[6] Jiangli et al. (2007), Jiangli and Pritsker (2008), Sarkisyan et al. (2010), Casu et al. (2011).

[7] 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 Hänsel (2008) and by Martín-Oliver and Saurina (2007) for Spanish financial institutions.

[8] 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.

[9] 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.

[10] 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.

[11] 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.

Table 1
Descriptive statistics.

Panel A: Whole sample

	All banks in the whole sample				Securitizers				Nonsecuritizers				Securitizers vs. nonsecuritizers		
	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 bank sample

	All banks in the large bank sample				Securitizers				Nonsecuritizers				Securitizers vs. nonsecuritizers		
	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 in the large bank sample				Major securitizers				Nonmajor securitizers				Major vs. nonmajor 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%									

Descriptive statistics for the whole sample (Panel A) and the large bank sample (Panel B).
*Statistical significance at 10% (two-tailed *t* test).
**Statistical significance at 5% (two-tailed *t* test).
*** Statistical significance at 1% (two-tailed *t* test).

Table 2
Formal vs. effective leverage.

Panel A: Whole sample

	All banks				Securitizers				Nonsecuritizers				Securitizers vs. nonsecuritizers		
	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***
Effective 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***

Panel B: Large bank sample

	All banks				Securitizers				Nonsecuritizers				Securitizers vs. nonsecuritizers		
	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***
Effective 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				Nonmajor securitizers				Major vs. nonmajor 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	32	14.660	11.364	15.3	41	14.267	11.746	15.1	0.393	0.671	3.3***
Effective leverage	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	Full period	Pre-crisis	Crisis	Post-crisis
Investment banks (IB) major sec.	18	14	12	10
Investment banks (IB) minor sec.	16	14	13	12
Commercial banks (CB) major sec.	14	14	11	11
Commercial banks (CB) minor sec.	25	14	22	20

Formal vs. effective leverage for the whole sample (Panel A) and the large bank sample (Panel B). Formal leverage is defined as the ratio of total assets to total equity. Effective leverage is computed in the same way but taking into account off-balance sheet securitization.
Number of large banks for each type (according to the business model and to the degree of securitization) over the full period (2001 Q2 – 2010 Q4), the pre-crisis period (2001 Q2 – 2007 Q2), the crisis period (2007 Q3 – 2009 Q1), and the post-crisis period (2009 Q2 – 2010 Q4). The business model classification is based on the ratio of total loans to total assets. The degree of securitization classification is based on the ratio of securitized assets off-balance sheet to total assets.

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 as 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 billion vs. $62.31 billion); and this difference is even bigger considering major securitizers that are more than four times bigger than minor securitizers ($316.81 billion vs. $74.64 billion). 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 largest 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%.

By inspection of Table 2 it is possible to have an idea of the extent to which securitization boosts effective leverage. Not only both mean and median effective leverage are higher when securitization is taken into account, but also differences in mean and median effective leverage of securitizers and non-securitizers are larger than the same differences in median and mean formal leverage. Moreover the impact of securitization on effective leverage increases in the size of (securitizer) banks and with the occurrence of being major securitizers: focusing on major securitizers, the mean effective leverage is about 25% higher than mean formal leverage, whilst for non-major securitizers mean effective leverage is only 0.48% higher than mean formal leverage.

3. 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.

Figs. 1 and 2 are quite informative. For the sample of large US BHCs there is a positive relationship between total (on-balance) assets and formal leverage, indicating pro-cyclicality. Moreover, pro-cyclicality becomes even stronger when we augment the value of total (on-balance) 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 when considering securitization.

We then examine whether the degree of US banks pro-cyclicality depends on their (asset side) business specialization. This interest comes from previous evidence in Baglioni et al. (2013) that for European banks points 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 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. (2013), a bank is considered a "mainly commercial" BHC if the loan ratio is above the median value for the whole sample (that is, 0.625) and a mainly investment BHC otherwise.

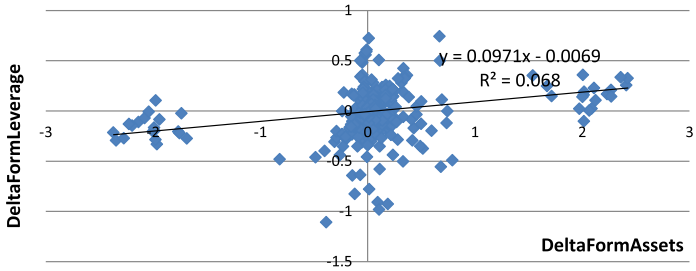

Fig. 1. Relationship between formal leverage and total on-balance sheet (formal) assets.

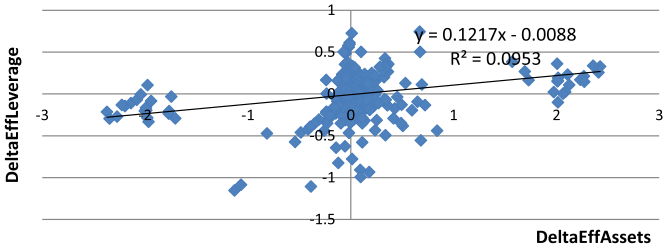

Fig. 2. Relationship between effective leverage and total on-balance sheet plus off-balance sheet (effective) assets.

Fig. 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 than 10 until the outbreak of the financial crisis. But even with the burst of the crisis, the reduction in leverage was limited. On the other hand the leverage of predominantly investment banks 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).

Figs. 1.a, 1.b, 2.a and 2.b (Appendix A) 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

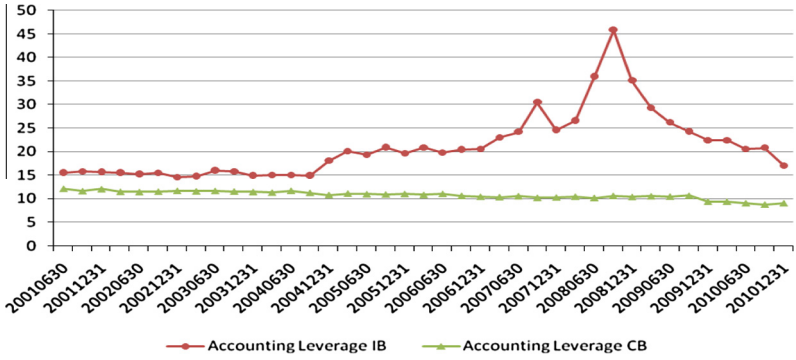

Fig. 3. Formal leverage of mainly commercial vs. mainly investment banks.

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 (Figs. 1.c, 1.d, 2.c and 2.d in Appendix A). These figures show that the slope of the trend line is much steeper when considering securitization and this is preliminary evidence 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 effective 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.

A K-means clustering with three clusters was performed. The one-way ANOVA reveals that the middle cluster was very predominant and characterized by the largest sized banks with the lowest loan ratio and deposit ratio, and the highest market-based funding ratio (i.e. less traditional business model). The first cluster was essentially medium-sized banks with medium loan ratio, deposit ratio and market based funding ratio. The third cluster was smallest-sized banks with the highest loan ratio and deposit ratio, and the lowest market-based funding ratio (i.e. more traditional banks).

4. Methodology

4.1. Baseline model

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 a set of two-ways fixed effects panel data regressions (correcting for the presence of autocorrelation in residuals).[12] Each regression is run for both formal and effective leverage:

$$\Delta Leverage^{j}_{i,t} = \beta_0 + \beta_1 \Delta Assets^{j}_{i,t} + \varepsilon_{i,t} \quad (1)$$

where:

$\Delta Leverage^{j}_{i,t}$ = quarterly log-differenced leverage of bank i at time t. When $j = f$ only on-balance sheet assets and leverage are considered, whilst $j = e$ means that both formal leverage and total assets are corrected to take into account off-balance sheet securitization. $\Delta Assets^{j}_{i,t}$ = 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; the relative size of β_1 when $j = f,e$ gives us a first rough idea of the impact of off-balance sheet securitization on the pro-cyclicality of bank leverage. $\varepsilon_{i,t} = \propto_i + \propto_{i,t-1} + e_{i,t}$ = error term, where $e_{i,t} \sim (0, \sigma^2_{i,t})$ with $\sigma^2_{i,t} \neq \sigma^2_{j,s}$ for $t \neq s$, in general. If securitization is an important phenomenon that must be taken into consideration when investigating the pro-cyclicality of bank leverage, regression (1) for $j = e$ should show a higher explanatory power than that of regression (1) for $j = f$. Moreover, if securitization determines a stronger pro-cyclicality, a higher β_1 is expected for $j = e$ than for $j = f$.

