Why do UK banks securitize?

Mario Cerrato*, Moorad Choudhry**, John Crosby*+ and John Olukuru*
*University of Glasgow Business School; +Grizzly Bear Capital London;
Brunel University

March 20, 2013

Abstract

The eight years from 2000 to 2008 saw a rapid growth in the use of securitization by UK banks. We aim to identify the reasons that contributed to this rapid growth. The time period (2000 to 2010) covered by our study is noteworthy as it covers the pre-financial crisis credit-boom, the peak of the financial crisis and its aftermath. In the wake of the financial crisis, many governments, regulators and political commentators have pointed an accusing finger at the securitization market - even in the absence of a detailed statistical and economic analysis.

We contribute to the extant literature by performing such an analysis on UK banks, focussing principally on whether it is the need for liquidity (i.e. the funding of their balance sheets), or the desire to engage in regulatory capital arbitrage or the need for credit risk transfer that has led to UK banks securitizing their assets.

We show that securitization has been significantly driven by liquidity reasons. In addition, we observe a positive link between securitization and banks' credit risk. We interpret these latter findings as evidence that UK banks which engaged in securitization did so, in part, to transfer credit risk and that, in comparison to UK banks which did not use securitization, they had more credit risk to transfer in the sense that they originated lower quality loans and held lower quality assets. We show that banks which issued more asset-backed securities before the financial crisis suffered more defaults after the financial crisis.

JEL Classification: G21, G28

Acknowledgement 1 *We are grateful to Jo Danbolt and Hong Liu for comments. The usual disclaimer applies*

1 Introduction

Securitization has been one of the most prominent developments in the international financial markets in recent decades.

In this study we consider securitization as the process by which heterogenous and illiquid credit-risky assets (e.g. bank loans) or instruments (e.g. a portfolio of bonds or credit default swaps) are pooled and repackaged into marketable securities; where risks related to these assets or instruments are separated from the transferrer's (i.e. the originator's) own credit and operating risk, and where securities are issued to investors which are designed for the specific risk tolerance profile of such investors. Therefore, we define securitization as the whole process whereby a bank or other financial institution issues marketable securities backed by the cash flows from a pool of underlying assets or instruments.

The securitization or repackaging process leads to three potential benefits for investors: Firstly, the potential benefit to create securities with a specific risk-reward profile (e.g. the different tranches of asset-backed securities (ABSs) or collateralised debt obligations (CDOs)) for investors; secondly, the inclusion of many different assets or instruments may diversify (and hence reduce) the credit risk faced by investors (at potentially lower cost than the investors could themselves diversify); thirdly, the repackaging process may lead to securities which are more readily marketable and more liquid than ownership interests in and loans against the underlying assets.

With each potential benefit comes a potential drawback for investors: Firstly, the repackaging process may lead to a lack of transparency or a delegation of the due diligence process to other parties (such as the originating bank itself (which has its best interests at heart and not those of the investors) or a ratings agency); secondly, the diversification of idiosyncratic risk may be illusory in the sense that default correlations are low in good economic times but may become very high in a credit-crunch or a recession; thirdly, there may be a perception of liquidity in a bull market but, in fact, liquidity in the market dried-up abruptly and completely in the summer of 2007.

From the point of view of the originating banks, there are three potential benefits to be gained by securitization: Firstly, the repackaging and sale of the banks' loans results in an inflow of cash and hence securitization enables the bank to fund itself; secondly, the transfer of credit risk to a third party - this means that, even if a bank has already lent substantially to a particular borrower or group of borrowers (for example, within a specific geographical region or sector of the economy), it can continue to lend to this same group (perhaps, for relationship reasons) because the transfer of credit risk, via securitization, reduces the issuing bank's concentration risk; thirdly, securitization may reduce the banks' regulatory capital requirements.

The process whereby a bank securitizes its loans and sells them onto third parties is usually termed the "originate-to-distribute" (OTD) model (as opposed to the traditional "loan-and-hold" model of using deposits to finance loans and holding the loans until maturity).

For part of our empirical analysis (section 4.4), we will draw a distinction between asset-backed securities (ABSs) and collateralised debt obligations (CDOs). The former repackage the originating bank's assets (i.e. loans) while the latter repackage the bank's liabilities or synthetic instruments such as a portfolio of bonds or credit default swaps.

Despite the size of the securitization markets and the popular viewpoint that securitization partially lead to the financial crisis, there have been few studies which have tried to shed some light on why banks used securitization and the effect of the OTD business model on banks' balance sheets after the financial crisis. In this paper, we attempt to address these issues using a unique dataset for UK banks. We seek to determine whether the liquidity motive is the dominant one or, on the other hand, whether it is regulatory capital arbitrage or credit risk transfer reasons that drove the increased securitization by UK banks before the financial crisis. We focus on the UK since it can be regarded as the securitization laboratory of the world. In fact, many of the securitization products widely used by the financial industry across the world have been developed in the UK. Furthermore, the UK securitization market is the largest market in Europe.

In contrast to most other studies that have considered the aggregate securitization (i.e. including both ABSs (assets) and CDOs (liabilities)) of banks, we split securitization into two separate categories - ABSs and CDOs - reflecting that these two different classes of securitization may serve different purposes.

Anticipating our main conclusions, we find:

1. The main driver of securitization has been liquidity i.e. the need for banks to fund their balance sheets.

2. Funding has been of greater importance in driving the issuance of ABSs than in driving the issuance of CDOs. For CDOs, regulatory capital has also been an important driver.

3. Banks which securitized tended to be larger than those which did not.

4. Those banks which had more rapid growth of their loan books, were more reliant on wholesale interbank funding and had a larger gap between the size of their loan books and their deposits were more likely to securitize.

5. Banks which securitized tended to have a greater proportion of non-performing loans in the aftermath of the financial crisis.

6. Large banks were the ones for which securitization was an important factor to explain profits while smaller ones were the ones whose balance sheets were most highly exposed to changes in the securitization market.

The rest of this paper is organized as follows. In the remainder of this section, we discuss the trends in global securitization, paying specific attention to the UK. In section 2, we review the extant literature. In sections 3 and 4, we describe the data, methodology used in this study and results, section 5 discusses policy implications of our findings for regulators and monetary authorities and section 6 analyses the robustness of our findings whilst section 7 concludes.

1.1 Trend in global securitization

Before the development of the securitization market, banks were essentially portfolio lenders using deposits to finance loans and holding the loans until maturity (the "loan-and-hold" model). Thus loans were funded principally by deposits, and sometimes by debt, which was a direct obligation of the bank (rather than a claim on specific assets).

Since the 1970s, the securitization market has grown exponentially with the aggregate securitization volumes exceeding $2.08 trillion worldwide (as of December 31, 2005). The securitization market in Europe was rather undeveloped until the late 1990s. Since then, there has been a significant increase in securitization activity. This increase may be linked to factors such as the greater integration of European financial markets as well as a shift towards a more market-based financial system. Figure 1 shows the growth of the European securitization market between 2000 and 2010. The market reached its peak in 2008 i.e. at the start of the financial crisis.

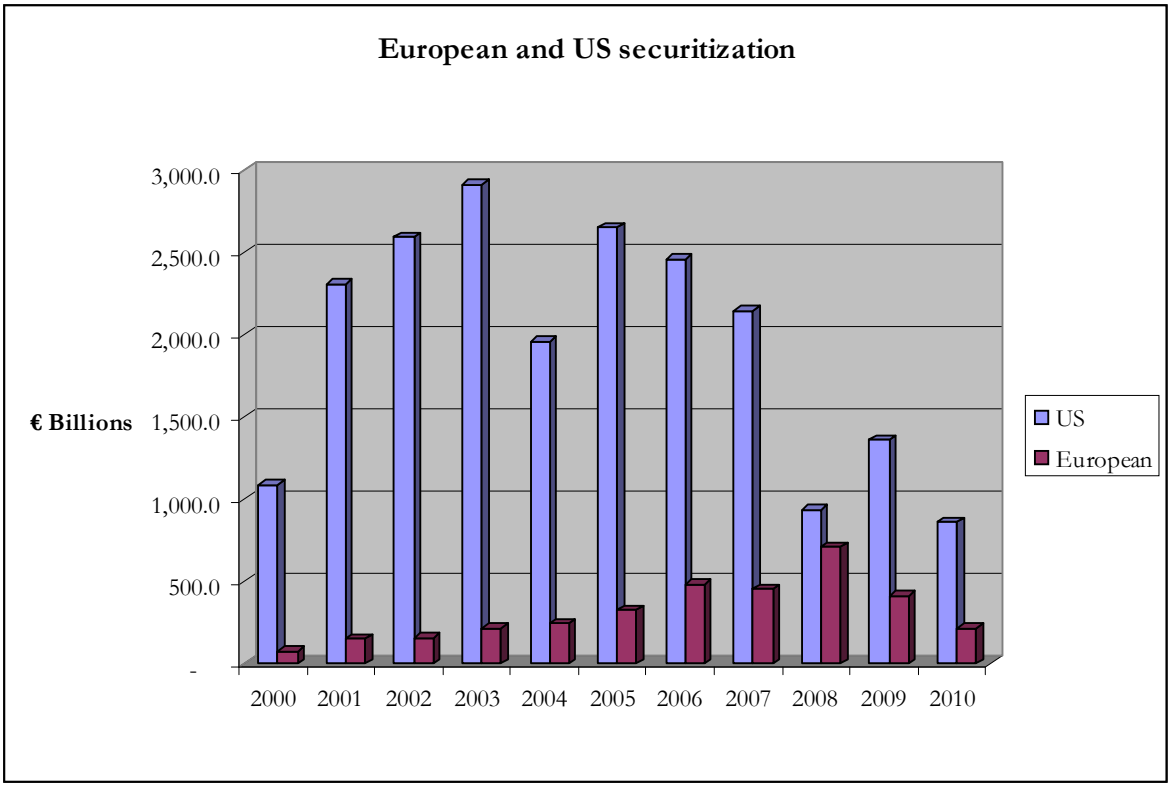

Figure 1: Total securitization in Europe and US between 2000 - 2010 Source - SIFMA

1.2 UK securitization market

Securitization in the UK has been on the increase since the end of 1990s (see Figure 2). This is not surprising since UK-based banks have been at the fore-front of financial innovation. Between 2002 and 2008, there was a dramatic increase in securitization activity. Since then, there has been an almost equally dramatic contraction.

