Covered Bond versus ABS Liquidity:
A Comment on the EBA's Proposed HQLA Definition

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Abstract

The EBA has analysed the liquidity of different asset classes as part of its work for the European Commission on definitions to be employed in a European implementation of the Liquidity Coverage Ratio. This paper critically examines the EBA's analysis, focussing on the exclusion of bid-ask spread data from the evidence employed. Using bid-ask spreads, we show that Asset-Backed Securities (ABS) and Covered Bonds (CB) do not exhibit radically different levels of liquidity in recent years. Furthermore, we show that, based on bid-ask spreads, some non-residential-mortgage-backed ABS (excluded from the LCR in the EBA proposals) have been more liquid than CBs.

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EXECUTIVE SUMMARY

The European Banking Authority (EBA) has been asked by the European Commission (EC) to analyse the relative liquidity of asset classes for the purpose of determining which assets should be eligible for inclusion in banks' liquidity buffers. The EBA's analysis is almost exclusively based on a single transactions database that omits the most obvious source of information on liquidity, namely bid-ask spreads.

This paper provides evidence on the relative liquidity of two important asset classes: Covered Bonds and Asset Backed Securities (ABS). Our key messages are:

1. On average, Covered Bond bid-ask spreads are narrower than those of ABS. But, for much of the sample period, spreads for the more liquid ABS are narrower than those of Covered Bonds, especially in the period of 2011-2012 when significant fears about sovereign solvency (and hence the prospects for Covered Bond bailouts) gripped the market.
2. Some short maturity non-mortgage-backed ABS such as auto-loan-backed ABS have liquidity as measured by bid-ask spreads that is generally comparable to that of Covered Bonds and indeed is markedly superior for non-Pfandbriefe Covered Bonds. This finding is in stark contrast to the conclusions of the EBA since they regard all non-mortgage-backed ABS as of very low liquidity.
3. The analysis presented in this paper provides a warning against reliance on a single dataset and the use of methods (such as those employed by the EBA) which depend heavily on frequency of trading and turnover rather than trading cost measures such as spreads. To understand why these approaches lead to very different results, one may focus on auto-loan-backed ABS. These are short maturity and hence rarely traded. However, when during the crisis holders wished to dispose of these securities, they were able to do so at a small cost.
4. As well as examining bid-ask spreads directly, we measure the discounts evident in the prices of securities that are relatively illiquid. These can be significantly greater than immediate bid-ask spreads as market participants price in trading costs that might be encountered in a future crisis. These measures suggest that the differences in price discounts between high- and low-liquidity securities between RMBS Residential Mortgage Backed Securities (RMBS) and Covered Bonds are comparable.

SECTION 1 – INTRODUCTION

The Liquidity Coverage Ratio (LCR) is a crucial component of the emerging, post-crisis regulation of bank liquidity. Under the LCR rules banks must hold High Quality Liquid Assets (HQLA) in excess of potential liability run offs that might occur in a crisis.

Two key aspects of these regulations are (i) how the runs offs are defined - we do not focus on this issue here[2] - and (ii) which assets are eligible for inclusion in the HQLA category? Different vintages of the Basel proposals, as well as their varying interpretations by national regulators, have led to a number of differing proposals and implementations of HQLA.

Generally, the Basel proposals: (i) break HQLA down into Category 1 and 2 assets with the former being extremely HQLA; (ii) permit Category 2 assets to contribute no more than a certain percentage of the total; and (iii) require that Category 2 assets are subject to haircuts. The differences between selected jurisdictional interpretations of HQLA are outlined in Table 1, overleaf.

The original Basel proposal (see BCBS (2010)) distinguished only between Category 1 and 2 assets. Category 1 assets included cash, central bank reserves, and securities guaranteed by sovereigns, quasi-sovereigns, central banks and multinational development banks with a Basel II zero risk weighting. Category 2 assets comprised the same assets as in 1 where these had 20% risk weightings as well as corporate and covered bonds rated with ratings no lower than AA-. Category 2 assets could contribute no more than 40% of the total assets and were subject to a minimum 15% haircut.

In 2012, Sweden adopted the BCBS (2010) approach with some restrictions on asset composition (see Finansinspektionen (2012)). In 2013, Australia announced that it would follow the same approach except that it would not recognise any Category 2 assets at all (see APRA (2013)). The United Kingdom devised and implemented an approach to liquidity regulation swiftly following the crisis. Details of this may be found in Financial Services Authority (2008), (2009a), (2009b) and (2009c).

In the revised Basel proposal (see BCBS (2013)), Category 1 assets are made up of the same asset classes but two new sub-categories of Category 2 assets are introduced: 2a and 2b. Category 2a assets are made up of the Category 2 assets from the previous BCBS proposal. Category 2b assets are described as of lower liquidity and comprise RMBS (subject to conditions) rated AA- or higher, corporate debt rated between A+ and BBB-, and certain equities. Category 2a assets are subject to 15% haircuts and Category 2b assets are subject to higher haircuts (of at least 25%) depending on asset class. Category 2 assets may make up not more than 40% of the total stock, and category 2b assets may (after haircuts) comprise not more than 15% of the total stock of HQLA.

[2] For a discussion of the key issues, see, for instance: European Banking Authority (2013b)

US regulators' proposed liquidity buffer rule (see OCC et al. (2013)) largely follows the revised BCBS framework, although their Category 2a assets only contain sovereign and multinational development bank debt (with a 20% risk weighting) and US 2b assets conist only of corporate debt and equities, with the same restrictions on HQLA composition and similar restrictions on haircuts to those in the original proposals.

The EBA has now been tasked by the European Commission with recommending, based on an empirical analysis, which assets should be eligible for inclusion in the Liquidity Coverage Ratio for European banks. In February 2013, the EBA published a description of the methodology it intended to employ in analysing the liquidity of different asset classes (see EBA (2013a)). Preliminary results of that analysis were disclosed at a public hearing in October 2013 (EBA, 2013c) and then, in December 2013, the EBA published its results,

In this paper, we provide a different perspective on the analysis of relative liquidity of different asset classes. The EBA's approach places heavy emphasis on a single data set, namely the MiFID transactions data, and on indirect indicators of liquidity that it infers from this data. For equities and gold, the EBA uses data from other sources, but for bonds including structured bonds and covered bonds, the EBA relies entirely on the MiFID data.