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 sample of US BHCs the evidence in Adrian and Shin (2010a) according to which commercial banks follow a policy of constant leverage targeting. Once again the regression is run for formal and effective leverage. The regression model becomes:

$$\Delta Leverage^{j}_{i,t} = \beta_0 + \beta_1 \Delta Assets^{j}_{i,t} + \beta_2 Commercial_i * \Delta Assets^{j}_{i,t} + \beta_3 Leverage^{j}_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

[12] This autoregressive model explores bank and time fixed-effects. It is characterized by a three-part error structure: $\propto_i$: bank fixed-effects, which controls for permanent differences among banks; $\propto_{i,t-1}$: autoregressive component; $e_{i,t}$: idiosyncratic error. The reason for correcting for autocorrelation stems from the results of the test for serial correlation in residuals. This test delivers, for regression (1) and over the full period, a value of LM of 3761, which confirms the presence of serial correlation in residuals as the null hypothesis of no serial correlation in residuals is rejected.

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. (2013).

$Leverage^j_{i,t-1}$ = (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 represents 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 characterizes 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 reflects the behavior of banks that try to correct deviations from some target levels. This regression for $j = e$ will allow us to detect possible differences in behavior of either investment or commercial banks once off-balance sheet securitization is taken into consideration. In particular we expect β_1 to be higher for $j = e$ than for $j = f$, whilst a change in sign and/or magnitude of $(\beta_1 + \beta_2)$ means that securitization affects commercial banks behavior as well as investment banks behavior.

We then test the impact of different levels of exposure to securitization on the pro-cyclicality of bank leverage. 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:

$$\Delta Leverage^j_{i,t} = \beta_0 + \beta_1 \Delta Assets^j_{i,t} + \beta_2 Major_i * \Delta Assets^j_{i,t} + \beta_3 Leverage^j_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

where:

$Major_i$ = dummy variable taking value 1 for major securitizers, that is banks 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 is expected to be small; $(\beta_1 + \beta_2)$ is the coefficient for major securitizers. We expect that $(\beta_1 + \beta_2)$ is positive and greater for $j = e$ than for $j = f$.

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).[13] 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 for 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:

$$\begin{aligned}\Delta Leverage^j_{i,t} = {} & \beta_0 + \beta_1 \Delta Assets^j_{i,t} + \beta_2 InvMaj_i * \Delta\Delta Assets^j_{i,t} + \beta_3 InvMin_i * \Delta Assets^j_{i,t} \\ & + \beta_4 ComMaj_i * \Delta Assets^j_{i,t} + \beta_5 Leverage^j_{i,t-1} + \varepsilon_{i,t}\end{aligned} \quad (4)$$

where:

$InvMaj_i$ = a dummy variable taking value 1 if a bank is both an investment bank and a major securitizer, and zero otherwise.

$InvMin_i$ = a dummy variable taking value 1 if a bank is an investment bank but that is not highly involved in securitization (minor securitizer), and zero otherwise.

[13] 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 and 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).

$ComMaj_i$ = 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, β_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 to securitization. The estimated coefficient for the group of commercial banks that are highly involved in securitization is $(\beta_1 + \beta_4)$; 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 may 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 $(\beta_1 + \beta_3)$. 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 $(\beta_1 + \beta_2)$ and the expectation is that β_2 is positive and higher than β_3, reflecting, once again a positive impact of securitization on leverage pro-cyclicality. Specifically, we test whether the business model as defined by the asset side dominates the securitization behavior in explaining pro-cyclicality or vice versa. In the first case the ordering of coefficients would be $(\beta_1 + \beta_2) \geqslant (\beta_1 + \beta_3) > (\beta_1 + \beta_4) \geqslant \beta_1$. In the second case we would have $(\beta_1 + \beta_2) \geqslant (\beta_1 + \beta_4) > (\beta_1 + \beta_3) \geqslant \beta_1$.

All the above regression are also run for different sub-periods (based on the classification of the Bank for International Settlements, 2010): the pre-crisis period (2001 Q2 – 2007 Q2), crisis period (2007 3Q – 2009 Q1) and post-crisis period (2009 Q2 – 2010 Q4), in order to check if the management of leverage has followed a constant pattern over time or whether the outbreak of the crisis had an impact on the use of securitization as a driver of leverage pro-cyclicality. For all banks – and especially for pre-crisis major securitizer investment banks – we expect that the role of securitization declined in the crisis and the post-crisis periods.

4.2. The interplay among regulation, leverage and securitization

We examine the impact of regulation on banks' behavior as for securitization and leverage policy in several ways. One may argue that, being US banks subject to a uniform (on-balance sheet) leverage limit, they may want to arbitrage this regulation by managing off-balance sheet securitization, which may therefore be strongly influenced by the actual regulation.[14] We attempted to test whether proximity to the regulatory leverage limit does actually affect securitization, by running the following regression:

$$\Delta Securitization_{i,t} = \beta_0 + \beta_1 \Delta Assets_{i,t} + \beta_2 ProximityPos_{i,t-1} * \Delta Assets_{i,t} + \beta_3 ProximityNeg_{i,t-1} * \Delta Assets_{i,t} + \beta_4 Leverage_{i,t-1} + \varepsilon_{i,t} \quad (5)$$

where:

$ProximityPos_{i,t-1}$ = positive distance of the bank leverage capital requirement from the minimum leverage capital requirement (i.e. ratio of Tier 1 capital to total assets of not than less than 4), which means that the bank has more capital than the minimum requirement. We expect that $\beta_2 \leqslant 0$: when a bank has a capital slack is less interested in increasing off-balance sheet securitization.

$ProximityNeg_{i,t-1}$ = negative distance of the bank leverage capital requirement from the minimum leverage capital requirement (i.e. ratio of Tier 1 capital to total assets of not less than 4), which means that the bank has less capital than the minimum requirement. We expect $\beta_3 > 0$: when the bank has a capital shortage (with respect to the limit set by regulators) has an incentive to securitize to make the minimum capital requirement less binding. On the other hand we expect $\beta_2 \leqslant 0$, but we do not expect this coefficient to be statistically significant.

A second step is examining to what extent the change in the total capital ratio of US banks was affected by regulatory boundaries (represented by the proximity to the lagged minimum leverage

[14] We are particularly grateful to an anonymous referee for suggesting us to pursue this analysis.

capital requirement), or by changes in the mix of financial sources such as securitization, the amount of repurchase agreements (repos), or simply by the lagged value of the total capital ratio. Securitization (Cdo, Cds and the like) and repos are indeed forms of financing which are cheaper than equity.[15] We are of course interested in both sign and size of betas in the following regression:

$$\Delta Totalcapitalratio_{i,t} = \beta_0 + \beta_1 \Delta Securitization_{i,t} + \beta_2 \Delta Repos_{i,t} + \beta_3 Totalcapitalratio_{i,t-1} + \beta_4 Proximity_{i,t} + \varepsilon_{i,t} \quad (6)$$

where:

$\Delta Securitization_{i,t}$ = quarterly log-differenced value of securitized assets by bank i at time t. In line with some findings in the literature (Acharya et al., 2013; Gorton and Souleles, 2005), we expect that an increase in securitization lowers the total capital ratio, that is: $\beta_1 < 0$.

$\Delta Repos_{i,t}$ = quarterly log-differenced repurchase agreements. We expect $\beta_2 < 0$ as an increase in repos may arbitrage out equity in a bank's balance sheet.

$Totalcapitalratio_{i,t-1}$ = actual lagged value of the total capital ratio. This variable is aimed at capturing the attempt of banks to increase their capital ratio today if it was low in the previous quarter and vice versa.

$DummyProximity_{i,t-1}$ = a dummy variable taking value 1 if a bank has a leverage capital requirement close to the minimum (i.e. between 3% and 5%), and zero otherwise.