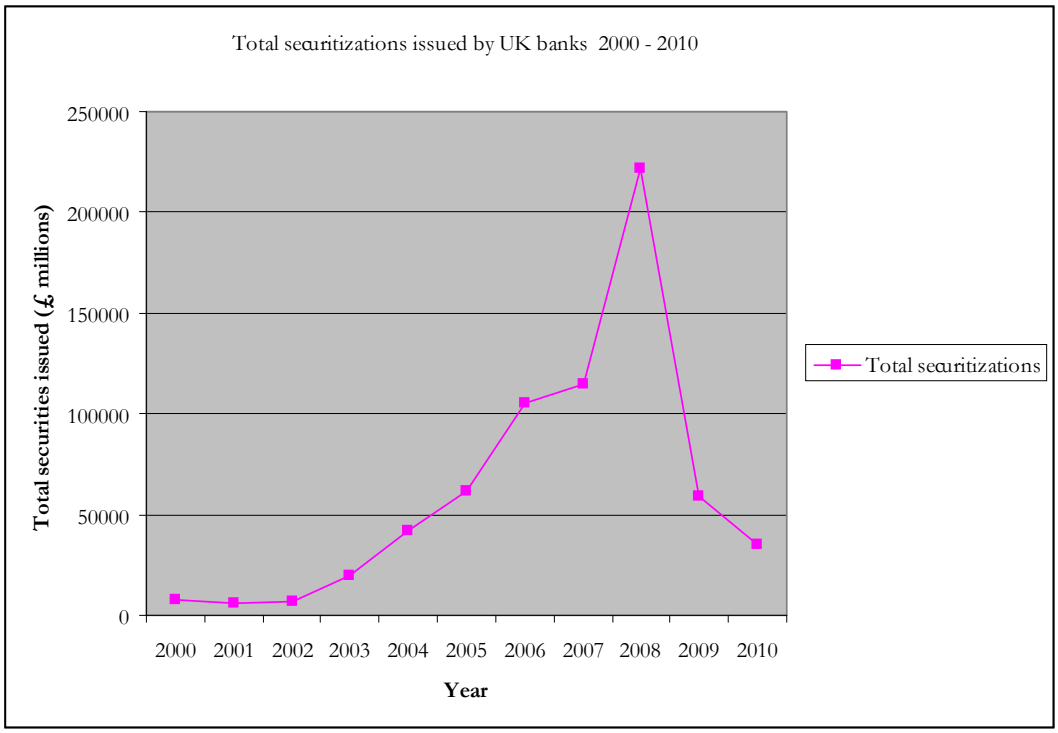

Figure 2: UK bank securitization 2000 - 2010; Source SIFMA

This motivates our desire to investigate the reasons for the sharp increase in the size of the securitization market in the UK and its effect on banks' balance sheets.

Some regulators and political commentators have blamed securitization for being a catalyst for the financial crisis. A popular viewpoint has been that banks have embraced securitization mainly for regulatory capital arbitrage [1]. Until recently, under the Basel I framework (Jackson et al. (1999)), the minimum capital that banks needed to retain was a very rough function of the level of risk held on their balance sheets. For example, a loan to a borrower needed 8% of capital, no matter what the risk of the borrower. In 1999 banking supervisors engaged in a thorough revision of the capital regulatory framework. This lead to the Basel II framework in which the capital requirements of banks were thought to be better aligned with the risk profile of their portfolios. Thus, banks were expected to hold a higher level of capital for loans granted to higher-risk borrowers. As a consequence of the 2007-2008 financial crisis, regulators are now discussing ways to implement a new regulatory (Basel III) framework to account for the main drawbacks of the Basel II framework.

[1] Regulatory capital arbitrage is any transaction that has little or no economic impact on a financial institution while either increasing its capital or decreasing its regulatory capital requirement.

2 Literature review

In this section, we review the extant literature on securitization pertinent to the subject of this paper.

DeMarzo and Duffie (1999) and DeMarzo (2005) conduct a theoretical analysis of securitization. These papers build a model for security design which, although not specifically designed for the securitization market, fits important applications such as asset-backed securities. They show that liquidity (a bank's need to fund its balance sheet) is an important driver for security design. they also show that securitization is used by banks to overcome the asymmetries that are associated with the transfer of credit risk.

There have not been many empirical studies attempting to shed light on why banks use securitization. Cardone-Riportella et al. (2010) is a notable exception. They use a Logit regression model applied to data on 408 Spanish banks to investigate the causes of the growth of securitization in Spain. Their results show that liquidity and the search for improved performance are the decisive factors for securitization, whilst they find very little evidence supporting credit risk transfer and regulatory capital arbitrage as motivating reasons. This result is consistent with the predictions of the DeMarzo and Duffie (1999) model (i.e. the desire for low-cost funding incentivizes the growth of the securitization market). However, the study of Cardone-Riportella et al. (2010) pre-dates the financial crisis. For this reason, as well as because of the much larger securitization market in the UK compared to Spain, we are motivated to build upon their results.

Dionne and Harchaoui (2008), using data for Canadian banks, investigate the effects of securitization (rather than the reasons for it) on the risks incurred by the banks. They conclude that there is a positive relation between securitization and banks' risk (defined to include interest rate risk, market risk, liquidity risk and credit risk, as well as systemic risks). Furthermore, they empirically show that securitization has a negative impact on Tier 1 capital[2]. Although this study makes an important contribution to the empirical literature, it does not address the fundamental question, which we seek to address, of why Canadian banks use securitization in the first place. Furthermore, in this paper, we relate banks' risks, at the onset of the financial crisis, to the OTD Model (see discussion in section 4.5).

Hänsel and Krahnen (2007) investigate whether the use of credit derivatives affects the risk taken by large banks. Using a data-set of European Collateralized Debt Obligations (CDOs), they find that the issuance of CDOs tends to raise the systematic risk (equity beta) of the issuing bank. They also perform a cross-sectional analysis to identify the determinants of the change in systematic risk and find that equity beta increases significantly if the issuing bank is financially weak (low profitability and high leverage). Overall, their findings suggest that credit securitization goes hand in hand with an increase in the risk appetite of the issuing bank.

Affinito and Tagliaferri (2008) investigate the determinants for loan securitization in Italy using data for Italian banks over the period 2000 to 2006. They show that, although securitization is a composite decision, capital requirements play a driving role, suggesting that Basel I may have created perverse regulatory incentives to move exposures off the balance sheet. The empirical results confirm the widespread opinion that bank securitization was a mechanism to engage in regulatory capital arbitrage. The main issue with that study is that, compared with other countries such as the USA, the UK and Spain, securitization in Italy has never been a widespread phenomenon.

[2]Tier 1 capital is the core measure of a bank's financial strength from a regulator's point of view. It is composed of core capital, which consists primarily of common stock and disclosed reserves (or retained earnings), but may also include non-redeemable non-cumulative preferred stock.

Indeed, Italian banks have mainly used customers' deposits to finance their loan positions and the securitization market has been concentrated in the hands of a very small percentage of Italian banks. Therefore, the main conclusion of Affinito and Tagliaferri (2008) might not be applicable in other countries.

Purnanandam (2011) investigates the originate-to-distribute (OTD) model of bank lending in the US and concludes that lack of borrower screening, coupled with leverage-induced risk-taking, contributed significantly to the sub-prime mortgage crisis. In section 4.5 we extend this result to ABS and CDO securities and link it to regulatory capital arbitrage.

Loutskina and Strahan (2009) consider the volume of jumbo mortgage originations relative to non jumbo originations and find that it increases with bank holdings of liquid assets and decreases with bank deposit costs. This result suggests that the increasing depth of the mortgage secondary market fostered by securitization has reduced the effect of a lender's financial condition on credit supply. Uzun and Webb (2007), using a panel of 112 banks in the US which use securitization and a matched panel of banks which did not use securitization, find that bank size is a significant determinant of whether a bank securitized its loans and it is negatively related to the bank's capital ratios[3]. This provides some support for the hypothesis that securitization is linked to regulatory capital arbitrage.

The papers reviewed earlier mainly analyse the motives for securitization and its effect on banks' risk profiles. However, there is also a strand of the literature which has focused on the relationship between securitization and banks' profitability. Securitization can increase banks' profits simply by giving them more options to manage the risk of their balance sheets. It can also reduce banks' profitability if it leads to more competition. The net effect of securitization on banks profit is therefore ambiguous. In section 4.6, we shed some light on this important issue.

Jiangli and Pritsker (2008) use data from 2001-2007 to assess the impact of securitization on banks' profitability and conclude that the former increases the latter. However, the data-set in that study does not allow the authors to distinguish between the types of banks (i.e. commercial banks, investment banks, savings banks, etc) nor between the securitization of banks' assets and liabilities.

3 Description of the data

The data-set used in this study, constructed using Bloomberg and Bankscope, covers the securitization market in the UK during the period 2000 to 2010. This data-set includes annual accounts[4] for 690 UK banks. The (annual) data-set covers commercial banks, real estate and mortgage banks, investment banks, securities firms, investment and trust corporations, specialized governmental credit institutions, Islamic banks, non-banking credit institutions, all types of bank holdings in

[3] These are ratios measuring a bank's financial stability, where, as a general rule, the higher the ratio the better the bank's financial position. A standard capital ratio is:

Total Capital Adequacy Ratio which is defined as Tier 1 Capital plus Tier 2 Capital divided by risk-weighted assets (see section 3.2.2).

[4] Both the consolidated and unconsolidated statements are used to screen the banks on Bankscope.

Only one bank (Investec group) had consolidated statements with no companion, 74 banks had statements of a mother bank integrating the statements of its controlled subsidiaries or branches with no unconsolidated companion, 200 had statements of a mother bank integrating the statements of its controlled subsidiaries or branches with an unconsolidated companion, 456 were banks with statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned bank with no consolidated companion.

the UK, micro-financing institutions, private banking institutions, asset management institutions, retail finance companies, clearing and custody institutions, group finance companies and corporative banks. It is worth of note that 484 banks (70% of the total sample considered) have survived between 2000 to 2010.

Table 1 shows the composition of our data-set (over the period 2000-2010) by specialization:

Table 1: The number of UK banks per specialisation for period 2000 - 2010

This table shows that the number of bank with respect to the classification in a given year. For example there were 41 banks in 2000 and increased to 46 in 2001, 50 commercial banks in 2002, then there are 225 commercial banks. The last column of the table gives the total number of banks per classification. The totals per column give the total number of banks in a given year considering all classifications.

Bank	Year											
Specialization	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Commercial	41	46	50	59	64	72	84	87	102	198	225	225
Real estate & Mortgage	11	11	13	13	14	17	20	25	29	64	82	82
Investment	11	12	14	15	16	16	17	18	23	62	70	70
Securities	9	10	11	12	13	15	18	18	32	64	69	69
Savings	2	2	2	2	2	2	2	2	2	7	7	7
Other classification[5]	33	41	43	49	58	65	74	79	104	190	237	237
Total	107	122	133	150	167	187	215	229	302	595	690	690

The largest single group of banks are commercial banks (225 banks), while savings banks (7 banks) are the smallest group. The other groups of banks are real estate and mortgage banks (82 banks), investment banks (70 banks) and securities firms (69 banks). The remaining 237 banks are all included under other specializations (Islamic banks, cooperative banks, non-banking credit institutions, bank holdings, central banks, micro-financing, private banking and asset management banks, finance companies, specialized governmental credit institutions, and multilateral government banks). A number of commercial banks and securities firms had their last information available for the year 2008, which is, perhaps, an indication of the effect of the financial crisis on the banking sector.