As a transactions dataset, the MiFID data does not include observations of the most obvious indicator of transactions costs, namely bid-ask spreads. To remedy the omission, the EBA calculates proxies for bid-ask spreads based on a calculation suggested by Roll (1984). Roll proposed an implicit measure of effective bid-ask spreads, applicable to transactions data, based on the autocovariance of returns.[3]

As a proxy for bid-ask spreads, the Roll measure is subject to well-known drawbacks and weaknesses. Dealer inventory effects and trading that conveys information (the two most widely proposed explanations for the existence of the bid-ask spread) affect the degree of autocovariance one might expect in prices, even leaving aside the Roll-style price bounce effect. Furthermore, the Roll measure is known to perform poorly when samples are small, which is certainly the case for many of the individual securities analysed by the EBA.

In this paper, we show how use of direct observations of bid-ask spread data may significantly alter one's understanding of the relative liquidity of some of the asset classes on which the EBA focusses. In particular, we show that bid-ask spreads suggest Covered Bonds[4] and some categories of ABS are comparable in liquidity. The most liquid AAA-rated RMBS are more liquid than similarly rated Covered Bonds although RMBS spreads show a long tail with some distinctly illiquid issues. Furthermore, we demonstrate that some non-mortgage-backed ABS, namely car-loan backed deals (which are viewed by the EBA as completely illiquid) have bid-ask spreads that are comparable to or tighter than those of Covered Bonds.

[3] If prices move randomly and one observes a random sequence of transactions at the bid and the ask price, then returns will tend to "bounce back". The dealer buys at the bid price, which is low, and sells at the ask price, which is high. If one observes a high return in one period, it is likely that it involved a pair of prices successively at the bid and the ask prices. If the latest price is most likely at the ask price, the following one will be the same or lower so the next return will be negative. Hence, return data based on transactions prices is likely to exhibit negative autocovariances and the size of the autocovariance depends on the size of the bid-ask spread.
[4] Useful descriptions of the Covered Bond market may be found in Mastroeni (2001), Packer, Stever and Upper (2007), and International Monetary Fund (2011).

Table 1

Jurisdictional HQLA Definitions

The table displays different jurisdictional interpretations of High Quality Liquid Assets, namely: the initial 2010 BCBS proposal, the 2013 updated BCBS proposal , the 2013 'Proposed Rule', the Swedish LCR (implemented in January 2013), and the Australian LCR (due to be implemented in January 2015). For each jurisdiction's interpretation of the LCR, the assets eligible as level 1 and - where appropriate - those eligible as levels 2a and 2b are stated. Finally, restrictions on Category 2 assets are listed, including maximum composition and minimum haircuts.

		Category definitions			
Approach	**Note**	**1**	**2a**	**2b**	**Restrictions on Category 2 assets**
BCBS (2010)		Cash; central bank reserves, and securities representing claims on or guaranteed by sovereigns, quasi-sovereigns, central banks and multilateral development banks given zero risk weighting under Basel II standardised approach to credit risk	No distinction between Levels 2a and 2b. Level 2 assets defined as Marketable securities representing claims on or claims guaranteed by sovereigns, quasi-sovereigns, central banks, and multi-lateral development banks, which are assigned a 20 per cent risk-weight under Basel II approach, corporate and covered bonds rated at least AA-.		Level 2 assets not to exceed 40% of the total stock of HQLA. Minimum haircut of 15% on level 2 assets.
BCBS (2013)	Introduced level 2b	Cash; central bank reserves, and securities representing claims on or guaranteed by sovereigns, quasi-sovereigns, central banks and multilateral development banks given zero risk weighting under Basel II standardised approach to credit risk	Marketable securities representing claims on or claims guaranteed by sovereigns, quasi-sovereigns, central banks, and multi-lateral development banks, which are assigned a 20 per cent risk-weight under Basel II approach, corporate and covered bonds rated at least AA-.	Certain RMBS rated AA or higher, corporate debt securities rated between A+ and BBB- ; and certain unemcumbered equities.	2a + 2b not to exceed 40% of total stock. 2b not to exceed 15% of total HQLA (after haircuts). Minimum haircut of 15% on 2a assets with higher haircuts on 2b assets: 50% on corporate debt securities, 50% on equities, and 25% on RMBS.
US - "Proposed Rule"		Federal Reserve Bank Balances; Foreign Withdrawable Reserves; Securities Issued or Guaranteed by: US Treasury or any other US Government Agency, Central Bank, Sovereign Entity, the BIS, IMF, ECB, EC or by a multilateral development bank; certain debt securities issued by soverign entities.	Certain claims on or guaranteed by US GSEs and certain claims on or guaranteed by sovereign entities or a multilateral development bank that are not included in Level 1 and have a 20% under Basel II Approach.	Certain publically traded corporate debt securities and publically traded shares of common stock, that are liquid and readily marketable.	2a + 2b not to exceed 40% of total stock. 2b not to exceed 15% of total HQLA. Haircut of 15% on 2a assets with 50% haircuts on 2b assets.
Sweden	Followed BCBS (2010)	Cash, Central Bank Balances, Sovereign Debt, Securities with Zero Risk Weight	No distinction between Levels 2a and 2b. Level 2 assets defined as: securities with a risk weight of 20% issued or guaranteed by sovereigns, central banks, public sector bodies, or multilateral development banks, Covered Bonds of Credit Quality Level 1, and Corporate Bonds of Credit Quality Level 1.		Level 2 not to exceed 40% of total stock. Haircut of 15% on Level 2 assets.
Australia	Followed BCBS (2010)	Cash, Balances held with RBA, Commonwealth Government and Semi-Government securities;	No Australian Category 2 assets are recognised.		