Finally, we explore whether the changes in regulation occurred in 2004 affected the cyclicality of US banks' formal leverage. Specifically, the new net capital rule implemented on April 28, 2004 by the SEC, allowed large investment banks to use mathematical models to compute the risk-discount on their securities (upon approval of the SEC). According to many commentators such an amendment to the net capital rule contributed to increase (formal) leverage.[16] Moreover, a second key regulatory change relates to an exemption from the 2003 FASB directive on the consolidation of SPVs: under this exemption, "assets in conduits were not considered assets for the purpose of calculating capital requirements" (Acharya et al., 2013). This allowed commercial banks to get favorable treatment of capital when they securitized assets. As already mentioned, Fig. 3 shows that the *level* of formal leverage of investment banks was roughly constant until mid-2004 and started rising after the mentioned change in regulation occurred, whilst the *level* of formal leverage of commercial banks was only very slightly declining over the overall period. One may wonder (i) whether the above mentioned rules affected the *cyclicality* of leverage in the same way as they affected the *level* of leverage; (ii) whether the net capital rule, by making formal leverage easier, also reduced the incentives of investment banks to securitize; (iii) whether the FASB exemption by incentivizing securitization for commercial banks, increased their leverage pro-cyclicality. This would show up in a reduced (or increased) difference in the pro-cyclicality of formal and effective leverage for either investment or commercial banks. In order to answer these questions, we re-estimate our regression model (2) for two sub-periods (2001 Q2 – 2004 Q1) and (2004 Q3 – 2010). We also attempted at analyzing the possible impacts of regulatory changes within the pre-crisis era by re-estimating our regression model (4) for the sub-periods (2001 Q2 – 2004 Q1) and (2004 Q3 – 2007 Q2). By using model (4) we are enabled to check whether changes in regulation have impacted leverage pro-cyclicality depending on either/or the business model and the securitization level of the sampled BHCs.

5. Empirical results

5.1. Regression results

Regression results for the full period are reported in Table 3 (Panel A). In the base regression (1), the estimated β_1 is positive and highly statistically significant, setting the case for leverage

[15] See Kashyap et al. (2008) for an overview of why short term borrowing and especially collateralized borrowing can solve managerial agency problems in banks, despite the potential to create more fragility in a bank's balance sheet.

[16] An example is Alan Blinder, who wrote in The New York Times (January 24, 2009): "The second error came in 2004, when the S.E.C. let securities firms raise their leverage sharply. Before then, leverage of 12 to 1 was typical; afterwards, it shot up to more like 33 to 1. What were the S.E.C. and the heads of the firms thinking? Remember, under 33-to-1 leverage, a mere 3% decline in asset values wipes out a company. Had leverage stayed at 12 to 1, these firms would not have grown as big or been as fragile".

pro-cyclicality in the sample of US bank holding companies. We also notice that effective leverage turns out to be slightly more pro-cyclical than formal leverage. Once we specialize the regression to take into account the impact of the business model on leverage pro-cyclicality (regression 2), several results emerge. First, β_1 remains positive and statistically significant for both formal and effective leverage, which indicates a clear pro-cyclicality of leverage especially for those BHCs whose business is more oriented to investment banking activities. If we compare our results with those in Baglioni et al. (2013), we observe a greater pro-cyclicality for US banks than for European banks (β_1 is higher here). Second, β_2 (for both formal and effective leverage) 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 activity 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 figures for the *F*-test, which controls for the effective presence of unobserved factors, enable us to reject the null hypothesis that the unobserved factors are equal to zero and, therefore, the estimated model is consistent.[17]

Regression 3 shows the pro-cyclicality of effective leverage becomes stronger for those banks that are major securitizers, although it remains positive (but small) also for minor securitizers. In regression 4 both the impact of securitization and of the business model are investigated. As expected, β_1 is roughly zero for both formal and effective leverage, pointing out that minor securitizers commercial banks are inclined to a policy of constant leverage targeting and that, for this base-group no relevant difference is detectable by looking at effective leverage instead of formal leverage. The estimated coefficient for the group of commercial banks that are highly involved in securitization is ($\beta_1 + \beta_4$): it is statistically significant and definitely positive especially when looking at effective leverage. This (in contrast to Adrian and Shin (2010a)) proves a significant degree of pro-cyclicality also for commercial banks, when off-balance sheet securitization is considered and strengthens the case for distinguishing between formal and effective leverage when studying leverage pro-cyclicality.[18] The pro-cyclicality of effective leverage is even higher when focusing on investment banks minor securitizers: ($\beta_1 + \beta_3$) is positive and greater than ($\beta_1 + \beta_4$): a weak signal that the asset side business model prevails on securitization in affecting pro-cyclicality when the whole period is considered. It is interesting to notice that the difference in (effective leverage) pro-cyclicality between major and minor securitizer commercial banks is wider than the difference found in the groups of major and minor securitizer investment banks. It can be said that being a major securitizer impacts more on the leverage policy of commercial banks than on such a policy of investment banks. Finally, the coefficient β_5 is negative and statistically significant, indicating that leverage is mean reverting for all US BHCs in the sample.

In short, Table 3 (Panel A) reveals that the active management of leverage concerns not only the small category of pure investment banks but, as for European banks (Baglioni et al., 2013), it is 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).

Panels B, C and D of Table 3 present the results of the four regression models for the pre-crisis, crisis and post-crisis sub-periods respectively. In the pre-crisis period (Panel B) all results just discussed for the whole period are substantially confirmed. There is evidence of pro-cyclicality of effective leverage, which is particularly strong for mainly investment banks but also for mainly commercial banks that are massively involved in securitization, when taking into account the off-balance sheet items

[17] 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.

[18] Our finding is consistent with the results of Kalemli-Ozcan et al. (2012).

Table 3
Regression results (two-ways fixed effects correcting for the presence of autocorrelation in residuals).

Panel A: full period [2063 obs.]									
Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	−0.064***	0.105***					Yes	8.21***	13%
	(0.014)	(0.008)							
ΔEffLeverage	−0.060***	0.121***					Yes	8.53***	13%
	(0.018)	(0.008)							
Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.360***	0.470***	−0.390***	−0.151***			Yes	18.12***	27%
	(0.029)	(0.033)	(0.034)	(0.013)					
ΔEffLeverage	0.404***	0.527***	−0.441***	−0.163***			Yes	22.67***	31%
	(0.302)	(0.316)	(0.032)	(0.130)					
Regression (3)	Constant	ΔAssets β_1	Maj * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.317***	0.087***	0.251***	−0.130***			Yes	13.83***	22%
	(0.029)	(0.007)	(0.036)	(0.012)					
ΔEffLeverage	0.424***	0.086***	0.416***	−0.173***			Yes	22.66***	32%
	(0.028)	(0.007)	(0.031)	(0.013)					
Regression (4)	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage	0.374***	0.073***	0.351***	0.414***	0.240***	−0.158***	Yes	18.94***	29%
	(0.027)	(0.006)	(0.065)	(0.038)	(0.040)	(0.013)			
ΔEffLeverage	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)			
Panel B: pre-crisis period [1361 obs.]									
Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	0.003	0.106***					Yes	13.51***	19%
	(0.010)	(0.007)							
ΔEffLeverage	0.025*	0.127***					Yes	14.37***	21%
	(0.014)	(0.08)							
Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3				F	R^2
ΔFormLeverage	0.344***	0.300***	−0.209***	−0.142***			Yes	17.56***	26%
	(0.036)	(0.044)	(0.045)	(0.015)					
ΔEffLeverage	0.453***	0.469***	−0.369***	−0.179***			Yes	26.91***	35%
	(0.038)	(0.039)	(0.039)	(0.016)					
Regression (3)	Constant	ΔAssets β_1	Maj * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.278***	0.088***	0.252***	−0.102***			Yes	17.99***	26%
	(0.035)	(0.007)	(0.034)	(0.13)					
ΔEffLeverage	0.457***	0.085***	0.462***	−0.174***			Yes	39.23***	45%
	(0.035)	(0.007)	(0.028)	(0.017)					
Regression (4)	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage	0.378***	0.082***	0.237***	0.234***	0.268***	−0.148***	Yes	20.10***	31%
	(0.036)	(0.007)	(0.071)	(0.053)	(0.037)	(0.016)			
ΔEffLeverage	0.401***	0.082***	0.538***	0.241***	0.432***	−0.160***	Yes	38.08***	45%
	(0.035)	(0.007)	(0.047)	(0.053)	(0.033)	(0.016)			