Out of 690 banks in our dataset, 92.61% are foreign banks and only 7.39% are British owned banks. This is due to mergers and consolidation. For example, Northern Rock was one of the banks that was nationalized by the UK Government, while Bradford & Bingley and Alliance & Leicester were acquired by Santander.

3.1 UK bank data

We divide the data-set into two main sub-samples. The first sample contains data for banks that recorded at least one securitization activity during the period 2000-2010. The second group contains data for banks that did not use securitization at all. We note that 527 banks issued securities at least once between 2000 to 2010. Table 2 shows the percentage[6] of banks using securitization. We can

[5] This include the Islamic banks, cooperative banks, non-banking credit institutions, bank holdings, central banks, micro-financing, private banking and asset management banks, finance companies, specialized governmental credit institutions, and multilateral government banks.

[6] The percentage of securitizing banks is computed as the number of securitizing banks at a given time divided by the number of banks considered in the data at the same time

see that the highest percentage of securitization activity was recorded by investment banks; 97% of the total number of investment banks securitized at least once between 2000 and 2010. Commercial banks have the lowest percentage (71%)[7]. The high proportion of real estate and mortgage banks, securities firms, investment banks and even savings banks involved in securitization, suggests that most UK banks have been actively involved in securitization in the last decade. Hence, in the main, UK banks may no longer be deposit takers with a "loan-and-hold" business model but instead have become originators of loans and issuers of securities with an "originate-to-distribute" business model. We shall discuss this issue further in the following sections.

Table 2: The percentage composition of UK banks that securitized for period 2000 - 2010

This table shows the percentage of banks using securitization. The percentage of securitizing banks is computed as the number of securitizing banks at a given time divided by the number of banks considered in the data at the same time. The formula is given as follows

$$\frac{\text{Total number of securitizing commercial banks between 2000 and 2010}}{\text{total number of commercial banks between 2000 and 2010}} * 100\%$$

Bank	Year											
Specialisation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Commercial	27	30	33	36	38	43	50	52	60	132	159	159
	66%	60%	75%	33%	40%	63%	58%	67%	53%	75%	100%	71%
Real state & Mortgage	10	10	11	11	12	14	17	21	23	55	69	69
	91%	0%	50%	0%	100%	67%	100%	80%	50%	91%	78%	84%
Investment	11	12	12	13	14	14	15	16	21	60	68	68
	100%	100%	0%	100%	100%	0	100%	100%	100%	100%	100%	97%
Securities	9	10	10	10	11	12	12	12	23	50	55	55
	100%	100%	0%	0%	100%	50%	0%	0%	79%	84%	100%	80%
Savings	1	1	1	1	1	1	1	1	1	6	6	6
	50%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	86%
Other specializations	28	33	35	38	43	48	55	58	74	130	170	170
	85%	63%	100%	50%	56%	71%	78%	60%	64%	65%	85%	72%
Total	86	96	102	109	119	132	150	160	202	433	527	527
	80%	67%	55%	41%	59%	65%	64%	71%	67%	79%	90%	76%

3.2 Definition of Variables:

The total amount of securitization[8] for each bank is constructed from the reported information in the Bankscope database (which comes from banks' annual accounts) on an annual basis for the period 2000 to 2010.

In the first part of this study, we consider variables which are good proxies for funding (i.e. liquidity risk), regulatory capital arbitrage and credit risk transfer.

For example:
$\frac{\text{Number of securitizing commercial banks in 2000}}{\text{total number of commercial banks in 2000}} = \frac{27}{41} = 66\%$

[7] The total percentage of banks securitizing within the given bank specialisation is calculated as follows
$\frac{\text{Total number of securitizing commercial banks between 2000 and 2010}}{\text{total number of commercial banks between 2000 and 2010}} = \frac{159}{225} = 71\%$

[8] This is the sum of securities (i.e. Asset-Backed Securities (ABSs) and Collateralized Debt Obligations (CDOs)) issued by each bank and is constructed from the reported information in the Bankscope database on an annual basis for the period 2000 to 2010.

We now discuss these proxies in detail.

3.2.1 Funding as motivator for securitization (L_i, $i = 1$ to 6)

Some of the empirical studies cited earlier find that funding (liquidity risk) is an important driver of securitization. We study the effect of six different measures of liquidity on whether banks chose to securitize or not.

Interbank Ratio (L_1): The first proxy for liquidity that we use is the Interbank Ratio. This is defined as the money lent to other banks divided by the money borrowed from other banks (all our proxies are expressed as a percentage). If one views customer deposits as core funding, i.e. a stable source of funds, then a measure of the liquidity risk that banks face is the degree to which banks rely on interbank (i.e. wholesale money-market) funding. The Interbank Ratio is shown in the formula below (money due from banks divided by money due to banks - here, due means the money owed irrespective of whether the time of payment has arrived or not):

$$\text{Interbank Ratio} = \frac{\text{Due from Banks}}{\text{Due to Banks}} \times 100 \tag{L1}$$

An Interbank Ratio greater than 100, means that the bank is a net liquidity provider to the rest of the banking sector i.e. the bank is a net placer rather than a net borrower of funds in the market and therefore it is more liquid. An Interbank Ratio smaller than 100 implies that the bank is a net liquidity buyer. For the largest banks in the world, the average interbank ratio is 74.6% (see table 5). These large banks, in aggregate, are net borrowers from the interbank market, relying on smaller banks, postal savings banks and credit unions, etc., to supply them with the funding necessary to support their loan portfolios.

Liquid Assets/Customer Deposits and Short term funding (L_2): In the second proxy, we consider the ratio of liquid assets to deposits and short term funding. The numerator is computed from all reserve assets (and hence implicitly assumes that all are equally liquid). This ratio can be considered as a deposit run off ratio since it is a proxy for what percentage of customer deposits and short term funding could be met if they were withdrawn suddenly. The higher this ratio, the more liquid the bank is and the less vulnerable it is to a classic run on the bank. The world average ratio is 21% (see table 5).

$$\text{Liquid Assets / Deposits \& Short - term Funding} = \frac{\text{Liquid Assets}}{\text{Customer \& Short - term Funding}} \times 100 \tag{L2}$$

Liquid assets/Total deposits and Borrowing (L_3): This ratio is the total amount of liquid assets available divided by the sum of deposits and borrowing.

Net Loans/Deposits & Short term funding (L_4): The fourth proxy for liquidity is the ratio of net loans to deposits and short term funding. This is often called reserves-to-deposits. In this ratio, all loans are considered equally illiquid (which is clearly a strong assumption). A higher ratio indicates a less liquid bank. The world average of loans to deposits is about 68.5% (see table 5).

$$\text{Net Loans / Deposits \& Short - term Funding} = \frac{\text{Loans}}{\text{Customer \& Short - term Funding}} \times 100 \tag{L4}$$

Net loans/Total Assets (L_5): The ratio of net loans to total assets indicates what percentage of the assets of the bank are tied up in loans. The higher the ratio the less liquid the bank is.

Net Loans/ Total deposits and Borrowing (L_6): This is a similar ratio to the previous one. The main difference is that the denominator is now replaced by total deposits and borrowing.

$$\frac{\text{Loans}}{\text{Customer \& S.T. funding} + \text{Other funding - total liability \& equity - subordinate debt}} \times 100\% \tag{L6}$$

3.2.2 Regulatory Capital Arbitrage (C_j, $j = 1$ to 7)

The second group of variables that we consider (a total of seven) are proxies for regulatory capital arbitrage.

Capital funds/Customer deposits and S.T. Funding (C_1): Capital funds are defined as the sum of equity capital, hybrid capital and long-term subordinated debt. The ratio of capital funds to customer and short term funding is defined as below.

$$\frac{\text{Equity} + \text{Hybrid capital} + \text{subordinate debt}}{\text{Customer funding \& S.T. funding}} \times 100\% \tag{C1}$$

Capital funds/Net loans (C_2): We also consider the ratio of capital funds to net loans. The ratio is given by:

$$\frac{\text{Equity} + \text{Hybrid capital} + \text{subordinate debt}}{\text{Net Loans}} \times 100\% \tag{C2}$$

Capital Funds/Total Assets (C_3): This ratio is a measure of the general financial soundness of the capital structure. The higher the ratio, the better is the solvency position of the bank.

$$\text{Cap Funds / Total Assets} = \frac{(\text{Equity} + \text{Hybrid capital} + \text{Subordinated debt}}{\text{Total liability} + \text{Equity}} \times 100 \tag{C3}$$

Equity/Liabilities (C_4): This leverage ratio is simply another way of looking at the equity funding of the balance sheet and is an alternative measure of capital adequacy.

$$\frac{\text{Equity}}{\text{Total liability \& Equity - Hybrid capital - subordinate debt}} \times 100\% \tag{C4}$$

Equity/Total Assets (C_5): The equity to total assets ratio measures the amount of equity protection that a bank has in place against loan impairment. The higher this ratio, the more protection the bank has. The ratio is computed as:

$$\text{Equity / Total Assets} = \frac{\text{Equity}}{\text{Total Liability \& Equity}} \times 100 \tag{C5}$$

Tier 1 ratio (C_6): Tier 1 ratio measures shareholder funds plus perpetual non cumulative preference shares as a percentage of risk weighted assets and off balance sheet risks as measured under the Basel rules. This should be at least 4%.[9]. Tier I Capital is the actual contributed equity plus retained earnings. It is used to describe the capital adequacy of a bank (it is its core capital). Generally, shareholders' equity and retained earnings are referred to as "Core" Tier 1 capital [10]. This ratio is given by:

$$\text{Tier 1 Capital / Risk - weighted Assets} = \frac{\text{Tier 1 Capital}}{\text{Risk - weighted Assets}} \times 100 \tag{C6}$$

Total Capital Adequacy Ratio (C_7): The final variable that we consider is the Total Capital Adequacy Ratio. This is the sum of Tier 1 + Tier 2 capital divided by risk weighted assets[11]. (expressed as a percentage). Under the Basel II and III frameworks, this ratio should be at least 8%. It is calculated internally by the bank in question. The Total Capital Adequacy Ratio is a measure of the amount of a bank's core capital expressed as a percentage of its assets weighted by its credit exposure and is calculated as:

[9] The Basel I agreement stipulated that Tier 1 capital should be a minimum of 4% although anecdotal evidence suggests that most investors will generally require a ratio of 10% or more in the aftermath of the financial crisis. The proposal in Basel III will increase Tier 1 capital during the January 2015 phase, from 4% to 6%.

[10] This include: common stockholders' equity, perpetual preferred stock, redeemable securities of subsidiary trusts, accumulated net gains on cash flow hedges, intangible assets, goodwill, other disallowed intangible assets, investment in certain subsidiaries among others

[11] Risk-weighted assets are a bank's assets weighted according to credit risk. Some assets, such as debentures, are assigned a higher risk than others such as government bonds. Banks' assets are classified and grouped in five categories according to credit risk, carrying risk weights of zero (for example, home country sovereign debt), twenty, fifty, eighty and up to one hundred percent (the latter category has, for example, most corporate debt). Banks with an international presence are required to hold capital equal to 8% of risk-weighted assets.

$$\text{CAR} = \frac{\text{Tier 1 capital} + \text{Tier 2 capital}}{\text{Risk - weighted assets}} \tag{C7}$$

3.2.3 Credit risk transfer (R_k, $k = 1$ to 6))

Credit risk is the risk that a counter-party will default or delay payment on an obligation or that the value of a flow of payments will decline due to an adverse movement in the counter-party's credit rating. Securitization offers banks the opportunity to transfer credit risk to third parties. We consider six credit risk ratios.