This latter conclusion is striking because it is well-known that car loan-backed ABS trade little. Being short-dated, they are typically placed and held to maturity. But in the recent crisis, anecdotal evidence suggests that they were easy to sell. It seems that this ease of disposal is reflected in the spreads that we observe.

Direct indicators of turnover or of transactions costs (like bid-ask spreads) are not the whole story, however, when it comes to liquidity. The LCR is intended to protect banks in the event of a crisis, particularly a crisis that affects the bank's own liquidity or (even more serious from a public policy viewpoint) the liquidity of the financial system as a whole. It is possible for a security to have a narrow bid-ask spread now but for the market to be concerned that transactions costs in the event of a future crisis will be large. In this case, the current price (both at the bid and the ask) will exhibit an illiquidity discount.

In the last section of the paper, we estimate illiquidity discounts in the prices of individual ABS and Covered Bonds. In this case again, we show that Covered Bonds and ABS are comparable.

The rest of this paper is organised as follows. Section 2 presents the EBA's methodology and results. Section 3 describes the data we have collected for individual ABS and Covered Bonds and the results of analysis on their bid-ask spreads. Section 4 presents results on the impact of liquidity on the prices of individual ABS and Covered Bonds. Section 5 concludes.

SECTION 2 – THE EBA'S RESULTS AND METHODOLOGY

The EBA was tasked by the European Commission with recommending definitions of HQLA applicable to European banks by the end of December 2013. The EBA published a discussion paper on its methodology in February 2013 and held a public meeting in October 2013 at which its preliminary findings were presented. In December 2013, the EBA presented its conclusions and recommendations. Before we turn to the methodology employed by the EBA, one may summarise its conclusions. These are shown in Table 2.

Category I assets or Extremely High Quality Liquid Assets (EHQLAs) are limited to ECAI1[5] (domestic currency) sovereign bonds of issue size exceeding €250m, ECAI1 Covered Bonds of issue size greater than €500m, cash and central bank reserves.

For fixed income securities, the EBA has adopted a methodology based on a single transactions database, namely the MiFID transactions reporting dataset. This is available from the start of 2008 until the end of June 2012 and includes 9 million transaction observations. For equities and gold, the EBA employs data from Bloomberg, Datastream and the World Gold Council.

[5] The External Credit Assessment Institution (ECAI) system of credit grades may be summarised as follows. If two ECAIs provide ratings, the lower of the two is chosen. If three ECAIs rate the security, the second best is employed. The mapping from rating to ECAI grades is (using Standard & Poor's notation) as follows: AA- and above is ECAI1, A- to A+ is ECAI2, BBB- to BBB+ is ECAI3, BB- to BB+ is ECAI4, B- to B+ is ECAI5, CCC+ and below is ECAI6.

Table 2

EBA recommendations on EHQLA and HQLA classification

The table summarises the European Banking Authority's recommendations based on a quantitative analysis (EBA, 2013c) for the appropriate definitions of Extremely High Quality Liquid Assets, High Quality Liquid Assets and assets they consider insufficiently liquid for inclusion in the LCR. Where appropriate, the table displays the minimum External Credit Assessment Institution (ECAI) rating, minimum issue and maximum time to maturity for each named asset.

Extremely High Quality Liquid Assets	Minimum Rating	Minimum Issue	
Sovereign Bonds issued in domestic currency	ECAI 1	€250m	
Covered Bonds	ECAI 1	€500m	
Central Bank reserves	-	-	
Notes and Coin	-	-	
High Quality Liquid Assets	**Minimum Rating**	**Minimum Issue**	**Maximum time to maturity**
Sovereign Bonds issued in domestic currency	ECAI 2	€100m	-
Covered Bonds	ECAI 1	€250m	-
Corporate Bonds	ECAI 4	€250m	10 years
RMBS	ECAI 1	€100m	5 years
Bonds issued by supranational institutions in EEA currencies	ECAI 1	€250m	-
Bonds issued by local government institutions in EEA currencies	ECAI 2	€250m	-
Insufficiently Liquid Assets			
Equities			
Gold			
Credit Claims			
ABS not backed by residential mortgages			
Central Bank Securities			
Securities issued by financial institutions			
Bank-issued government guaranteed bonds			
Bonds issued by promotional banks			

In its February and December 2013 documents, the EBA emphasizes the use of different liquidity indicators inferred for bond asset classes from the MiFID data. For each security, monthly averages of daily observations are calculated to generate monthly individual-asset-specific 'observations' of the liquidity indicator in question. The liquidity indicators the EBA employs are as follows:

1. The Amihud illiquidity ratio[6]
2. An un-scaled price impact measure
3. The Roll measure[7]
4. Trading volume
5. Turnover ratio
6. The number of zero trading days

[6] See Amihud (2002) and Brennan, Hu and Amihud (2013).
[7] See Roll (1984), Huang and Stoll (1997), Stoll (2000) and Harris (1990).

7. Price volatility

Each indicator is averaged over assets and then over the sample period to obtain asset-class-level indicators from which integer rankings are derived for each asset class. A final liquidity score for each asset class is obtained by summing the integer rankings of each asset class and re-ranking the asset classes based on the values of these summed indicators.

By using this methodology, the EBA ranks covered bonds as substantially more liquid than ABS. This can be seen in Table 3, below:

Table 3
EBA Fixed Income Instrument Rankings

This table displays the EBA's ordinal rankings for the eight liquidity indicators over each of the five asset classes it considers. The Amihud Ratio is the time absolute averaged daily return, divided by the value of trade each day. Price impact is the time averaged absolute daily return. Both the Amihud Ratio and Price Impact measure are averaged across each month (per asset) and then averaged across each asset class. Roll Meas. is the Roll measure, the square root of minus the covariance between consecutive returns, multiplied by two. Trading volume is calculated as the sum of trades in Euros for an asset in a month. Turnover ratio is the trading volume divided by the outstanding amount in each month. Zero-trade days is the percentage of trading days each month on which the asset in question is not traded out of a total of 21 possible trading days. Return volatility is the monthly standard deviation of daily returns. 30-day price change is the maximum absolute price change over a thirty day period. The Roll measure, trading volume, turnover ratio, zero-trade days, return volatility and 30-day price change measures are all averaged across assets in each class. Avg. Rank is the average rank of each asset class, calculated as the sum of all eight liquidity proxies' ordinal rankings divided by eight.