Table 3 (*continued*)

Panel C: crisis period [244 obs.]									
Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	−0.012	0.087***					Yes	5.89***	13%
	(0.020)	(0.027)							
ΔEffLeverage	−0.015	0.089***					Yes	6.27***	14%
	(0.021)	(0.027)							
Regression (2)	Constant	ΔAssets β_1	CB ∗ ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	1.381***	0.377***	−0.353***	−0572***			Yes	26.89***	50%
	(0.126)	(0.060)	(0.065)	(0.070)					
ΔEffLeverage	1.434***	0.388***	−0.364***	−0.577***			Yes	27.90***	51%
	(0.133)	(0.061)	(0.066)	(0.069)					
Regression (3)	Constant	ΔAssets β_1	Maj ∗ ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	1.631***	0.071***	0.012	−0.657***			Yes	18.80***	41%
	(0.135)	(0.023)	(0.126)	(0.071)					
ΔEffLeverage	1.764***	0.067***	0.033	−0.708***			Yes	20.96***	44%
	(0.135)	(0.023)	(0.129)	(0.072)					
Regression (4)	Constant	ΔAssets β_1	InvMaj ∗ ΔAssets β_2	InvMin ∗ ΔAssets β_3	ComMaj ∗ ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage		0.024	0.033	0.417***	−0.007	−0.526***	Yes	20.96***	51%
		(0.023)	(0.157)	(0.070)	(0.167)	(0.069)			
ΔEffLeverage	1.267***	0.025	0.17	0.404***	−0.091	−0.556***	Yes	21.62***	51%
	(0.130)	(0.023)	(0.152)	(0.071)	(0.193)	(0.070)			
Panel D: post-crisis period [258 obs.]									
Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	−0.015	0.143***					Yes	10.43***	20%
	(0.011)	(0.020)							
ΔEffLeverage	0.007	0.148***					Yes	11.19***	21%
	(0.014)	(0.019)							
Regression (2)	Constant	ΔEffAssets β_1	CB ∗ ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	2.161***	0.542***	−0.458***	−0.926***			Yes	51.81***	64%
	(0.131)	(0.149)	(0.148)	(0.075)					
ΔEffLeverage	2.328***	0.481***	−0.397***	−0.977***			Yes	56.36***	66%
	(0.136)	(0.147)	(0.146)	(0.077)					
Regression (3)	Constant	ΔAssets β_1	Maj ∗ ΔAssets β_2	LagLeverage			Time dummies	F	R^2
ΔFormLeverage	2.302***	0.083***	0.175	−0.966***			Yes	42.08***	60%
	(0.139)	(0.018)	(0.110)	(0.073)					

(*continued on next page*)

Table 3 (*continued*)

ΔEffLeverage	2.445***	0.090***	−0.026	−1.027***			Yes	50.81***	64%
	(0.131)	(0.016)	(0.107)	(0.070)					
Regression (4)	Constant	ΔAssets β_1	InvMaj ∗ ΔAssets β_2	InvMin ∗ ΔAssets β_3	ComMaj ∗ ΔAssets β_4	LagLeverage β_5	Time dummies	*F*	R^2
ΔFormLeverage	2.184***	0.083***	0.285	0.551***	0.019	−0.935***	Yes	41.04***	65%
	(0.133)	(0.016)	(0.228)	(0.178)	(0.115)	(0.077)			
ΔEffLeverage	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)			

Results of the two-ways fixed effects regressions (correcting for autocorrelation in residuals) on: the pro-cyclicality of both formal and effective leverage (regression 1); accounting for the business model (regression 2); accounting for the involvement in securitization (regression 3); and accounting for both the business model and the involvement in securitization (regression 4). Results are reported for the large bank sample over full period (2001 Q2 – 2010 Q4) in Panel A, the pre-crisis period (2001 Q2 – 2007 Q2) in Panel B, the crisis period (2007 Q3 – 2009 Q1) in Panel C, and the post-crisis period (2009 Q2 – 2010 Q4) in Panel D.

* Statistical significance at 10% (two-tailed *t* test).

** Statistical significance at 5% (two-tailed *t* test).

*** Statistical significance at 1% (two-tailed *t* test).

(effective leverage). Also, the explanatory powers of the regression is high before the crisis: in model 4 the R^2 reaches 45%. Interestingly, it can be seen that in the pre-crisis period the degree of involvement in securitization prevails on the traditional asset side business model (commercial vs. investment banks) in explaining pro-cyclicality, as it turns out that $(\beta_1 + \beta_2) \geqslant (\beta_1 + \beta_4) > (\beta_1 + \beta_3) \geqslant \beta_1$.

Not all previous results are confirmed as for the crisis period (Table 3, Panel C), proving that the outbreak of the financial crisis contributed to change the previous pattern of US banks' behavior. In particular (regression 1) we document that securitization no longer plays the same role as in the pre-crisis period (β_1 does not get bigger as one moves from formal leverage to effective leverage): securitization does not contribute to explain the relationship between the change in total assets and the change in leverage during the crisis. This is confirmed by the fact that the β_2 in regression 3 and 4 and β_4 in regression 4 are not statistically significant. Overall, pro-cyclicality is still statistically significant during the crisis (pro-cyclical deleveraging); however β_1 is lower than in the pre-crisis sub-period, pointing to a decline in pro-cyclicality. Regression 2 shows that the pro-cyclicality of commercial banks' leverage vanishes in the crisis sub-period ($\beta_1 + \beta_2 \approx 0$), signaling that mainly commercial banks follow a policy of leverage targeting in the crisis period. The coefficient β_3 in regression 2, 3 and 4 has remained negative and statistically significant, like in the pre-crisis period, but now it has a higher negative value in all regressions. That is, the adjustment mechanism of banks' leverage to some target levels has become stronger. During the crisis only mainly investment banks show leverage pro-cyclicality. However it seems that being a major securitizer no longer affects significantly the pro-cyclical management of leverage of investment banks. Actually, it turns out that only minor securitizers display a significant pro-cyclical behavior (regression 4, $(\beta_1 + \beta_3)$). Summing up, in the crisis sub-period only the predominant type of business activity (commercial vs. investment banking) is able to discriminate the level of pro-cyclicality, whereas securitization seems to have lost relevance.

As for the post-crisis sub-period (Table 3, Panel D), results substantially confirm those obtained for the crisis sub-period. 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, whilst securitization dos not gain new relevance, except for minor securitizer investment banks (regression 4). At the same time, the explanatory power of our regressions increases substantially. The reduction in securitization activities implemented by financial institutions after the crisis leaves the business model (commercial vs. investment banking) as the sole factor at work in determining the different degrees of pro-cyclicality.

Summarizing, the breakdown of the analysis into the three act-periods shows a permanence over time of some pro-cyclicality of US banks' leverage. 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.

5.2. The interplay with regulation

The main results of our analysis of the role of regulation on the behavior of US bank holding companies are shown in Table 4. Regression (5) in Panel A tells us that, as expected, the increase in securitization is positively affected by the bank having had less capital than the minimum requirement ($\beta_3 > 0$, significant at 5%). However, changes in securitization cannot be said to be affected by the past positive proximity to the minimum capital requirement ($\beta_2 < 0$, as expected, but not statistically significant). Also the past level of formal leverage is not significant in explaining the change in securitization. The explanatory power of regression (5) is very low. Overall, minimum capital requirements seem to have weekly affected banks' decision to change their securitization involvement and only when banks were actually short of capital with respect to the required minimum level.

Table 4
Regulation, securitization and leverage: full period.

Panel A: Securitization and proximity [1130 obs.]

Regression (5)	Constant	ΔAsset β_1	LagProximityPos * ΔAssets β_2	LagProximityNeg * ΔAssets β_3	LagFormalLeverage β_4	Time dummies	F	R^2
ΔSecuritization	−0.064	0.516*	−0.060	0.224**	0.005	Yes	1.82**	6%
	(0.155)	(0.289)	(0.061)	(0.110)	(0.071)			

Panel B: Total capital ratio, securitization and proximity [1098 obs.]