Impaired (doubtful) loans/Equity (R_1): These are loans that may not be recovered and are not covered by equity. This indicates the weakness of the loan portfolio relative to the bank's capital. The higher this percentage, the worse is the bank's position.

Non-performing Loans/Gross Loans (R_2): This ratio is a measure of the amount of total loans which are doubtful. The lower the ratio, the better the quality of the assets.

$$\text{Non performing loans/Gross loans} = \frac{\text{Non performing loans}}{\text{Gross loans}} \times 100 \tag{R2}$$

Loan loss /Net interest (R_3): This ratio shows the relationship between the loan loss and the net interest income over the same period.

Loan Loss Reserve/Gross Loans (R_4): The fourth ratio we consider is the loan loss reserve to gross loans. This ratio indicates how much of the total portfolio has been provided for but not charged off. It is a reserve for losses expressed as percentage of total loans. The higher the ratio, the poorer the quality of the loan portfolio.

$$\text{Loan Loss Reserve / Gross Loans} = \frac{\text{Loan Loss Reserve}}{\text{/ Gross Loans}} \times 100 \tag{R4}$$

Unreserved Impaired (doubtful) Loans/ Equity (R_5): These are loans that may not be recovered and are not covered by reserves. It shows what percentage of the bank's capital would be written off if the accumulated impairment reserves were 100% of impaired loans and how vulnerable a bank's capital ratio would be as a result.

Net Charge-offs/ Average Gross Loans (R_6): We define a charge-off as a debt that has been determined uncollectible by the original creditor, usually after the debtor has become seriously delinquent. Charge-offs often occur after six months of non-payment.

$$\text{Net Charge Offs/Average Loans} = \frac{\text{Year - to - Date Charge Offs - Year - to - Date Recoveries}}{\text{Year - to - Date Average Loans}} \times 100\% \tag{R6}$$

The net charge-off to average loans ratio indicates what percentage of the loan portfolio has been cancelled by the balance sheet as it is considered definitely not recoverable. The lower the ratio, the better is the bank's position.

3.2.4 The control variables

For control purposes, we also include a general characteristic of the originating entity in the analysis as an additional regressor, namely the size of the bank. We analyze the impact of bank size, which we measure as the natural logarithm of the bank's total assets.

3.3 The model

In this section we describe the model used in the first part of the paper. Consider the following Cumulative Distribution Function (CDF) for a Logit model:

$$\Pr(Y_i = 1 \mid L_i, C_j, R_k, \alpha, \beta_i\ , \gamma_j\ , \delta_k\ ) = \frac{\exp(\alpha + \sum_{i=1}^{6} \beta_i\ L_{i,t-1} + \sum_{j=1}^{7} \gamma_j\ C_{j,t-1} + \sum_{k=1}^{6} \delta_k\ R_{k,t-1})}{1 + \exp(\alpha + \sum_{i=1}^{6} \beta_i\ L_{i,t-1} + \sum_{j=1}^{7} \gamma_j\ C_{j,t-1} + \sum_{k=1}^{6} \delta_k\ R_{k,t-1})} \tag{1}$$

where if bank i, $i = 1, 2..., N$ securitized over the period under consideration, $Y_i = 1$, otherwise $Y_i = 0$.

We let $L_{i,t-1}$ denote the funding ratios, $C_{j,t-1}$ denote the regulatory capital ratios and $R_{k,t-1}$ denote the credit risk transfer ratios described above.

The general model we estimate can be written as:

$$Y_{i,t} = \alpha + \sum_{i=1}^{6} \beta_i\ L_{i,t-1} + \sum_{j=1}^{7} \gamma_j\ C_{j,t-1} + \sum_{k=1}^{6} \delta_k\ R_{k,t-1} \tag{2}$$

In the above equation, all explanatory variable are lagged one period to avoid potential problems of endogeneity. The relationship between the dependent variable Y_i and the probability p that a bank records a securitization activity over a period of one year is given by:

$$p = \Pr(Y_i = 1 \mid L_i, C_j, R_k, \alpha, \beta_i\ , \gamma_j\ , \delta_k\ ) = \frac{e^{Y_i}}{1 + e^{Y_i}} = \frac{1}{1 + e^{-Y_i}}. \tag{3}$$

Table 3 below shows the expected signs for the explanatory variables in the model above. We expect that the first three ratios measuring liquidity (interbank ratio, liquid assets to deposits and short term funding and liquid assets to total deposits and borrowing) should make a negative contribution to the probability of securitization while we expect that the remaining three ratios should make a positive contribution. The regulatory capital ratios are all expected to be negative while the credit risk transfer ratios and the control variable representing banks size are all expected to be positive.

Table 3: Expected sign for the model

In this table, we have the expected signs of the explanatory variables. (+) implies the positive contribution of the variable to the securitization process while (-) implies negative contribution

Variable	Expected sign
Funding	
Interbank ratio	(-)
Liquid assets/Customer deposits & ST funding	(-)
Liquid assets/Total deposits & borrowing	(-)
Net loans/Deposits & ST funding	(+)
Net loans /Total assets	(+)
Net loans/Total deposits & Borrowing	(+)
Capital regulation	
Cap.Funds/Deposits & ST funding	(-)
Cap.Funds/Net loans	(-)
Cap. Funds / Total assets	(-)
Equity/Liabilities	(-)
Equity/Total assets	(-)
Tier 1 Ratio	(-)
Total capital ratio	(-)
Risk transfer	
Impaired loans/Equity	(+)
Impaired loans/ Gross loans	(+)
Loan loss prov. / Net int.Rev	(+)
Loan loss Res. / Gross loans	(+)
Unreserved impaired loans /Equity	(+)
Net charge-off/Average Gross loans	(+)
Size	
Log total assets	(+)

4 Results

4.1 Descriptive statistics

We start with some descriptive statistics of our sample of UK banks (there are 690 banks in total) which we split into two sub-samples: banks that securitized at least once during the period 2000 to 2010 (a total of 527 banks - see Table 4a) and those that did not participate in securitization at all during the period 2000 to 2010 (consisting of 163 banks - see Table 4b).

We make some general observations. We note that the Interbank Ratio (L_1) is lower in banks that did not securitize their assets (42.2% for non securitizing banks against 73.6% for securitizing). The Interbank Ratio for both samples are significantly less than 100. Hence, UK banks, in aggregate, are net liquidity buyers. We may be able to interpret this result as tentative evidence that banks turn to securitization as a source of funds.

The mean percentage of liquid assets to deposits and short term funding (L_2) is 53.9% for banks that are involved in securitization compared to 59.7% for those that did not securitize. This may suggest that UK banks are, generally, highly liquid (the ratios are higher than the world average ratio, 21%-see table 5)[12]. The ratio is lower for banks that used securitization. The other liquidity ratios (net loans to deposits and short-term funding) give similar results. Again, these results may tentatively suggest that UK banks are using securitization to raise funds. It is also important to note that the ratios for both groups of banks are less than the world ratio (68.5%) which would confirm the high liquidity of UK banks in comparison to the world average.

We now consider the credit risk transfer ratios. We start with the loan loss reserve to gross loans (R_4). This ratio is 5.1% for banks that use securitization compared with 1% for banks that do not use it. The world average (see Table 5) is 2%. This may indicate that the quality of loans issued by UK banks that securitize are not, in general, of good quality, and thus banks may resort to securitization in order to transfer credit risk.

The non-performing loans to the gross loans ratio (R_2) is 5% for banks that use securitization versus 0.38% for banks that did not use it. Again, this result may suggest that securitization is used as a way to transfer credit risk. Banks that did not securitize have a lower ratio which may imply that their assets are of higher quality.

Finally, we consider the regulatory capital ratios. Banks that use securitization (see table 4 (a)) have, on average, a lower Total Capital Adequacy Ratio (C_7) than those that do not (see table 4 (b)) use it (3.8% against 4.6%). It is also important to note that in both cases, the ratio is significantly lower than the minimum 8% expected under Basel II. Both the two groups (i.e. banks that use securitization and those that do not use) have lower Tier 1 ratio (C_6) than the required Basel II's minimum requirement of 4%. We note that under Basel III the Tier 1 ratio is expected to be 6%.

The equity to total asset ratio (C_5) is lower for banks that use securitization than banks that do not use it (22% versus 29%). Thus, banks using securitization seem to have a lower cushion or protection than banks that do not use it.

Banks which use securitization are, on average, larger (7.6 against 5.4) than those which do not. In the Appendix, we repeat the statistical analysis after accounting for outliers. The results are very similar indicating that our results are robust to outliers.

[12] Table 5 shows the world averages values of ratios available in Bank-scope. 30,052 banks have been used from north America, Asia, Eastern Europe, Western Europe, Middle East, Africa, Oceania.

Table 4 (a): Descriptive statistics, banks using securitization, with N=527

	Mean	Std.Dev	Skewnesss	Kurtosis
Funding				
Interbank ratio	73.56	153.07	3.17	14.27
Liquid assets/Customer deposits & ST funding	53.85	118.47	5.36	35.30
Liquid assets/Total deposits & borrowing	42.27	101.04	5.73	41.04
Net loans/Deposits & ST funding	51.75	84.35	5.11	39.19
Net loans /Total assets	33.01	32.56	0.49	1.75
Net loans/Total deposits & Borrowing	33.08	49.63	5.36	66.33
Capital regulation				
Cap.Funds/Deposits & ST funding	19.29	80.40	6.39	44.19
Cap.Funds/Net loans	23.79	77.02	6.79	60.73
Cap. Funds / Total assets	8.13	16.91	3.59	17.04
Equity/Liabilities	55.58	142.93	3.60	16.54
Equity/Total assets	22.07	34.01	1.11	25.59
Tier 1 Ratio	2.48	6.53	3.53	18.42
Total capital ratio	3.82	12.71	11.39	190.29
Risk transfer				
Impaired loans/Equity	10.35	38.36	7.65	82.08
Impaired loans/ Gross loans	1.27	5.28	11.37	177.31
Loan loss prov. / Net int.Rev	16.39	58.00	1.20	61.89
Loan loss Res. / Gross loans	1.39	5.07	8.58	92.93
Unreserved impaired loans /Equity	5.14	19.69	7.09	72.88
Net charge-off/Average Gross loans	0.18	0.88	8.54	91.64
Size				
Log total assets	7.66	2.49	0.48	3.28

We have the descriptive statistics of the explanatory variables for number of securitizing banks, N=527.