	Amihud Ratio	Price Impact	Roll Meas.	Trading Volume	Turnover Ratio	Zero-Trade Days	Return Volatility	30-Day Price Change	Avg. Rank
Government Bonds	1	2	3	1	1	2	3	3	2.00
Covered Bonds	2	1	1	3	3	4	1	1	2.00
Non-Financial Corporate Bonds	3	3	2	5	4	3	2	2	3.00
ABS (incl. RMBS)	4	4	4	4	5	5	5	4	4.38
Equities	5	5	5	2	2	1	4	5	3.63

Although the EBA devotes considerable attention to this exercise in its December 2013 report, perhaps slightly confusingly the above composite integer score approach based on individual liquidity indicators plays no role in its recommendations for the EHQLA and HQLA definitions.

Instead, the EBA's approach to deducing liquid asset definitions is as follows. The EBA selects a benchmark liquidity category, namely ECAI1 sovereign bonds with issue size no less than €250mn. For other asset classes, the EBA considers a set of possible definitions of eligible assets. For each of these definitions, the EBA checks to see if, for one of the two metrics, its median indicator at least matched the median of one of the two indicators for the benchmark sovereign bond category. If it did, the EBA checks to see if a given quantile of the second indicator (75% quantile in the case of the turnover ratio and 25% quantile in the case of price volatility) at least matches the median of the corresponding indicator for the benchmark sovereign bond category.

Only for one asset class did the EBA find definitions that satisfied, for some definitions, the quantile matching conditions just described, namely Covered Bonds. For Covered Bonds, therefore, for each definition consistent with the matching conditions described above, the EBA calculated the fraction of bonds satisfying a given candidate definition that were actually illiquid (Type I error) and the fraction that did not satisfy the definition but which were actually liquid (Type II errors). The EBA then chose the liquidity definition that yielded a balanced amount of Type 1 and Type 2 errors. The selection of Type 1 and 2 error levels appears to be arbitrary. This definition is the basis for the EHQLA definition for Covered Bonds.

To establish definitions for HQLA, the EBA considered all sovereign bonds not in the category of EHQLA. For these, the EBA calculated the Type 1 and Type 2 errors for a set of different definitions. Choosing the minimum Type 1 error for a given level of Type 2 error (where the latter was set arbitrarily) the EBA fixed on a definition of HQLA sovereign bonds. Again, definitions for other asset classes were compared to see if some existed that satisfied the matching conditions described above. If so, a definition was selected that minimised the Type 1 error for a given Type II error.

The indicators employed by the EBA, both in the initial ranking of asset classes, and in the subsequent actual identification of liquid assets may be questioned. In particular, the most obvious indicator of transactions costs, the bid-ask spread, is omitted. The EBA's February 2013 methodology discussion paper presents illustrative results based on bid-ask spreads, but then proposes a methodology that makes no use of direct bid-ask spread observations. The paper argues "*that several measures are typically needed to get an accurate picture of an asset's market liquidity. For example, a tight bid ask spread is not enough to define an asset as extremely liquid unless a large quantity can be transacted at the best quotes relatively quickly*." But this is not an argument to ignore bid-ask spread information altogether.

In its initial asset class ranking exercise, the EBA employed a proxy for the bid-ask spread suggested by Roll (1984). Roll's approach infers a notional bid–ask spread from negative autocovariance in price changes. It is only a fully valid measure if there are no other reasons why autocovariance in transactions price changes might be present. The measure is known to be biased downwards in the presence of asymmetric information or inventory effects. Harris (1990) shows that the simple Roll measure is also subject to major small sample bias. In Roll's original paper, there were cases in which the autocovariance was positive implying a negative bid-ask spread! In its empirical work, where the EBA finds a Roll measure of the wrong sign, it sets the value to zero without saying how frequently this occurs in the data it employs.

The EBA's relatively mechanical methodology of ranking asset classes based on liquidity indicators misses the "big picture" question which is: "how likely it is that a bank would be able to sell asset holdings in a liquidity crisis involving (i) itself alone, (ii) the banking sector or (iii) the financial system generally?"

In a crisis, individual financial market segments become illiquid depending on how close they are to the centre of the crisis. This suggests that one should allow moderately diversified liquidity buffers rather than requiring a strict cut-off between liquid and illiquid asset classes.

Also, immediate transactions costs are not the only aspect one may wish to measure. Illiquidity generates price discounts in asset prices, lowering both bid and ask prices, because

investors are concerned about future transactions costs and attribute a risk premium to those future costs. It is sensible to evaluate asset classes not just from the point of view of immediate transactions costs (as measured by the bid-ask spread) but also based on how large and variable are liquidity-related discounts. In what follows below, we examine how ABS and Covered Bonds measure up in these two ways.

SECTION 3 – AN ALTERNATE VIEW OF COVERED BOND AND ABS LIQUIDITY

In this section, we present a comparison of bid-ask spreads for individual European ABS and Covered Bonds to shed light on the relative liquidity/illiquidity of these asset classes. According to the preliminary EBA findings, Covered Bonds are substantially more liquid than ABS. While Covered Bonds obtain the same liquidity score as sovereign bonds, ABS are inferior in liquidity to all other asset classes. A common presumption by regulators is that, among ABS, RMBS are significantly more liquid than anything else and as a result are the only ABS sub-class that should be considered liquid. We are able to shed light on this view.

S&P provided us with ABS data including daily bid and ask quotes, characteristic information and cash flow projections for pricing (e.g. prepayment rates and weighted-average lives).[8] The sample period runs from 26th May 2009 to 30th September 2013. The total number of AAA-rated bond bid-ask spread observations is 722,613, of which 564,467 are RMBS observations.