Regression (6)	Constant	ΔSecuritization β_1	ΔRepos β_2	LagTotalcapitalratio β_3	DummyProximity β_4	Time dummies	F	R^2
ΔTotalcapitalratio	0.291***	−0.001	−0.024***	−0.021***	0.236***	Yes	7.50***	23%
	(0.038)	(0.008)	(0.008)	(0.002)	(0.031)			

Panel C: Regulatory structural change 2Q2004 (net capital rule, guarantees rule)

	Pre 2004 2Q (2001 2Q – 2004 1Q) [612 obs.]						Post 2004 2Q (2004 3Q – 2010 4Q) [1332 obs.]						Chow test	
Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3	Time dummies	R^2	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3	Time dummies	R^2	ΔAssets β_1	CB * ΔAssets β_2
ΔFormLeverage	0.765	0.620***	−0.535***	−0.313***	Yes	50%	0.587***	0.476***	−0.403**	−0.256***	Yes	33%	1.95	1.73
	(0.062)	(0.056)	(0.057)	(0.028)			(0.035)	(0.038)	(0.039)	(0.019)				
ΔEffLeverage	0.640***	0.679***	−0.570***	−0.255***	Yes	56%	0.266***	0.352***	−0.310***	−0.487***	Yes	2%	12.76***	9.26***
	(0.066)	(0.047)	(0.048)	(0.028)			(0.049)	(0.049)	(0.049)	(0.031)				
	Pre 2004 2Q (2001 2Q – 2004 1Q) [612 obs.]						Post 2004 2Q – Pre crisis (2004 3Q – 2007 2Q) [628 obs.]						Chow test	
Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3	Time dummies	R^2	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3	Time dummies	R^2	ΔAssets β_1	CB * ΔAssets β_2
ΔFormLeverage	0.765	0.620***	−0.535***	−0.313***	Yes	50%	1.030***	0.252***	−0.170***	−0.450***	Yes	45%	10.39***	5.19***
	(0.062)	(0.056)	(0.057)	(0.028)			(0.077)	(0.052)	(0.053)	(0.032)				
ΔEffLeverage	0.640***	0.679***	−0.570***	−0.255***	Yes	56%	0.992***	0.225***	−0.140**	−0.433***	Yes	43%	29.65***	15.38***
	(0.066)	(0.047)	(0.048)	(0.028)			(0.079)	(0.054)	(0.055)	(0.034)				

	Pre 2004 2Q (2001 2Q – 2004 1Q) [612 obs.]							Post 2004 2Q – Pre crisis (2004 3Q – 2007 2Q) [628 obs.]						
Regression (4)	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	R^2	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	R^2
ΔFormLeverage	0.312***	0.093***	0.775***	0.543***	−0.004	−0.133***	Yes	43%	0.817***	0.076***	0.355***	0.123*	0.257***	−0.314***	Yes	45%
	(0.052)	(0.005)	(0.080)	(0.095)	(0.046)	(0.020)			(0.079)	(0.009)	(0.116)	(0.063)	(0.038)	(0.031)		
Chow test pre vs. post		0.47	5.75***	6.25***	4.69***											
ΔEffLeverage	0.486***	0.090***	0.680***	0.501***	0.741***	−0.196***	Yes	70%	0.878***	0.076***	0.179*	0.532**	0.274***	−0.338***	Yes	47%
	(0.055)	(0.008)	(0.043)	(0.096)	(0.047)	(0.023)			(0.079)	(0.009)	(0.129)	(0.062)	(0.039)	(0.031)		
Chow test pre vs. post		0.51	11.37***	9.81***	12.60***											

Results on the interplay among regulation, leverage and securitization. Two-ways fixed effects regressions (correcting for autocorrelation in residuals) on: the relation between the change in securitization and the proximity to the regulatory leverage limit (Panel A); the relation between the change in the total capital ratio and the change in securitizaion, controlling for the lagged level of total capital ratio, the change in repos and the proximity to the leverage limit (Panel B); the pro-cyclicality of both formal and effective leverage accounting for the 2004 changes in the US regulation that is the net capital rule and the guarantees rule (Panel C). Results are reported over the full period for the large bank sample.

* Statistical significance at 10% (two-tailed t test).

** Statistical significance at 5% (two-tailed t test).

*** Statistical significance at 1% (two-tailed t test).

Regression (6) in Panel B shows that changes in total capital ratios were negatively affected by increases in repos ($\beta_2 > 0$, as expected, and highly statistically significant). The increased access to repos did actually arbitrage out equity in US BHC's balance sheets. The mean reversal tendency for the total capital ratio is captured by the negative sign of β_3 (also highly significant), whilst a positive (and significant) β_4 tells us that banks were actually increasing their total capital ratios when they were in the neighborhood of the minimum regulatory level. Once again it emerges the week impact of increases in securitization on the changes in total capital ratios.

As already mentioned, the 2004 change in the net capital rule has sometimes been alleged for the large observed increase in leverage of US banks. Panel C of Table 4 shows that, overall, the change in the net capital rule contributed to the reduction of leverage pro-cyclicality as well as to a lesser role of off-balance sheet securitization in explaining leverage pro-cyclicality. The Chow test conducted in all the regressions run confirms there is a structural break in the time series. The details are as follows: (i) the coefficient β_1 in regression (2) is lower as for the post 2004-2Q period than for the pre 2004-2Q period, whilst the substantial a-cyclicality of average commercial banks' leverage is present in both periods; (ii) the pro-cyclicality of effective leverage was higher than that of formal leverage before 2004-2Q and reverted to be lower after the regulatory reform; (iii) in order to rule out the possible crisis-effect on the results mentioned under (i) and (ii) regression (2) was runned also for a period spanning from 2004-3Q and 2007-2Q: the obtained changes in US banks' behavior did actually occur well before the crisis. Our regression results document that it is the occurrence of the regulatory reform that makes for most of the change in leverage pro-cyclicality; (iv) regression (4) shows that changes in regulation did not affect the pro-cyclicality of leverage in the same direction as they did for the levels: as far as major securitizer investment banks are concerned, after the new SEC net capital rule the pro-cyclicality of their formal leverage declined dramatically (β_2 more than halved) and the role of securitization also was reduced as effective leverage became even less pro-cyclical than formal leverage for this group of banks; (v) after the FASB exemption, the formal leverage of commercial banks deeply involved in securitization became pro-cyclical (in the post 2004-2Q – pre crisis period), whilst effective leverage pro-cyclicality was reduced. Hence we do not find confirmation that commercial banks made use of the favorable treatment of capital as allowed by the FASB exemption. Summing up the 2004 changes in regulation strongly increased the *level* of formal leverage of investment banks but reduced their pro-cyclicality, and had no effect on the *level* of formal leverage of commercial banks highly involved in securitization and opposite and unexpected effects on their formal and effective leverage pro-cyclicality.

5.3. Robustness tests

5.3.1. Robustness tests on the sample

Table 5, Panel A, B and C shows that our regression results are robust to the sample selection. Panel A shows the results obtained by running the regressions employing a sample of all securitizer banks (337 banks and 8361 observations), whilst Panel B contains the results obtained by using all banks in the data set (2809 banks and 54,735 observations), but excluding two clusters of outliers that may be suspected to drive the results, and Panel C is based on large banks only, once again excluding two clusters of outliers. It is apparent that all the conclusions reached in our original sample are confirmed. Hence we can conclude that the above results are not driven by our sample selection.

5.3.2. Robustness tests on the method

In our analysis banks are grouped into securitizers/nonsecuritizers (and even further into major/minor securitizers) and commercial/investment. These groupings are made with respect to time invariant thresholds levels of securitization or loans. One might wonder whether our results are affected by this grouping procedure, particularly in presence of volatility in the use of securitization over time by individual banks. To address this concern we have performed a robustness test by using time varying dummies. Table 6 shows the results for the full period and our previous conclusion are confirmed.

We further checked the robustness of the results presented in Section 5.1 by using the Generalized Methods of Moments (GMM), introduced by Hansen (1982), as an alternative estimation strategy. The

Table 5
Robustness tests on the sample (all banks, all securitizers, all banks without two clusters of outliers): full period.