Table 4 (b): Descriptive statistics, banks not using securitization				
We have the descriptive statistics of the explanatory variables for number of securitizing banks, N=163.				
	Mean	Std.Dev	Skewnesss	Kurtosis
Funding				
Interbank ratio	42.23	145.11	4.36	23.23
Liquid assets/Customer deposits & ST funding	59.68	115.38	4.33	26.49
Liquid assets/Total deposits & borrowing	27.04	53.23	3.13	17.37
Net loans/Deposits & ST funding	5.74	30.34	3.16	29.74
Net loans /Total assets	1.00	3.19	4.52	26.32
Net loans/Total deposits & Borrowing	5.96	28.70	5.71	38.93
Capital regulation				
Cap.Funds/Deposits & ST funding	10.52	63.60	10.84	130.06
Cap.Funds/Net loans	25.31	99.40	6.49	50.35
Cap. Funds / Total assets	4.94	13.36	4.71	27.59
Equity/Liabilities	52.18	115.88	3.17	13.19
Equity/Total assets	29.04	34.13	0.87	2.68
Tier 1 Ratio	1.01	8.66	11.86	151.95
Total capital ratio	4.58	45.31	12.86	171.49
Risk transfer				
Impaired loans/Equity	1.53	11.88	10.52	123.67
Impaired loans/ Gross loans	0.38	2.25	6.71	49.73
Loan loss prov. / Net int.Rev	5.74	30.34	3.16	29.75
Loan loss Res. / Gross loans	1.00	3.19	4.52	26.32
Unreserved impaired loans /Equity	4.62	59.82	13.56	185.16
Net charge-off/Average Gross loans	0.39	2.55	8.04	72.67
Size				
Log total assets	5.46	2.32	0.36	2.72

Table 5: World average values for the ratios (Bankscope)

Variable	China	Japan	Rest of Asia	Europe	North America	Australia	World average
Asset quality							
Loan loss reserve/Gross loans	1.70	2.20	1.90	2.20	1.40	0.90	2.00
Loan loss reserve/Impaired loans	11.00	64.60	112.80	77.80	185.00	255.90	70.00
Impaired loans/Gross loans	15.50	3.40	1.70	2.80	0.80	0.40	2.90
Loan loss provisions/Net interest revenue	23.70	52.20	25.10	13.80	9.20	7.30	16.20
Capital adequacy							
Basel Tier 1 capital/Risk assets	8.50	5.80	8.60	8.20	9.70	7.30	8.10
Basel total capital/ Risk assets	10.10	11.10	11.90	11.60	13.40	10.20	11.80
Equity/Total assets	3.80	4.00	7.60	4.10	8.20	7.30	5.00
Profitability and efficiency							
Return on average assets	0.40	0.20	1.00	0.50	1.10	0.90	0.60
Return on average equity	11.60	4.60	12.60	12.00	13.60	12.90	11.80
Net interest margin	2.20	1.00	2.90	1.30	2.90	2.30	1.70
Expense ratio	45.10	54.10	51.50	63.70	63.80	56.70	61.20
Liquidity							
Interbank ratio	205.10	98.10	196.10	76.40	46.50	85.20	74.60
Net loans/Deposits and Short term funding	65.30	62.10	74.80	68.40	70.00	100.60	68.50
Liquid assets/Deposits and short term funding	10.50	8.80	22.70	23.50	27.50	8.90	21.00

4.2 Analysis of multicollinearity

In order to ensure that or results are not contaminated by multicollinearity, we use a very simple test - the Variance Inflation Factor[13] The results (reported in Table A3 in the Appendix) confirm that multicollinearity is not a serious problem in our model.

4.3 Empirical Results

We employ the model described in equation (2) to shed some light on why UK banks have used securitization. Despite the fact that understanding why banks have used securitization is an important policy issue (see discussions in sections 2 and 5), there have been few empirical studies in this area and the two similar studies that we are aware of (Affinito et al (2008) and Cardone-Riportella et al (2010)) are limited in their applicability (the first by using data from the Italian markets and the second by only covering the pre-financial crisis period). Hence, it is not easy to compare and contrast the results we report in this paper.

We start the empirical analysis by fitting the model in Equation (1) using a Logit model. Five out of the six liquidity ratios are statistically significant and generally with the expected sign. The Interbank Ratio (L_1) and the liquid assets to customer deposits and short term funding (L_2) are statistically significant (at 5% and at 10%) and have the expected sign. Net loans to deposits and short term funding (L_4) is significant (at 10%) with the expected sign. Net loans to total assets

[13] We have also looked at the matrix of correlations (see the appendix) but there was no strong evidence of high dependence amongst the variables in the model.

(L_5) and net loans to total deposits and borrowing (L_6) are statistically significant but do not have the expected sign.

We now turn to the regulatory capital ratios. The Tier 1 ratio (C_6) and the Total Capital Adequacy Ratio (C_7) are significant and both have the expected sign. Size is statistically significant in each case.

Table 6: Logit Models;
where * represents significance at 1%; **significance at 5%; and ***significance at 10%.

	Coefficient	Probability
Funding		
Interbank ratio	-0.922	0.03**
Liquid assets/Customer deposits & ST funding	-0.002	0.02**
Liquid assets/Total deposits & borrowing	0.001	0.54
Net loans/Deposits & ST funding	0.002	0.09***
Net loans /Total assets	-0.071	0.09***
Net loans/Total deposits & Borrowing	-0.778	0.04***
Capital regulation		
Cap.Funds/Deposits & ST funding	-0.001	0.20
Cap.Funds/Net loans	-0.002	0.12
Cap. Funds / Total assets	0.017	0.11
Equity/Liabilities	-0.005	0.58
Equity/Total assets	0.002	0.36
Tier 1 Ratio	-1.161	0.03**
Total capital ratio	-0.225	0.01*
Risk transfer		
Impaired loans/Equity	0.53	0.21
Impaired loans/ Gross loans	0.01	0.33
Loan loss prov. / Net int.Rev	0.07	0.46
Loan loss Res. / Gross loans	0.04	0.15
Unreserved impaired loans /Equity	0.02	0.58
Net charge-off/Average Gross loans	0.00	0.28
Size		
Log total assets	0.73	0.01*

*significance at 1%; **significance at 5%;***significance at 10%.

The Logit model suggests that liquidity is the most important driver of securitization in the UK while it provides weaker evidence that UK banks have used securitization for regulatory capital arbitrage and no evidence that they have used it for credit risk transfer.

Overall the results in Table 6, using the Logit model, confirm our expectations (see table 3). We expect a higher probability that a bank will securitize when the Interbank Ratio is lower or when the size of the loans issued by the bank are large relative to the bank's deposits and short-term funding (i.e. the bank is less liquid). To further check these results we now use a Binary Probit model. Results are reported in Table 6, left-hand-side panel.

Overall, the Binary Probit model is supportive of the hypothesis that liquidity is an important factor. Three of the liquidity ratios are significant (at 10%) and all have the expected sign.

However, there is now evidence that regulatory capital arbitrage and credit risk transfer cannot be neglected. Four out of the seven regulatory capital arbitrage ratios are now significant (and all four have the expected sign) and two of those are significant at 5%. Four out of the six credit risk transfer ratios are now significant (and all four have the expected sign) and two of those are significant at 1%.

4.4 Results using ABS and CDO data

In this section we refine our definition of securitization and split the data by separately considering ABSs and CDOs. Limited somewhat by data availability, we now use data for 231 banks issuing ABSs and for 335 banks issuing CDOs. Cardone-Riportella et al (2010) remark that since CDOs are related to the banks' portfolio of liabilities, credit risk transfer should not to be a motivating factor for these securities while it should be an important factor for ABSs[14].

The ABS and CDO markets in the UK both grew substantially in the five years prior to 2008 to become amongst the largest in the world which merits our investigation into its causes. We follow broadly the same approach as in the previous section. However, we now use fewer variables (four as proxies for liquidity, four as proxies for regulatory capital arbitrage and three as proxies for credit risk transfer) - mainly to reflect the availability of data.

Firstly, we consider ABSs for which our data-set consists of 231 banks for the period 2004-2010.

Table 7 shows the empirical results. We, initially, discuss the results of the Logit model. When we split the data down the ABS and CDO dimensions, it seems that the need for funding is still a significant factor but the Interbank Ratio (L_1) is no longer significant and two of the three ratios which generate significant coefficients do not have the expected sign.

Turning to the regulatory capital ratios, the Tier 1 ratio (C_6) and the Total Capital Adequacy Ratio (C_7) are significant at 5% and both have the expected sign.

The Binary Probit model shows qualitatively similar results but the Interbank Ratio is now highly significant. The credit risk transfer ratios are insignificant for the Logit model but two out of three are significant (Impaired Loans/Equity (R_1) at 10% (but not with the expected sign) and Loan Loss reserve/ Gross Loans (R_4) at 5%) when the Probit model is used. Overall, there is evidence that credit risk transfer seems also to be a motivating factor for the growth of the market for ABSs in the UK.

[14] However, we believe that this remark is too strong. In fact, CDOs, especially synthetic CDOs, are also used as credit risk transfer vehicles.

Table 7: ABS Market.

where * significance at 1%; **significance at 5%;***significance at 10%.

N=231

Funding	Coefficient	Probability
Interbank ratio	-0.045	0.52
Liquid assets/Customer deposits & ST funding	-0.018	0.10***
Net loans/Deposits & ST funding	-0.012	0.02**
Net loans /Total assets	-0.016	0.09***
Capital regulation		
Cap.Funds/Net loans	-0.019	0.49
Equity/Total assets	0.039	0.48
Tier 1 Ratio	-0.102	0.03**
Total capital ratio	-0.039	0.02**
Risk transfer		
Impaired loans/Equity	-0.016	0.89
Impaired loans/ Gross loans	-0.098	0.90
Loan loss Res. / Gross loans	-0.168	0.57
Size		
Log total assets	0.147	0.07

Secondly, we consider CDOs for which our data-set consists of 335 banks covering the period 2004-2010. Table 8 shows the empirical results. We, initially, discuss the Logit model. Although funding seems, once again, to be an important driver of CDO growth in the UK, regulatory capital arbitrage seems also important in understanding the growth of these financial securities. Two out of four regulatory capital ratios are statistically significant (Capital funds/Net loans (at 5%) and Tier 1 ratio (at 10%)) but only one of these is correctly signed (Tier 1 ratio). The Binary Probit model reinforces the previous results. Thus, although the search for cheap funding seems to be relevant, the growth of CDOs in the UK may have also been driven by regulatory capital arbitrage. This is an important and new result with possible policy implications for governments and regulators. Credit risk transfer seems to be less important for the large expansion of the issuance of these securities in the UK.

The size of the bank seems to be a determinant factor to explain the growth of securitization in the UK regardless of the methodology used. This is also a noteworthy result. To put it another way, large banks (perhaps, too-big-to-fail or the so-called G-SIFIs (Global Systemically Important Financial Institutions)) are more likely to securitize - and this remark applies to ABSs and (even more to) CDOs.