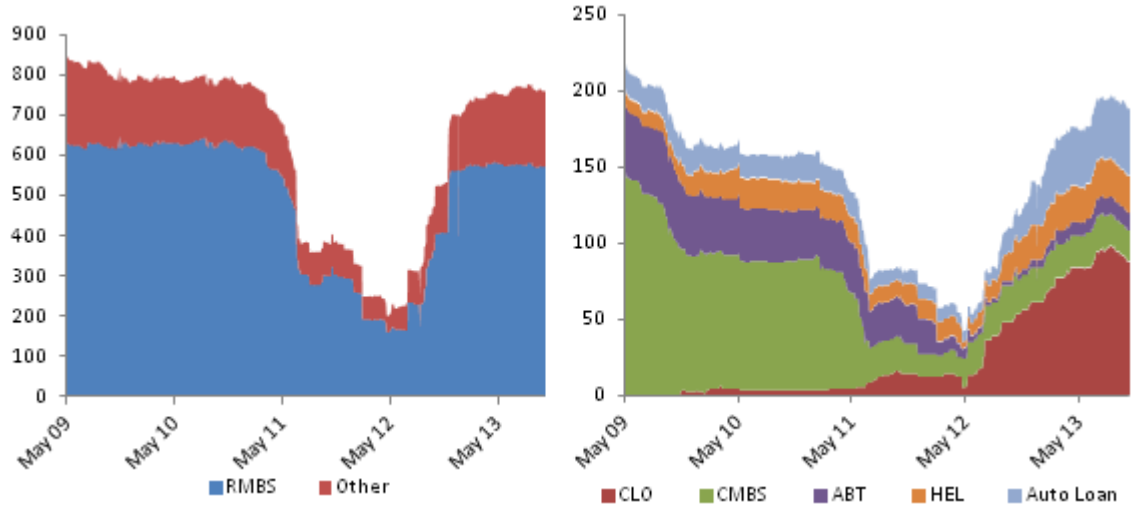

Figure 1 - Distribution over Time of the ABS Data: The two graphs present the evolution of the ABS sample over time. In the left hand graph, ABS are grouped by whether they are Residential Mortgage Backed Securities (RMBS) or not. On the right hand graph, all non-RMBS ABS are grouped by the sub-class of ABS to which they belong. The y-axis measures the number of ABS daily bid-ask spread observations. These are plotted against time. The graphs are stacked so that, for instance, in May 2009 there were approximately 800 ABS observations. Of these over 600 were RMBS and over 200 were other types. Of these other types approximately 150 were Collateralised Mortgage Backed Securities (CMBS).

Aspects of the distribution over time of the ABS data are illustrated in Figure 1. We focus on AAA-rated ABS since these seem most relevant for a HQLA definition (even though for some asset categories, the EBA has admitted AA and other ratings). Most of the observations in our sample consist of RMBS. In the middle part of the sample period, there was a marked

[8] A description of the proprietary algorithm used by Standard and Poor to calculate bid-ask spread data is given in Appendix 1.

decline in the number of observations, mostly reflecting downgrades and, in some cases, subsequent upgrades in ratings, and, to some extent, changes in the coverage of the S&P dataset. The breakdown of the non RMBS data by asset class is shown in the right hand panel of the figure. As one may observe, there are considerable changes in the numbers of some asset classes within the sample, particularly CLOs and CMBS.

In the case of Covered Bonds, we use data on components of the Bank of America Merrill Lynch Euro Covered Bond Index (ECV0). We focus on Euro-denominated investment grade covered bonds publicly traded in the Eurobond or Euro member domestic markets. We require that there be at least one year remaining term to final maturity, a fixed coupon schedule, and a minimum amount outstanding of EUR 250 million. We obtained daily bid and ask quotes from Bloomberg covering the period from the 26th of May 2009 to the 30th of September 2013.[9] The total number of AAA-rated bond bid-ask spread observations is 1,334,538.

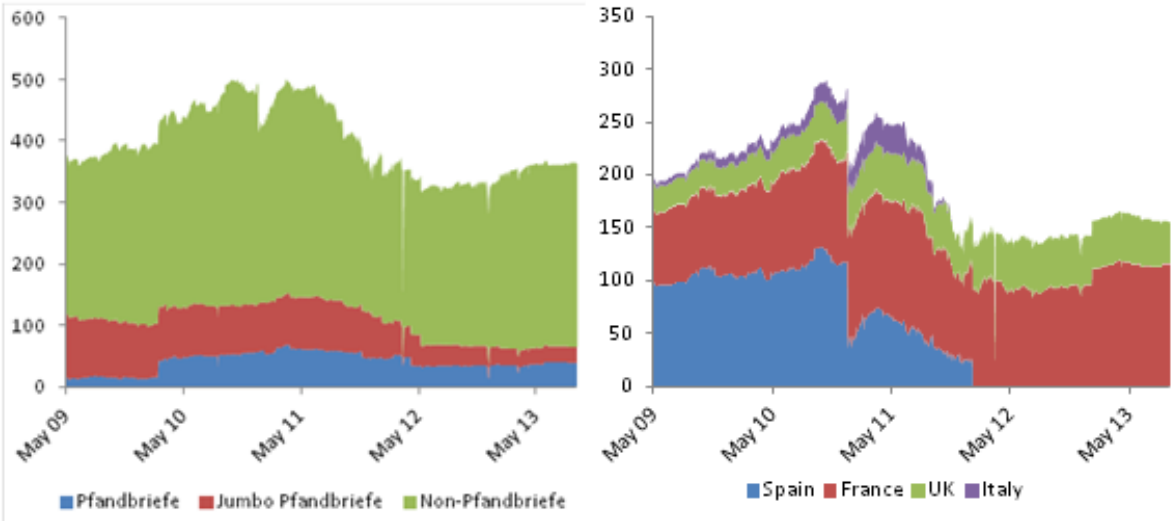

Figure 2 - Distribution over Time of the Covered Bond Data: The two graphs present the evolution of the Covered Bonds sample over time. On the left hand graph, Covered Bonds are grouped by subclass, specifically, whether they are Pfandbriefe, Jumbo Pfandbriefe or Non-Pfandbriefe. On the right hand graph Covered Bonds are grouped by country of issuance. The y-axis measures the number of daily Covered Bond, bid-ask spread observations, which are plotted against time on the x-axis. As is true for Figure 1, both graphs are stacked.