Panel A: All securitizers, 337 banks [8361 obs.]									
Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	0.072***	0.364***					Yes	18.40***	8%
	(0.007)	(0.018)							
ΔEffLeverage	0.076***	0.485***					Yes	32.95***	14%
	(0.007)	(0.016)							
Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.249***	0.277***	−0.157***	−0.899***			Yes	262.04***	57%
	(0.017)	(0.017)	(0.030)	(0.010)					
ΔEffLeverage	1.883***	0.334***	−0.059**	−0.832***			Yes	262.31***	57%
	(0.009)	(0.015)	(0.027)	(0.010)					
Regression (3)	Constant	ΔAssets β_1	Maj * ΔAssets β_2	LagLeverage			Time dummies	F	R^2
ΔFormLeverage	0.236***	0.197***	0.066**	−0.901***			Yes	261.27***	58%
	(0.017)	(0.019)	(0.028)	(0.010)					
ΔEffLeverage	0.238***	0.198***	0.134***	−0.876***			Yes	282.23***	59%
	(0.017)	(0.019)	(0.025)	(0.010)					
Regression (4)	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage	0.232***	0.091***	0.213***	0.161***	0.069	−0.898***	Yes	249.80***	57%
	(0.017)	(0.032)	(0.040)	(0.039)	(0.050)	(0.010)			
ΔEffLeverage	0.238***	0.095***	0.231***	0.156***	0.253***	−0.875***	Yes	269.44***	59%
	(0.017)	(0.033)	(0.037)	(0.040)	(0.044)	(0.010)			
Panel B: All banks, 2809 banks [54735 obs.]									
Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	0.067***	0.378***					Yes	119.82***	8%
	(0.003)	(0.007)							
ΔEffLeverage	0.076***	0.405***					Yes	137.44***	9%
	(0.003)	(0.007)							
Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	1.276***	0.478***	−0.220***	−0.496***			Yes	472.47***	27%
	(0.004)	(0.009)	(0.013)	(0.005)					
ΔEffLeverage	1.221***	0.484***	−0.217***	−0.496***			Yes	500.22***	28%
	(0.004)	(0.009)	(0.012)	(0.005)					
Regression (3)	Constant	ΔAssets β_1	Maj * ΔAssets β_2	LagLeverage			Time dummies	F	R^2
ΔFormLeverage	1.240***	0.359***	0.001	−0.517***			Yes	481.54***	26%
	(0.004)	(0.007)	(0.023)	(0.005)					
ΔEffLeverage	1.283***	0.365***	0.109***	−0.500***			Yes	490.49***	27%
	(0.004)	(0.007)	(0.018)	(0.005)					
Regression (4)	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage	0.912*	0.360***	0.063**	0.014	−0.170***	−0.512***	Yes	454.64***	27%
	(0.539)	(0.007)	(0.027)	(0.026)	(0.044)	(0.005)			
ΔEffLeverage	0.944*	0.354***	0.130***	0.010	0.054*	−0.513***	Yes	467.10***	27%
	(0.536)	(0.007)	(0.020)	(0.026)	(0.037)	(0.005)			

Table 5 (*continued*)

Panel C: Large banks without two clusters of outliers, 72 banks [2027 obs.]

Regression (1)	Constant	ΔAssets β_1					Time dummies	F	R^2
ΔFormLeverage	0.001	0.319***					Yes	6.79***	12%
	(0.013)	(0.028)							
ΔEffLeverage	0.004	0.454***					Yes	11.91***	19%
	(0.013)	(0.026)							
Regression (2)	Constant	ΔAssets β_1	CB ∗ ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.362***	0.475***	−0.530***	−0.154***			Yes	14.86***	23%
	(0.026)	(0.032)	(0.055)	(0.012)					
ΔEffLeverage	0.388***	0.536***	−0.370***	−0.160***			Yes	19.17***	28%
	(0.027)	(0.030)	(0.052)	(0.012)					
Regression (3)	Constant	ΔAssets β_1	Maj ∗ ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.391***	0.310***	−0.054***	−0.165***			Yes	11.80***	19%
	(0.026)	(0.032)	(0.057)	(0.013)					
ΔEffLeverage	0.401***	0.306***	0.235***	−0.164***			Yes	18.10***	27%
	(0.027)	(0.033)	(0.049)	(0.012)					
Regression (4)	Constant	ΔAssets β_1	InvMaj ∗ ΔAssets β_2	InvMin ∗ ΔAssets β_3	ComMaj ∗ ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage	0.383***	0.016	0.403***	0.468***	0.049	−0.161***	Yes	13.32***	22%
	(0.026)	(0.052)	(0.082)	(0.065)	(0.085)	(0.013)			
ΔEffLeverage	0.392***	0.022	0.602***	0.450***	0.405***	−0.159***	Yes	18.95***	29%
	(0.026)	(0.054)	(0.072)	(0.067)	(0.077)	(0.012)			

Two-ways fixed effects regressions (correcting for autocorrelation in residuals) on: the pro-cyclicality of both formal and effective leverage (regression 1); accounting for the business model (regression 2); accounting for the involvement in securitization (regression 3); and accounting for both the business model and the involvement in securitization (regression 4). Results are reported over the full period for all securitizers (Panel A), all banks in the whole sample (Panel B), and large banks without two clusters of outliers (Panel C).

* Statistical significance at 10% (two-tailed t test).

** Statistical significance at 5% (two-tailed t test).

*** Statistical significance at 1% (two-tailed t test).

Table 6
Robustness tests on the method (time-varying dummies): full period.

Regression (2)	Constant	ΔAssets β_1	CB * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.395***	0.166***	−0.129***	−0.165***			Yes	14.89***	23%
	(0.028)	(0.014)	(0.022)	(0.013)					
ΔEffLeverage	0.443***	0.182***	−0.140***	−0.188***			Yes	18.15***	26%
	(0.028)	(0.014)	(0.023)	(0.014)					
Regression (3)	Constant	ΔAssets β_1	Maj * ΔAssets β_2	LagLeverage β_3			Time dummies	F	R^2
ΔFormLeverage	0.254***	0.084***	0.109***	−0.110***			Yes	12.00***	19%
	(0.028)	(0.008)	(0.023)	(0.012)					
ΔEffLeverage	0.400***	0.078***	0.206***	−0.176***			Yes	19.40***	27%
	(0.028)	(0.007)	(0.022)	(0.014)					
Regression (4)	Constant	ΔAssets β_1	InvMaj * ΔAssets β_2	InvMin * ΔAssets β_3	ComMaj * ΔAssets β_4	LagLeverage β_5	Time dummies	F	R^2
ΔFormLeverage	0.404***	−0.007	0.257***	0.194***	0.235***	−0.170***	Yes	16.13***	25%
	(0.028)	(0.015)	(0.033)	(0.030)	(0.042)	(0.013)			
ΔEffLeverage	0.392***	−0.032**	0.370***	0.245***	0.373***	−0.172***	Yes	20.40***	30%
	(0.031)	(0.016)	(0.032)	(0.031)	(0.040)	(0.014)			

Two-ways fixed effects regressions (correcting for autocorrelation in residuals) on: the pro-cyclicality of both formal and effective leverage (regression 1); accounting for the business model (regression 2); accounting for the involvement in securitization (regression 3); and accounting for both the business model and the involvement in securitization (regression 4). Results are reported over the full period for the large bank sample (number of observations: 2063).
*Statistical significance at 10% (two-tailed t test).
** Statistical significance at 5% (two-tailed t test).
*** Statistical significance at 1% (two-tailed t test).

Table 7
Robustness tests on the method (generalized method of moments): full period.