Summarizing the empirical results reported above, we conclude that i) the search for funding is the predominant reason why UK banks used the securitization market (this result is also in line with theoretical models such as DeMarzo and Duffie (1999) and DeMarzo (2005)) and ii) regulatory capital arbitrage and credit risk transfer have also played an important role and therefore these factors cannot be neglected. The latter result contrasts with Cardone-Riportella et al (2010) who find that the search for funding drives securitization.

Table 8: CDO		
where *significance at 1%; **significance at 5%;***significance at 10%.		
Funding	Coefficient	Probability
Interbank ratio	-0.017	0.044**
Liquid assets/Customer deposits & ST funding	-0.002	0.104***
Net loans/Deposits & ST funding	0.015	0.616
Net loans /Total assets	-0.013	0.090
Capital regulation		
Cap.Funds/Net loans	0.011	0.025
Equity/Total assets	0.039	0.782
Tier 1 Ratio	-0.067	0.032
Total capital ratio	-0.012	0.119
Risk transfer		
Impaired loans/Equity	0.087	0.093
Impaired loans/ Gross loans	0.039	0.541
Loan loss Res. / Gross loans	-0.021	0.516
Size		
Log total assets	0.012	0.101***

4.5 The Effect of the originate-to-distribute Model (OTD) on Banks' Defaults

Although the search for liquidity funds may have been a strong factor driving securitization, UK banks have also used the securitization market to transfer credit risk and therefore for risk management purposes. However, at the onset of the financial crisis in the summer of 2007, the securitization market suddenly became frozen and therefore banks were unable to further securitize their assets. This would have left them with considerable credit risk that they were unable to transfer to third parties - at exactly the time that banks were facing dramatically increased funding and credit risks (Purnanandam (2011)). In order to investigate this important issue and estimate the effect of the OTD model on banks' ABS and CDO annualised default rates we follow Purnanandam (2011) (who investigated mortgage lending and the OTD model in the US) and use the following bank fixed-effects model:

$$default_{it} = \mu_i + \eta_1 \text{after}_t + \eta_2 \text{after}_t * \text{preotd}_i + \sum_{k=1}^{k=K} \theta_k X_{it} + \epsilon_{it} \tag{4}$$

The dependent variable in equation (4) above measures the default rate of the portfolio of bank i in year t. We use net charge-offs (net of recoveries) as a proxy for the default rate[15]. The intercept μ_i is the bank fixed effect, while X_{it} is a vector of bank characteristics[16]. The OTD participation of bank i at time t is measured by the volume of CDOs (or ABSs) originated by a bank each year between 2004 to 2010 scaled by the bank's position in CDOs (or ABSs) at the beginning of the year.

[15] Due to data limitation we cannot use non-performing assets. Net charge-off indicates the percentage of the asset issued by the bank that may have been finally written off the book. Thus it is an appropriate proxy for the default rate.

[16] Note that for all the empirical results we present in this section, we only use those variables which have been found statistically significant in all the models investigated earlier.

The variable $preotd_i$ is a time invariant variable measuring the extent of the bank's participation in the Originate-to-distribute (OTD) market. This is measured by the time-averaged value of the OTD ratio for every bank i until 2007. The variable $after_t$ is a dummy variable taking the value one in the period after the financial crisis began and zero otherwise. Thus, the coefficient on this variable captures the time trend in default rate before and after the financial crisis[17] The coefficient on the interaction term (i.e., $after_t * preotd_i$) measures the change in net charge-offs around the crisis period across banks with varying intensities of participation in the OTD market prior to the crisis. Thus, η_2 measures the change in default rate for banks that originated loans primarily to sell them to third parties, as compared with the corresponding change for banks that originated loans primarily to retain them on their own balance sheets.

4.5.1 Empirical Results

Table 9(a) and 9(b) present the empirical results of the model in equation (4).

Table 9(a): Default rate for ABS issued 2004 -2010
*significance at 1%; **significance at 5%;***significance at 10%.

	Coefficient	Probability
η_1	0.14	0.011*
η_2	0.58	0.096
Funding		
Interbank ratio	0.26	0.013**
Net loans /Total assets	0.42	0.002*
Capital regulation		
Cap.Funds/Net loans	0.40	0.180
Tier 1 Ratio	0.22	0.004*
Risk transfer		
Impaired loans/Equity	0.02	0.050**
Impaired loans/ Gross loans	0.01	0.847
Size		
Log total assets	0.03	0.045**

[17] We consider the period 2004 to 2007 (respectively, 2008 to 2010) as the period before (respectively, after) the financial crisis.

Table 9(b): Default rate for CDOs issued period 2004 - 2010 *significance at 1%; **significance at 5%;***significance at 10%.		
	Coefficient	Probability
η_1	0.03	0.002*
η_2	0.01	0.088***
Funding		
Interbank ratio	0.26	0.003*
Net loans /Total assets	0.00	0.870
Capital regulation		
Cap.Funds/Net loans	0.40	0.003*
Tier 1 Ratio	0.22	0.001*
Risk transfer		
Impaired loans/Equity	-0.02	0.084***
Impaired loans/ Gross loans	-0.08	0.014**
Size		
Log total assets	0.01	0.059***

We note that η_1 is significant at 1% both in the case of ABSs and CDOs. This confirms the obvious in telling us that the financial crisis has been a contributing factor in the increase in default rates suffered by UK banks. η_2 is also statistically significant and positive. This means that the banks that were using an OTD model before the financial crisis, were the ones to suffer the most from defaults after the financial crisis. We attribute this to the fact that the market for ABSs was frozen abruptly in the summer of 2007 and hence banks were unable to sell off their securitized loans and suffered the consequences. It is important to remark the high statistical significance of the coefficent η_2 and that it is not explained away by the other variables which we have included. These results are in line with Purnanandam (2011) who investigated the effects of the OTD model on mortgage lending in the US. We note that the η_2 coefficient is much larger for ABSs (0.5778) compared to CDOs (0.0142). This indicates that banks had a much larger proportion of ABSs written off after the financial crisis (compared to CDOs).

The results in Table 9(a) and 9(b) seem to question the OTD model as a valid risk-management model[18]. However, if the significant trend in banks' defaults in Tables 9(a) and 9(b) is the consequence of using the OTD model, one would not observe it if the same analysis was conducted on banks which did not use securitization at all. In Table 9(c) we consider precisely these banks[19].

[18] Purnanandam (2011) shows that banks using the OTD model have less incentive to screen clients to whom they issues mortgages and therefore banks, at the start of financial crisis, found their balance-sheets overloaded with poor quality securities which they were not able to sell.

[19] The banks in this sample include United National Bank, Catholic Building Society, NBG International, Northern Bank Limited, Having Bank Limited, Bath Investment and Building Society, Bank of New York (Mellon) and Southern Pacific Mortgage Limited.

Table 9(c): Default rate for Non-securitizing banks, period 2004 - 2010 *significance at 1%; **significance at 5%;***significance at 10%.		
	Coefficient	Probability
η_1	0.21	0.0117*
Funding		
Interbank ratio	0.02	0.0233*
Net loans /Total assets	0.04	0.1826
Capital regulation		
Cap.Funds/Net loans	1.15	0.2216
Tier 1 Ratio	1.09	0.5315
Risk transfer		
Impaired loans/Equity	-0.05	0.0795***
Impaired loans/ Gross loans	-0.03	0.2504
Size		
Log total assets	0.01	0.0028***
Adjusted R^2	0.8039	

The results are in line with those in Table 9(a) and 9(b). None of the variables capturing regulatory capital arbitrage is now significant while some of those for liquidity and credit risk transfer are. It is important to note that η_1 is still highly significant and the size of the coefficient is even larger than before. This implies that there is a significant increasing trend in default rates even for banks which did not use securitization. This may suggest that the significant increase in default rates for these banks during the financial crisis may have been the consequence of lack of liquidity and/or poor risk management. Taken together, our results suggest that banks which issued ABSs before the financial crisis suffered more defaults after the financial crisis but banks which issued CDOs fared no worse than banks which did not use securitization. In short, all banks may have suffered the consequences of poor risk management but those issuing ABSs fared the worst.

4.6 Profitability of UK banks that securitized

Jiangli et al (2008) consider securitization in the US and concluded that there is weak evidence that banks relying on the OTD model were more profitable than others. We conduct the same analysis for UK banks but consider both asset (ABSs) and liability (CDOs) securitization. Is the OTD model a profitable business model for UK banks? Securitization can increase banks' profits simply by giving banks more options to manage the risk of their balance sheets. It can also reduce banks' profitability if it leads to more competition. The net effect of securitization on banks' profits is therefore ambiguous and we seek to shed some light on it.

We split banks into two groups - the first group consists of commercial and savings banks and the second group consists of investment and real estate banks. We consider the following linear model for a measure of profitability, Rate of Return on Operating Assets (RROA). This model is based on the empirical model of Wheelock et al (2001) for bank insolvency risk and Jiangli et al (2008) for securitization in the US:

$$RROA_{it} = \phi_i + \sum_{s=1}^{4} \varphi_{is} M_{is} + \lambda \sum_{g=1}^{2} \omega_{is} G_{ig} \tag{5}$$

where $RROA_{it}$ is the profitability ratio Rate of Return on Operating Assets for bank i at a given year t, M_{is}, $s = 1,2,3,4$, are measures of securitization considered in the study (ABSs and CDOs issued, total assets and Loans) and G_{ig}, $g = 1,2$, represents the group classification of the banks that securitized and where the parameter λ takes the value 1 for the group of commercial and savings banks and 0 for the group of investment and real estate banks.

We start with the results presented in the first four rows of Table 10 (which do not differentiate between the type of bank but, instead, differentiate on whether the bank securitized or not). The results in Table 10 indicate that large banks (with high total assets) are the ones for which securitization is more important to explain profits[20]. This may also reflect economies of scale that large banks can realise via securitization . Note, further, that all the coefficients, on the variables used, are statistically significant and carry the correct sign.

We now turn to the lower panel of Table 10 where we divide our sample into commercial and savings banks and investment and real estate banks. The idea is to see how securitization has impacted on the profitability of these two different group of banks. The size of the coefficients is generally larger for commercial and savings banks as opposed to investment and real estate banks. This result may suggest that commercial and savings banks were more exposed to the securitization market than investment and real estate banks (i.e. their balance sheets were more sensitive to changes in the conditions of the securitization market). Therefore, while investment banks were the ones for which securitization was more important to explain profits, commercial and savings banks are the ones more exposed to price fluctuations in this market[21] - and, of course, the price fluctuations were greatest during the financial crisis.

Table 10: Profitability of UK banks 2004 -2010

*, **, and *** are coefficient significance at 1%, 5% and 10%.