The distribution of the Covered Bond data by sub-sector is shown in Figure 2. Most of the data is for non-Pfandbriefe. All Pfandbriefe data are from the German market, with a split between jumbo and non-jumbo Pfandbriefe. The non-Pfandbriefe Covered Bond data comes from Spain, France, the UK and Italy. The observations from Spain and Italy exhibit the effects of the sovereign ratings ceiling which means that after a certain date, as these countries were downgraded, no Covered Bond securities could obtain AAA ratings. This is due to the ratings agency practice of imposing a sovereign ceiling on structured ratings. Detail on ratings agency policies on sovereign ratings ceilings may be found in Fitch Ratings (2013), Moody's (2011) and Standard & Poor's (2013).

The first exercise we perform with our data is to examine the evolution over time of bid-ask spreads for different asset-class sub-categories of the securities in our sample. In each case,

[9] A description of the proprietary algorithm used by Bloomberg to calculate bid-ask spreads is given in Appendix 1.

we calculate, for each working day, the mean bid-ask spread, and the 10% and 90% quantiles of the distributions of bid-ask spreads observable on each day. Note that, here, the 10% quantile denotes level for which 10% of the bid-ask spreads in the sample are less than this level and 90% are higher. Correspondingly, the 90% quantile is the level for which 90% of the sample bid-ask spreads are lower and 10% higher. The results of these calculations for a set of ABS sub-categories are shown in Figure 3.

The broad picture that emerges is one in which, for house-market-sensitive ABS (RMBS and HEL), bid-ask spreads, on average, tend to decline over the sample period as concerns about the quality of mortgage lending in the countries in question gradually fell, while spreads for CLOs and CMBS tended to increase initially before subsequently declining.

Figures 4 and 5 show comparable time series of daily means, 90%-quantiles and 10% quantiles for Covered Bond bid-ask spreads. In Figure 4, bid-ask spreads for Pfandbriefe, Jumbo Pfandbriefe and Other Covered Bonds are exhibited. Some jumps occur in the series reflecting changes in the coverage of the data available. The broad picture is of a rise in Covered Bond spreads in the three categories, particularly in the case of the non-Pfandbriefe or Other Covered Bond category, during the sovereign debt crisis of 2011. The impact of the major ECB interventions of 2012 are evident (a 'Draghi effect') in the sustained recovery that occurs in the first half of 2012.[10]

Figure 5 shows bid-ask spreads by country for the non-Pfandbriefe Covered Bonds. Here, the plots show bid-ask spreads in France peaking just before the Draghi intervention. UK Covered Bond bid-ask spreads remain persistently high for slightly longer. The Spanish and Italian series terminate early because of the effects of sovereign ratings ceilings mentioned earlier which lead to the disappearance of AAA-rated securities in these markets.

The average levels over time of the bid-ask spreads, by asset sub-class, may be grasped more readily from Table 4a which shows averages (i) over the sample period and (ii) from the start of 2011 onwards, for the daily means, 90% quantiles and 10% quantiles of the bid-ask spreads.

[10] On the 8th of December 2011, Mario Draghi, President of the ECB announced a programme of Longer Term Refinancing Operations or LTROs (Draghi, 2011). These were loans with a three year term, 1% interest rate, and accepted loans from the banks' portfolios as collateral. The total programme was announced for the sum of $640bn dollars or €489.2bn, an almost unprecedented intervention by the ECB. For market reaction, see, for instance: Ewing and Jolly (2011) or Stirling and Hirtling (2011). A useful overview of regulatory intervention in European markets over this crisis period, with a strong focus on intervention in secured debt markets (particularly, the Covered Bond market) is provided by Fawley and Neeley (2013).