Regression (1)	Constant	ΔAssets β_1					Hansen
ΔFormLeverage	−0.006***	0.094***					40.914***
	(0.001)	(0.001)					
ΔEffLeverage	−0.007***	0.096***					43.639***
	(0.001)	(0.001)					
Regression (2)	Constant	ΔAssets β_1	CB ∗ ΔAssets β_2	LagLeverage β_3			Hansen
ΔFormLeverage	0.136***	0.517***	−0.434***	−0.059***			71.061***
	(0.002)	(0.005)	(0.005)	(0.001)			
ΔEffLeverage	0.123***	0.802***	−0.722***	−0.053***			71.314***
	(0.001)	(0.003)	(0.003)	(0.001)			
Regression (3)	Constant	ΔAssets β_1	Maj ∗ ΔAssets β_2	LagLeverage			Hansen
ΔFormLeverage	0.164***	0.089***	0.475***	−0.071***			68.154***
	(80.003)	(0.001)	(0.005)	(0.001)			
ΔEffLeverage	0.137***	0.089***	0.820***	−0.059***			65.313***
	(0.002)	(0.001)	(0.002)	(0.001)			
Regression (4)	Constant	ΔAssets β_1	InvMaj ∗ ΔAssets β_2	InvMin ∗ ΔAssets β_3	ComMaj ∗ ΔAssets β_4	LagLeverage β_5	Hansen
ΔFormLeverage	0.143***	0.083***	0.103***	0.412***	0.636***	−0.063***	67.013***
	(0.002)	(0.001)	(0.025)	(0.004)	(0.010)	(0.001)	
ΔEffLeverage	0.130***	0.082***	0.832***	0.406***	0.629***	−0.057***	67.322***
	(0.001)	(0.001)	(0.002)	(0.003)	(0.011)	(0.001)	

Generalized method of moments estimation of: the pro-cyclicality of both formal and effective leverage (regression 1); accounting for the business model (regression 2); accounting for the involvement in securitization (regression 3); and accounting for both the business model and the involvement in securitization (regression 4). Results are reported over the full period for the large bank sample (number of observations: 2136).
*** Statistical significance at 1% (Hansen/Sargan test). The significance levels are based on robust standard errors (in parenthesis).

instrument variable set contains the lagged (one- and two-quarters) values of log-differenced total assets (precisely, formal values in regressions 1 and 2, and effective values in regressions 3, 4 and 5). For each of these instruments to be valid they must be correlated with the endogenous variable and uncorrelated with the error term. An Hansen/Sargan test of instrument validity is conducted. The rejection of the null hypothesis points to the validity of the instrument set employed. Table 7 shows the results obtained for the full period.[19] Our previous conclusions are confirmed. For example, in regression (4) coefficient β_4 becomes even larger than coefficient β_3: this indicates that major securitizer commercial banks display an even higher pro-cyclicality than minor securitizer investment banks.

5.3.3. Robustness tests on the market funding and bank size

In order to take into account bank characteristics that may affect the pro-cyclicality of leverage, we controlled for the funding side business model (i.e. differences in the on-balance sheet funding) and bank size (as measured by the lagged log of total assets). As for the funding, given that the correlation between securitization and market based funding of banks is 0.55 (significant at 1%), we include a proxy for the use of market based funding (i.e. repos). Repos themselves show positive and statistically significant coefficients, but do not alter our previous conclusions on pro-cyclicality (Table 8). As for size, it results non-significant in all regressions but regression (1), where the coefficient is positive as expected (Table 9). Accounting for bank size does not alter our main result about pro-cyclicality and securitization. Our previous conclusions are therefore confirmed when controlling for both market-based funding and bank size.

[19] Results for the pre-crisis, crisis and post-crisis periods are available from the authors upon request. These results confirm the robustness of our main findings.

Table 8
Robustness tests on the market funding: full period.

Regression (1)	Constant	ΔAssets β_1	Repos β_2					Time dummies	F	R^2
ΔFormLeverage	−0.009	0.103***	0.448***					Yes	8.45***	14%
	(0.014)	(0.008)	(0.001)							
ΔEffLeverage	−0.007	0.118***	0.430***					Yes	10.08***	16%
	(0.015)	(0.008)	(0.001)							
Regression (2)	Constant	ΔAssets β_1	CB ∗ ΔAssets β_2	LagLeverage β_3	Repos β_4			Time dummies	F	R^2
ΔFormLeverage	0.383***	0.434***	−0.356***	−0.166***	0.473***			Yes	18.47***	28%
	(0.027)	(0.034)	(0.035)	(0.013)	(0.001)					
ΔEffLeverage	0.419***	0.498***	−0.413***	−0.175***	0.467***			Yes	23.18***	32%
	(0.028)	(0.032)	(0.033)	(0.013)	(0.001)					
Regression (3)	Constant	ΔAssets β_1	Maj ∗ ΔAssets β_2	LagLeverage β_3	Repos β_4			Time dummies	F	R^2
ΔFormLeverage	0.411***	0.082***	0.237***	−0.180***	0.709***			Yes	16.76***	26%
	(0.027)	(0.007)	(0.035)	(0.013)	(0.001)					
ΔEffLeverage	0.466***	0.082***	0.409***	−0.197***	0.765***			Yes	24.87***	34%
	(0.027)	(0.006)	(0.030)	(0.013)	(0.001)					
Regression (4)	Constant	ΔAssets β_1	InvMaj ∗ ΔAssets β_2	InvMin ∗ ΔAssets β_3	ComMaj ∗ ΔAssets β_4	LagLeverage β_5	Repos β_6	Time dummies	F	R^2
ΔFormLeverage	0.410***	0.073***	0.321***	0.364***	0.232***	−0.176***	0.472***	Yes	19.02***	30%
	(0.026)	(0.006)	(0.065)	(0.042)	(0.040)	(0.013)	(0.120)			
ΔEffLeverage	0.409***	0.074***	0.520***	0.350***	0.365***	−0.181***	0.501***	Yes	26.21***	36%
	(0.028)	(0.007)	(0.049)	(0.043)	(0.037)	(0.013)	(0.001)			

Two-ways fixed effects regressions (correcting for autocorrelation in residuals) on: the pro-cyclicality of both formal and effective leverage accounting for repos (regression 1); accounting for the business model and repos (regression 2); accounting for the involvement in securitization and repos (regression 3); accounting for the business model, the involvement in securitization and repos (regression 4). Results are reported over the full period for the large bank sample (number of observations: 2063).

*Statistical significance at 10% (two-tailed t test).

**Statistical significance at 5% (two-tailed t test).

*** Statistical significance at 1% (two-tailed t test).

Table 9
Robustness tests on the size: full period.

Regression (1)	Constant	ΔAssets β_1	LagSize β_2					Time dummies	F	R^2
ΔFormLeverage	−0.562**	0.118***	0.031**					Yes	7.86***	14%
	(0.222)	(0.010)	(0.012)							
ΔEffLeverage	−0.667***	0.137***	0.036***					Yes	9.06***	16%
	(0.227)	(0.010)	(0.012)							
Regression (2)	Constant	ΔAssets β_1	CB ∗ ΔAssets β_2	LagLeverage β_3	LagSize β_4			Time dummies	F	R^2
ΔFormLeverage	0.260	0.464***	−0.383***	−0.181***	0.008			Yes	19.53***	29%
	(0.193)	(0.033)	(0.034)	(0.013)	(0.013)					
ΔEffLeverage	0.124	0.529***	−0.438***	−0.185***	0.018			Yes	22.99***	33%
	(0.189)	(0.032)	(0.032)	(0.013)	(0.012)					
Regression (3)	Constant	ΔAssets β_1	Maj ∗ ΔAssets β_2	LagLeverage β_3	LagSize β_4			Time dummies	F	R^2
ΔFormLeverage	0.318	0.086***	0.244***	−0.159***	0.0004			Yes	14.74***	24%
	(0.202)	(0.009)	(0.035)	(0.013)	(0.013)					
ΔEffLeverage	0.160	0.092***	0.396***	−0.186***	0.016			Yes	22.07***	33%
	(0.192)	(0.009)	(0.031)	(0.013)	(0.013)					
Regression (4)	Constant	ΔAssets β_1	InvMaj ∗ ΔAssets β_2	InvMin ∗ ΔAssets β_3	ComMaj ∗ ΔAssets β_4	LagLeverage β_5	LagSize β_6	Time dummies	F	R^2
ΔFormLeverage	0.475***	0.069***	0.329***	0.415***	0.239***	−0.187***	−0.002	Yes	20.20***	32%
	(0.171)	(0.009)	(0.065)	(0.037)	(0.039)	(0.013)	(0.012)			
ΔEffLeverage	0.323**	0.075***	0.535***	0.404***	0.362***	−0.192***	0.007	Yes	27.88***	38%
	(0.169)	(0.009)	(0.049)	(0.038)	(0.036)	(0.014)	(0.019)			

Two-ways fixed effects regressions (correcting for autocorrelation in residuals) on: the pro-cyclicality of both formal and effective leverage when taking into account size, as measured by the lagged log of total assets (regression 1); accounting for the business model and size (regression 2); accounting for the involvement in securitization and size (regression 3); and accounting for the business model, the involvement in securitization and size (regression 4). Results are reported over the full period for the large bank sample (number of observations: 2063).