	Securitizing banks		Non securitizing banks	
Variable	Coefficient	Probability	Coefficient	Probability
abs	0.03	0.004*		
cdo	0.22	0.002*		
loans	0.64	0.011*	0.02	0.008*
total assets	0.51	0.003*	0.01	0.001*
Adjusted R^2	0.57		0.54	

Variable	Coefficient	Probability	Coefficient	Probability
abs	0.42	0.003*	0.02	0.001*
cdo	0.50	0.001*	0.49	0.002*
loans	0.20	0.003*	0.00	0.004*
total assets	072	0.001*	0.69	0.001*
Adjusted R^2	0.59		0.56	

[20] Note that the R-squared for the two groups is very close. However, it becomes much larger when banks are divided into two sub-groups (i.e. commercial and savings vs investment and real estate).

[21] To account for endogeneity between bank's profitability and securitization, we have also repeated the empirical exercise in Table 10 using GMM but results were qualitatively unchanged.

5 Policy Relevance of our Results

Given that central banks can be expected to continue accepting ABSs as collateral in their funding operations for the foreseeable future, our empirical findings have potentially significant policy implications for regulators and central banks.

The key result we observed is that liquidity is the most important driver of securitization for UK banks, ahead of regulatory capital arbitrage and credit risk transfer. This is not to underestimate the motivating influence of the latter two factors, but it does put into perspective the value of securitization as a funding tool in the financial markets. The other key result we noted was the higher probability that a bank will securitize when its interbank ratio is lower (that is, when it is a net borrower from the interbank market).

In the first instance we conclude that securitization will remain an important technique for funding purposes. The emphasis on bank funding models in the post-2008 environment is for a reduced reliance on unsecured short-term wholesale funding, and greater reliance on customer deposits and secured long-term wholesale funds. It is reasonable to expect that securitization markets will form part of the latter, either in the form of ABSs or Covered Bonds.

The Basel III and FSA liquidity regimes place a greater emphasis on secured funding, which banks are addressing by embarking on "asset enablement" programmes, to ensure that sufficient collateral is available for use in secured funding transactions. Our findings suggest that it is imperative for banks with interbank ratios lower than 100% to make asset enablement a priority. The long-term significance of this is considerable: Some banks will have to modify their business models substantially before they are in a position to originate only assets that are viable for use as secured collateral. Banks that are not able to do this, and still wish to run customer loan-deposit ratios greater than 100%, will remain net borrowers from the interbank market. In the long run this will add substantially to their costs, because their liquid asset buffer requirement will be higher.

The other side of this is the impact on the bank funding model. As the share of encumbered assets grows, as banks move to secured funding including securitization, the position of senior unsecured and subordinated debt holders worsens as the encumbrance ratio worsens and the loss-given-default value in a bankruptcy event rises higher. This has implications for the long-term viability of unsecured long-term debt from an investor perspective, and will result in higher unsecured funding costs. Ultimately, the requirements of the Basel III Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR) suggest that banks will need to continue to employ securitization as part of their long-term liquidity funding strategy.

Regulators may need to provide incentives for banks to invest in ABS tranches to ensure that non-bank investors continue to remain engaged in the market. If a transaction is not undertaken for risk transfer purposes, the originator can retain the junior tranche but mezzanine tranches may not find institutional investors and have to be placed with banks. The regulatory capital risk weighting on these tranches may be a disincentive for banks to purchase them.

For securitization to produce any regulatory capital benefit requires that banks demonstrate "significant risk transfer" arising from the transaction. Therefore if the primary motivation for the structure is to transfer credit risk, rather than raise funding or generate regulatory capital arbitrage, it would be more appropriate to consider a synthetic securitization. This would avoid the need to find cash investors for the deal.

We remarked above that regulators may need to provide incentives for banks to invest in ABS tranches. Other incentives or disincentives are also possible: In 2010, the UK government introduced a tax on banks proportional to their volume of short-term wholesale funding as a mechanism to

try to reduce their reliance upon it. It is worthy of note that the savings rate of UK citizens is rather lower than that of citizens in Germany and Italy, for example, and much lower than that in Asian countries such as Japan and China. The UK government might consider tax incentives for UK citizens to save a greater proportion of their incomes. This would have the effect of increasing the pool of savings which might be deposited with UK banks. Tax incentives to encourage private saving might be politically easier to implement than incentives for banks to issue or invest in ABS tranches.

6 Robustness analysis

In this section we present robustness checks on the main results presented above. In order to account for possible outliers, we use robust regression (see Rousseeuw and Leroy (1996). We start with Table 11 (a) where we repeat the same empirical analysis as in Table 6 but we add one variable at a time and measure the contribution of each variable by reporting the R-squared each time we add a new variable to the model:

Table 11 (a): Robust regression, change in R^2 (0.82) when adding variables one after the other

	Coefficient	Change in R^2
Funding		
Interbank ratio	-0.908	-0.44
Liquid assets/Customer deposits & ST funding	-0.002	-0.08
Liquid assets/Total deposits & borrowing	-0.002	-0.11
Net loans/Deposits & ST funding	0.001	0.27
Net loans /Total assets	-0.065	0.00
Net loans/Total deposits & Borrowing	-0.765	-0.31
Capital regulation		
Cap.Funds/Deposits & ST funding	-0.002	0.00
Cap.Funds/Net loans	-0.003	0.00
Cap. Funds / Total assets	0.032	0.00
Equity/Liabilities	0.003	0.10
Equity/Total assets	0.007	-0.52
Tier 1 Ratio	-0.164	-0.30
Total capital ratio	-0.097	-0.19
Risk transfer		
Impaired loans/Equity	-0.554	0.01
Impaired loans/ Gross loans	0.091	0.15
Loan loss prov. / Net int.Rev	0.074	0.00
Loan loss Res. / Gross loans	0.004	0.00
Unreserved impaired loans /Equity	0.024	-0.33
Net charge-off/Average Gross loans	0.037	-0.26
Size		
Log total assets	0.753	0.02

*significance at 1%; **significance at 5%;***significance at 10%.

We do this so that we can look at the contribution of each variable to the final empirical results

in Table 6. Overall the coefficients in Table 11 (a) have the same (expected) sign and the same statistical significance as the ones in Table 6. Furthermore, it appears that the largest proportion of explanatory power of the model comes from the variables falling within the funding group. This is in line with the results in Table 6[22].

In Table 11 (b) and 11 (c), we repeat the analysis of section 4.4 but we now consider two dummy variables in the model. The two dummy variables enable us to see how the characteristic of a bank (commercial bank or savings bank) affects its decision to securitize its loans. Therefore we now control for the type of financial institution. The results in Table 11(b) confirm those reported in section 4.4: While the search for funding is important in understanding the growth of the securitization market in the UK, regulatory capital arbitrage and credit risk transfer cannot be neglected. All the coefficients have the expected sign. While both the two dummy variables are significant, savings banks seem to be the ones more willing to implement a liability securitization program. This result is in line with the analysis of Cardone-Riportella et al. (2010) for Spanish banks and in line with the results in Table 10.

We now turn to the ABS market. Results in Table 11 (c) are in line with those reported earlier. Furthermore, it is noteworthy that neither of the two dummy variables is now significant. In addition to the robustness results reported in this section, we have used a battery of additional tests (GMM, Panel OLS with both random and fixed effects) and results (unreported) are similar to the ones reported in this paper.

Table 11 (b): CDO robust regression variables

*significance at 1%; **significance at 5%;***significance at 10%.

Funding	Coefficient	Probability
Interbank ratio	-0.19	0.055*
Liquid assets/Customer deposits & ST funding	0.08	0.046
Net loans/Deposits & ST funding	0.50	0.000*
Net loans /Total assets	0.66	0.004*
Capital regulation		
Cap.Funds/Net loans	-0.06	0.001*
Equity/Total assets	-0.09	0.047*
Tier 1 Ratio	-0.11	0.000*
Total capital ratio	-0.44	0.001*
Risk transfer		
Impaired loans/Equity	0.06	0.000
Impaired loans/ Gross loans	-0.58	0.000
Loan loss Res. / Gross loans	-0.19	0.051
Size		
Log total assets	0.03	0.001*

[22]However, as we noted regulatory capital arbitrage and credit risk transfer also play an important role.

Table 11 (c): ABS robust regression variables.		
*significance at 1%; **significance at 5%;***significance at 10%.		
Funding	Coefficient	Probability
Interbank ratio	-0.43	0.002***
Liquid assets/Customer deposits & ST funding	0.13	0.048
Net loans/Deposits & ST funding	0.27	0.000*
Net loans /Total assets	-0.03	0.585
Capital regulation		
Cap.Funds/Net loans	-0.01	0.070***
Equity/Total assets	0.30	0.000
Tier 1 Ratio	-0.53	0.074*
Total capital ratio	-0.86	0.000*
Risk transfer		
Impaired loans/Equity	-0.02	0.074
Impaired loans/ Gross loans	0.42	0.106
Loan loss Res. / Gross loans	-0.89	0.589
Size		
Log total assets	0.70	0.000*

7 Conclusion

This study has analysed the reasons why UK banks securitize or did securitize during the period before the 2007 financial crisis. We have shown that the search for liquidity (i.e. the need to fund their balance sheets) has been the principal motive for UK banks to securitize. We have also shown that regulatory capital arbitrage and credit risk transfer have played a role, albeit a smaller one, in the decision of banks to securitize. We have shown that banks which issued more asset-backed securities (ABSs) before the financial crisis suffered more defaults after the financial crisis. We attribute this to the fact that the market for ABSs was frozen abruptly in the summer of 2007 and hence they were unable to sell off their loans and suffered the consequences as the credit-crunch and the global financial crisis took their toll on the quality of the banks' loan books.

Finally, we showed that large banks were the ones for which securitization was more important to explain profits while commercial and savings banks were the ones whose balance sheets were the most exposed (and highly sensitive) to changes in the conditions of the securitization market.

As Cardone-Riportella et al. (2010) note in their study, since the credit-crunch started in the summer of 2007, "more and more banks have been seen to underwrite their own securitization programs in order to use them as a guarantee to obtain funding from the European Central Bank (ECB)". Already extant securitized bonds have been used in a similar fashion. Although such funding will require substantial "haircuts", the fact that the ECB, and other central banks, will accept ABSs as collateral in return for funding strengthens the motivation to understand why banks securitize and what the consequences are.

References

[1] Affinito M. and E. Tagliaferri (2008), "Why do banks securitize their loans? Evidence from Italy", working paper.

[2] Agostino M. and M. Mazzuca (2008), "Why do banks securitize? Evidence from Italy". In XVI Spanish Finance Forum Conference Proceedings. Spanish Finance Association, Madrid.

[3] Ambrose M. Lacour-L. and A.B. Sanders (2005), "Does regulatory capital arbitrage, reputation, or asymmetric information drive securitization?", Journal of Financial Services Research 28, pp. 113-133.

[4] Bannier C.E. and D.N. Hänsel (2008), "Determinants of European banks' engagement in loan securitization". Discussion Paper, Deutsche Bundesbank.

[5] Cardone-Riportella Clara, R. Samaniego and A. Trujillo-Ponce (2010), "What Drives Bank Securitization? The Spanish Experience," Journal of Banking & Finance, Vol. 34, No.11, pp. 2639-2651.