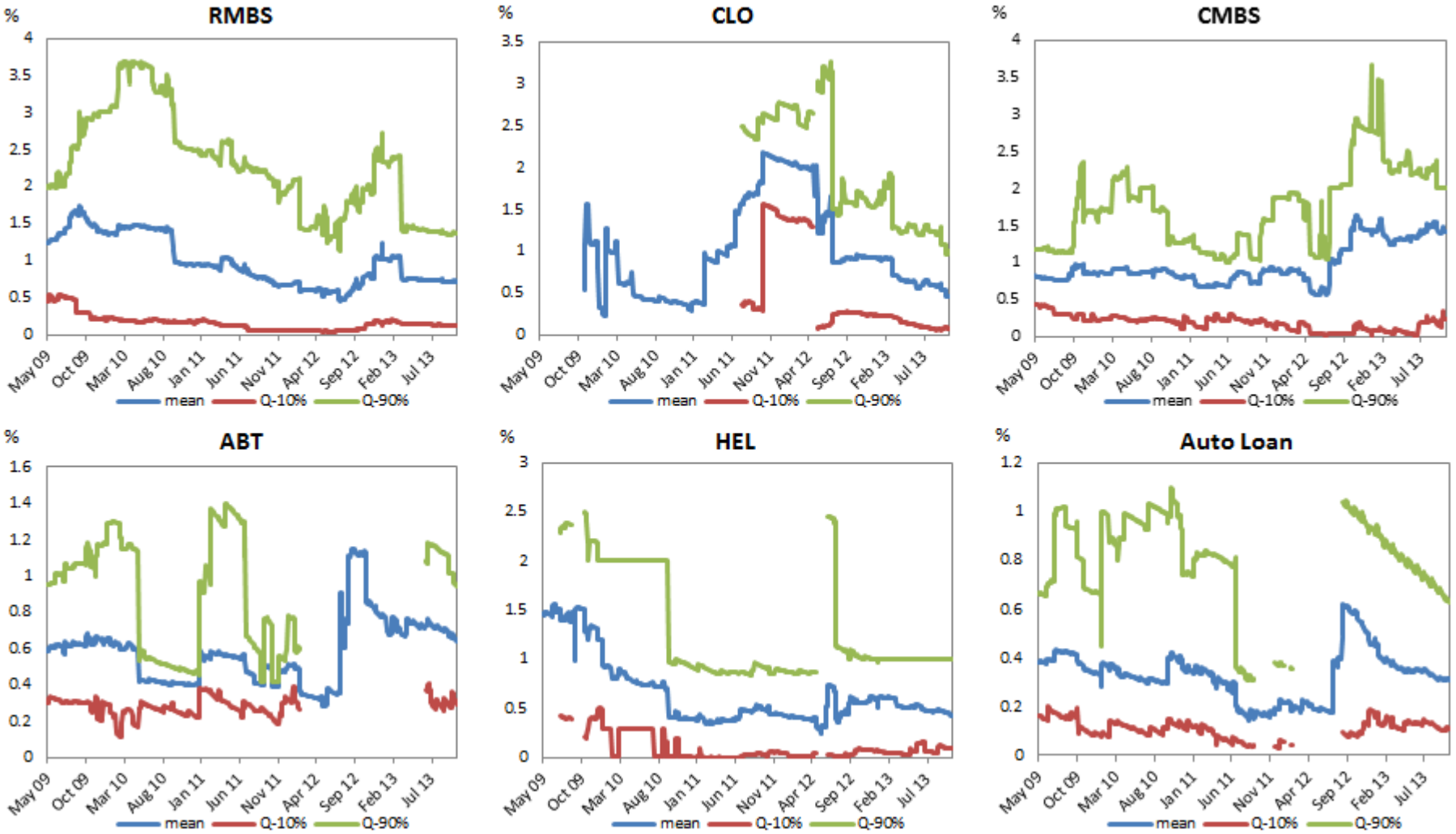

Figure 3 - Bid -Ask Spreads for ABS: The graphs display the evolution over time of summary statistics for six ABS sub-classes' observed bid-ask spreads. The y-axis shows the bid-ask spread measured as a percentage of the bond's par value, plotted against time (on the x-axis). The three summary statistics displayed are mean, 10% quartile and 90% quartile. The six ABS sub-classes are (clockwise from the top left hand graph): Residential Mortgage Backed Securities, Collateralised Loan Obligations, Collateralised Mortgage Backed Securities, Asset Backed Tranches, Home Equity Loans, and Auto-Loan Asset Backed Securities. To give an illustrative example, in May 2009, the average RMBS bid-ask spread was 1.3% of its par value. 90% of RMBS bid-ask spreads were below 2% of par, and 10% were below 0.5%.