* Statistical significance at 10% (two-tailed t test).
** Statistical significance at 5% (two-tailed t test).
*** Statistical significance at 1% (two-tailed t test).

6. 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 between 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 effective leverage rather than on formal leverage. The interest in effective 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 lose rules for the recognition of securitized assets. Formal leverage may therefore be significantly lower and less pro-cyclical than effective 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 effective leverage is appropriately defined and accounted for, several interesting results emerge. First, the degree of pro-cyclicality of effective leverage is stronger than that of formal leverage, 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 to "spontaneous" lower securitization activity during the crisis. When investigating whether the crisis is the actual turning point for securitization and pro-cyclicality, interestingly it emerges that the major changes occurred well before the crisis, following the 2004 changes in regulation (the new SEC net capital rule and the exemption from the FASB directive on consolidation of SPVs). Indeed, the regulatory reform *per se* is able to account for most of the change in leverage pro-cyclicality and in the role of securitization in explaining it. 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. Hence, in the pre-crisis period, securitization activity appears to dominate the business model in explaining pro-cyclicality. Our main results prove to be robust to alternative estimation strategies (time-varying dummies and GMM), to the sample selection and to controls on the on-balance sheet funding. Third, securitization seems to be weekly affected by the proximity of banks to the regulatory minimum capital ratio and only when banks happen to have a lower capital ratio than the minimum required. Changes in the total capital ratios were negatively affected by the availability of short term cheap financing sources such as repos and also by the past value of the total capital ratio itself. Once again, the relation between securitization and capital ratios was week. The 2004 changes in regulation albeit strongly increased the *level* of formal leverage of investment banks did not increase and actually reduced their pro-cyclicality, and had no effect on the *level* of formal leverage of commercial banks highly involved in securitization whilst increasing the pro-cyclicality of their formal leverage and reducing the pro-cyclicality of their effective leverage.

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 behavior 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 et al. (2011).

The steps recently taken by the Basel III Committee on Banking Supervision must be welcome, although the chosen leverage threshold (33) may be regarded as too high. According to theory-based suggestions (Blum, 2008), those 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 supports 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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Appendix A

See Figs. 1a–2d

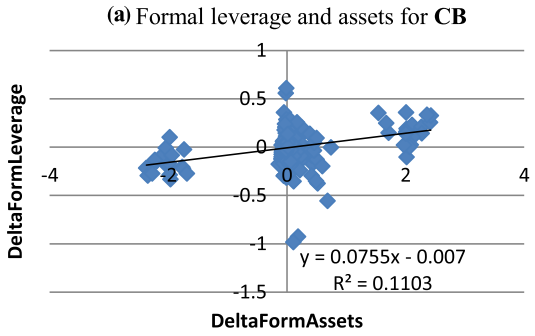

Fig. 1a. Formal leverage and assets for CB.

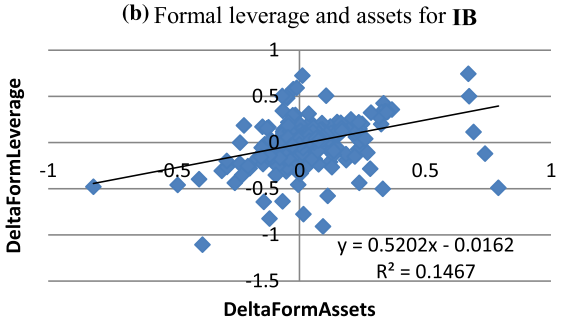

Fig. 1b. Formal leverage and assets for IB.

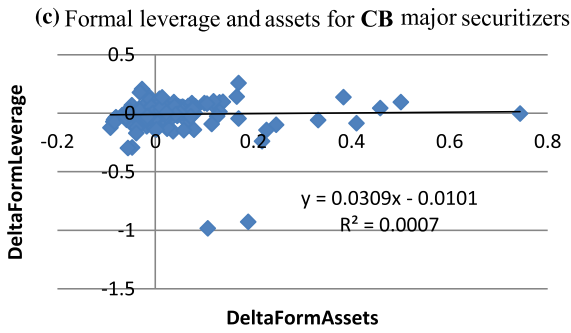

Fig. 1c. Formal leverage and assets for CB major securitizers.

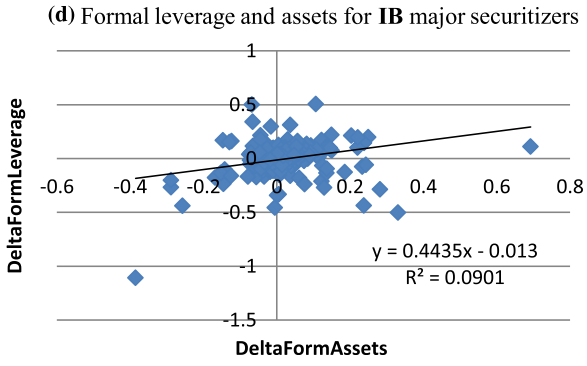

Fig. 1d. Formal leverage and assets for IB major securitizers.

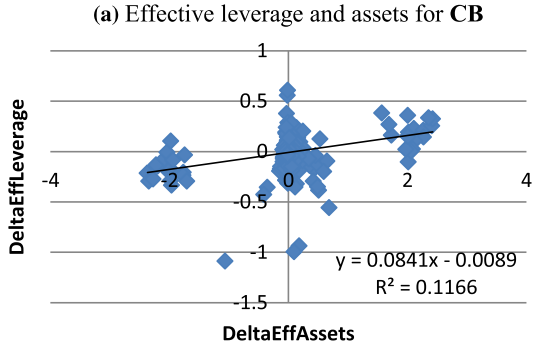

Fig. 2a. Effective leverage and assets for CB.

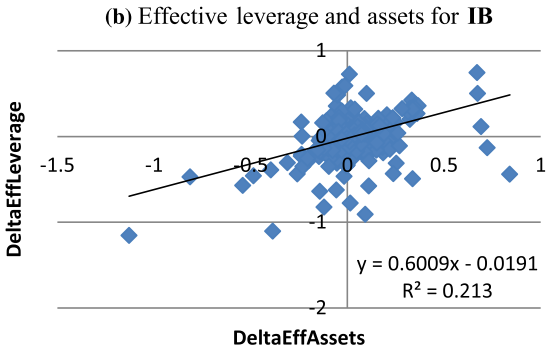

Fig. 2b. Effective leverage and assets for IB.

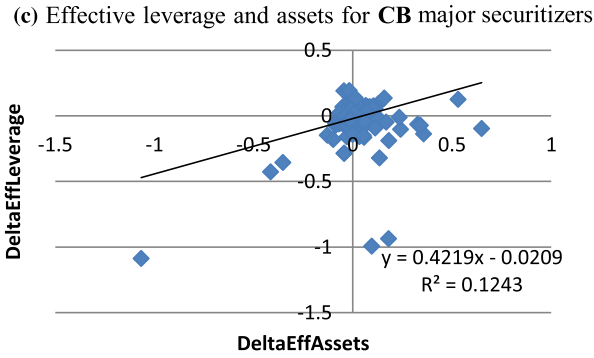

Fig. 2c. Effective leverage and assets for CB major securitizers.

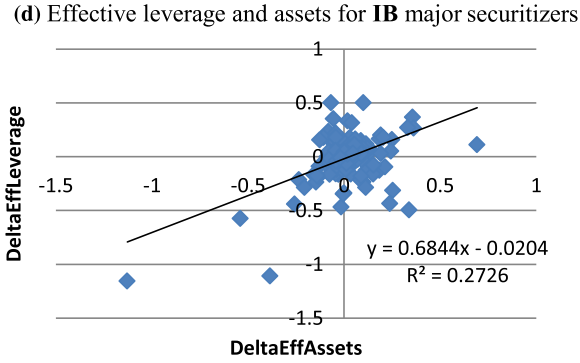

Fig. 2d. Effective leverage and assets for IB major securitizers.

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