[6] Cumming C. (1987), "The Economics of Securitization". Federal Reserve Bank of New York Quarterly Review 12, 3, pp. 11-23.

[7] DeMarzo P. (2005), "The Pooling and Tranching of Securities: A Model of Informed Intermediation", Review of Financial Studies, 18: pp. 1-36.

[8] De Marzo P. and D. Duffie (1999), "A Liquidity-Based Model of Security Design", Econometrica, Vol. 67, pp. 65-99.

[9] Donahoo K.K. and S. Shaffer (1991), "Capital Requirements and the Securitization Decision," Quarterly Review of Economics and Business 31, 4, pp. 12-23.

[10] Duffie D. and N. Garleanu (2001), "Risk and Valuation of Collateralized Debt Obligations", Financial Analysts Journal 57 (2001), pp. 41-59.

[11] Gorton G.B. and N. Souleles (2006) "Special Purpose Vehicles and Securitization", In: M. Carey and R. Stulz, Editors, The Risks of Financial Institutions, University of Chicago Press, Chicago .

[12] Greenbaum S. and A. Thakor (1987), "Bank Funding Modes: Securitization Versus Deposits". Journal of Banking and Finance, 11, pp. 379-401.

[13] Hänsel D.N. and J.P. Krahnen (2007), "Does Credit Securitization Reduce Bank Risk? Evidence from the European CDO market". SSRN Working Paper.

[14] Jackson P., C. Furfine, H. Groenveld, D. Hancock, D. Jones, W. Perraudin, L. Radecki and M. Yoneyama (1999), "Capital Requirements and Bank Behaviour: the Impact of the Basel Accord", Basel Committee on Banking Supervision Working Paper No. 1, BIS, April.

[15] Jiangli W. and M. Pritsker (2008), "The Impacts of Securitization on US Bank Holding Companies", SSRN no. 1102284.

[16] Jones D. (2000), “Emerging Problems with the Basel Capital Accord: Regulatory Capital Arbitrage and Related Issues”, Journal of Banking and Finance 24, pp. 35-58.

[17] Loutskina E. and P. Strahan (2009), "Securitization and the Declining Impact of Bank Finance on Loan Supply: Evidence from Mortgage Originations", Journal of Finance 64 pp. 861-88.

[18] Mansini R. and M.G. Speranza (2002), "Multidimensional Knapsack Model for Asset-Backed Securitization", The Journal of the Operational Research Society, Vol. 53, No. 8, pp. 822-832.

[19] Martín-Oliver A. and J. Saurina (2007), "Why do Banks Securitize Assets?", XV Spanish Finance Forum Conference Proceedings, Spanish Finance Association, Palma de Mallorca (2007).

[20] Minton B.A., A. Sanders and P. Strahan (2004), "Securitization by Banks and Finance Companies: Efficient Financial Contracting or Regulatory Arbitrage?", Working Paper, Ohio State University.

[21] Purnanandam A. (2011), "Originate-to-Distribute Model and the Subprime Mortgage Crisis", The Review of Financial Studies, Vol. 24, 6,pp. 1881-1915.

[22] Rousseeuw P. and A. Leroy (1996), Robust Regression and Outlier Detection. John Wiley & Sons., 3rd edition.

[23] Uzun H. and E. Webb (2007), "Securitization and Risk: Empirical evidence on US banks, The Journal of Risk Finance 8, pp. 11-23.

[24] Wheelock D.C. and P.W. Wilson (2001), “New Evidence on Returns to Scale and Product Mix Among U.S. Commercial Banks,” Journal of Monetary Economics, 47, pp. 653-74.

8 Appendix

8.1 Detection of Outliers

As explained earlier, we have used robust regression to deal with outliers. In this section, we aim to identify outliers and remove them from our data before carrying out the statistical analysis in Table 4 (a). Our simple approach uses the interquartile range. By multiplying the interquartile range by 1.5, adding the result to the upper quartile and subtracting it from the lower quartile, we get (benchmark) data points. If any data point is outside these values, it is a mild outlier. We use the same approach to identify extreme outliers (in this case we multiply the interquartile range by 3). We find that the data points representing extreme outliers come mainly from large banks that securitized. Table A1 below shows the descriptive statistics after excluding the outliers. The results are similar to those reported in Table 4(a) and therefore we conclude that outliers do not significantly influence our results.

	Mean	Standard Error	Standard Deviation	Kurtosis	Skewness	N	Confidence Level(95.0%)
Funding							
Interbank Ratio	68.61	7.58	157.90	13.52	3.51	434	14.90
Liquid Assets /Dep & ST Funding	63.13	6.31	131.47	18.87	4.07	434	12.40
Liquid Assets /Tot Dep & Bor	40.10	4.67	97.30	28.40	4.96	434	9.18
Net Loans /Tot Assets	31.25	1.61	33.59	-1.15	0.59	434	3.17
Net Loans /Dep & ST Funding	48.38	4.56	95.01	40.23	5.53	434	8.96
Net Loans /Tot Dep & Bor	25.32	1.85	38.46	2.65	1.61	434	3.63
Capital regulation							
Cap Funds /Tot Assets	5.87	0.71	14.89	19.82	4.22	434	1.40
Cap Funds /Dep & ST Funding	15.37	2.91	60.57	37.68	5.95	434	5.71
Cap Funds /Net Loans	14.99	2.49	51.93	40.46	5.84	434	4.90
Equity /Tot Assets	29.34	1.79	37.37	12.97	-0.81	434	3.53
Equity /Liabilities	71.48	7.63	159.00	9.39	3.04	434	15.00
Tier 1 Ratio	3.10	0.46	9.61	60.37	6.42	434	0.91
Total Capital Ratio	3.64	0.56	11.74	100.43	8.07	434	1.11
Risk transfers							
Impaired Loans /Gross Loans	1.51	0.29	6.00	172.21	11.36	434	0.57
Impaired Loans /Equity	9.57	1.44	30.07	29.48	4.92	434	2.84
Loan Loss Prov /Net Int Rev	11.91	2.89	60.27	70.07	0.99	434	5.69
Loan Loss Res /Gross Loans	1.68	0.27	5.60	66.63	7.31	434	0.53
Unreserved Impaired Loans /Equity	4.91	0.88	18.35	37.05	5.68	434	1.73
NCO /Average Gross Loans	0.39	0.14	2.92	131.31	9.03	434	0.28
Bank size							
Total Assets (£bn GBP)	43.14	9.32	194.16	43.14	6.32	434	18.32

Table A1: Descriptive Statistics

8.2 Multicollinearity analysis

The correlation matrix, in Table A2, shows that the explanatory variables are uncorrelated.

Table A2; Matrix of correlation

	IR	LA /D&ST F	LA/D& B.	NL /TA	N L/D &ST F	N Loans/T.Dep &Bor	C F/TA	CF/D &ST F
Interbank ratio	1.0000							
liquid assets/Dep &ST Funding	0.2781	1.0000						
Liquid assets/Dep. & Bor.	0.0914	0.2761	1.0000					
Net loans/Total assets	0.0959	-0.2074	-0.2096	1.0000				
Net loans/Dep &ST funding	0.0095	-0.0025	-0.0763	0.4169	1.0000			
Net loans/Tot Dep &Bor	0.0055	-0.0332	0.0176	0.5462	0.3633	1.0000		
Cap Funds/Total Assets	0.0665	0.1179	0.1971	-0.0617	0.0590	0.1902	1.0000	
Cap Funds/Dep &ST funding	0.1416	0.3063	0.2742	-0.0502	0.1515	0.2177	0.4561	1.0000
Cap Funds/Net loans	0.0747	0.1510	0.2330	-.0567	0.0393	0.1722	0.4898	0.4164
Equity/Total Assets	-0.1609	0.0336	0.1020	-0.3621	-0.1295	-0.2464	-0.0473	-0.0597
Equity/Liabilities	-0.0960	0.1315	0.2856	-0.2519	-0.0621	-0.1208	-0.0265	-0.0064
Tier 1 Ratio	0.2973	0.1239	-0.0329	0.0742	0.220	0.1262	0.0137	-0.0238
Total Capital ratio	0.3166	0.2519	0.0877	0.0360	0.0100	0.1117	0.0066	-0.0210
Impaired loans/Gross loans	0.0355	0.0154	0.0332	0.0760	0.0176	0.1298	0.3009	0.0949
Impaired loans/Equity	-0.0026	-0.0761	-0.0556	0.2913	0.1046	0.2774	0.0575	-0.0169
Loan loss prov/Net. Int Rev	-0.0081	-0.1004	-0.1035	0.1882	0.1270	0.0692	-0.0398	-0.1052
Loan loss reserve/Gross loans	0.0656	0.0869	0.0791	0.0054	0.1454	0.0838	0.1472	0.1290
Unreserved impaired loans/Equity	-0.0075	-0.0736	-0.0516	0.2282	0.0676	0.2022	0.0757	-0.0200
NCO/Average Gross loans	0.0123	-0.0310	-0.0432	0.0608	-0.0053	0.0528	-0.0324	-0.0422
Total assets	0.0413	0.0071	-0.0161	0.0330	0.0438	0.90.07	0.0015	0.0212

Table A2; Matrix of correlation, (Continued)

	CF/NL	E/TA	E/L	Tier 1 R	TCR	IL/GL	IL/E	LLP/NIRev	LL/GL	UR IL/E	NCO/AG L	Total assets
Cap Funds/Net loans	1.0000											
Equity/Total Assets	-0.0648	1.0000										
Equity/Liabilities	-0.0140	0.5042	1.0000									
Tier 1 Ratio	0.0115	-0.1278	-0.0849	1.0000								
Total Capital ratio	0.0110	-0.0898	-0.0318	0.6383	1.0000							
Impaired loans/Gross loans	0.4547	-0.0921	-0.0487	0.0848	0.0792	1.0000						
Impaired loans/Equity	0.0567	-0.1887	-0.1226	0.1484	0.1574	0.4739	1.0000					
Loan loss prov/Net. Int Rev	-0.0590	-0.0736	-0.0449	0.0734	0.0826	0.1866	0.2246	1.0000				
Loan loss reserve/Gross loans	0.1565	-0.0369	-0.0209	0.0525	0.0478	0.2199	0.1147	0.1161	1.0000			
Unreserved impaired loans/Equity	0.0816	-0.1629	-0.1029	0.1485	0.1525	0.5243	0.8962	0.1464	0.0794	1.0000		
NCO/Average Gross loans	-0.0306	-0.0577	-0.0485	0.0483	0.0477	0.1903	0.0538	0.2672	0.1936	0.0251	1.0000	
Total assets	0.0228	-0.1475	-0.0920	0.1447	0.1547	0.1131	0.2606	0.0871	0.0235	0.2405	0.0264	1.0000

8.2.1 Variance inflation factors

In this section we shall use an alternative approach to detect the presence of multicollinearity in our model. We shall rely on a simple test: the variance inflation factors (VIF). As the name suggests, a variance inflation factor (VIF) quantifies how much the variance is inflated. As shown in the table A3, all values are less than 3, indicating that multicollinearity is not a problem.