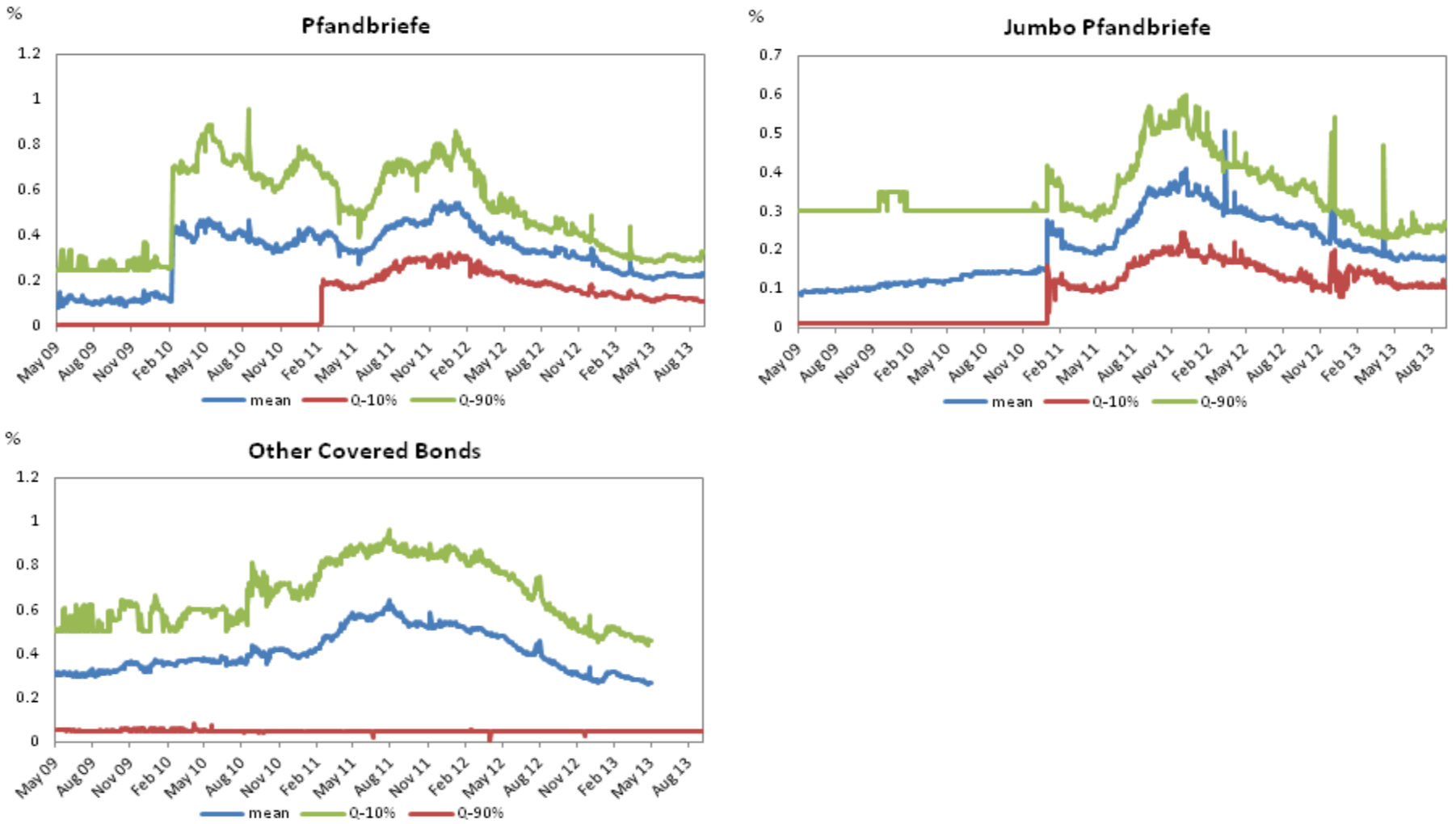

Figure 4 – Bid-Ask Spreads for Covered Bond Classes: A key message of this figure is that Auto Loan ABS bid-ask spreads averaged close to Pfandbriefe and less than those of Other Covered Bonds. From 2011 onwards RMBS and HEL bid ask spreads averaged less than all Covered Bonds including Pfandbriefe. The graphs display the evolution over time of summary statistics for three Covered Bond sub-classes' observed bid-ask spreads. The y-axis shows the bid-ask spread measured as a percentage of the bond's par value, plotted against time (on the x-axis). The three summary statistics displayed are the mean, 10% quartile and 90% quartile as before. The three Covered Bond sub-classes are (clockwise from the top left hand graph): Pfandbriefe, Jumbo Pfandbriefe, and Other Covered Bonds.

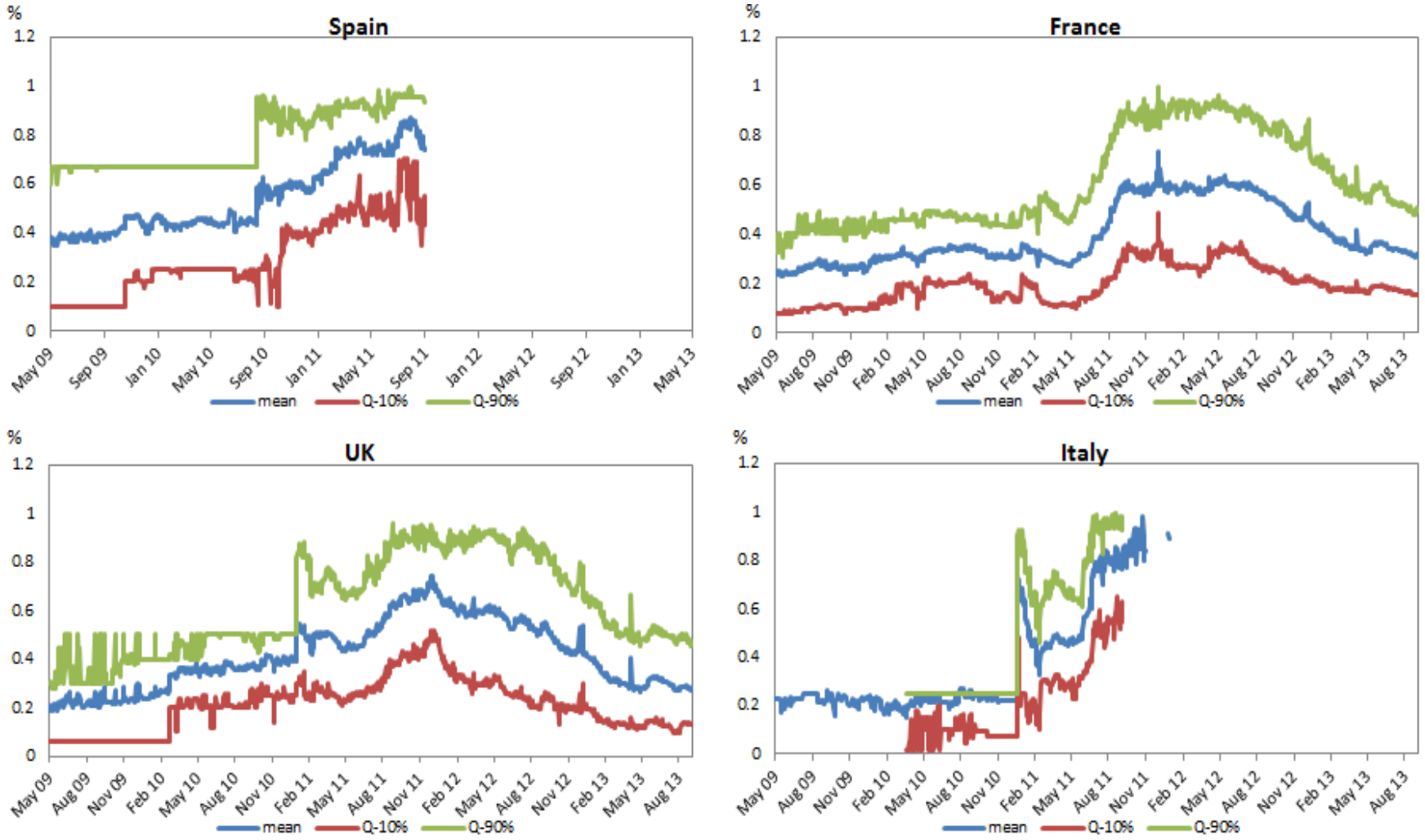

Figure 5 – Bid-Ask Spreads for All Covered Bonds by Country: The graphs display the evolution over time of summary statistics for Covered Bonds' observed bid-ask spreads in four countries: Spain, France, the UK, and Italy. The y-axis shows the bid-ask spread measured as a percentage of the bond's par value, plotted against time (on the x-axis). The three summary statistics displayed are the mean, 10% quartile and 90% quartile as before.

Over the sample period as a whole, Covered Bond bid-ask spreads were on average less than those of ABS. Strikingly, this was not the case for Auto-Loan ABS bid-ask spreads which averaged 33 basis points (bps) compared to 32, 20 and 40 for Pfandbriefe, Jumbo Pfandbriefe and Other Covered Bonds respectively.

Table 4

Bid-Ask Spread Time Series Key Statistics for Entire and Post-Crisis Periods

Tables 4a and 4b below display key summary statistics for time series of assets grouped by asset sub-class and (for Covered Bonds and RMBS) by country. For each aggregation the mean, average standard deviation, average 90% quantile and average 10% quantile are calculated. All the time series' summary statistics are calculated for each aggregation over both the whole sample period and from January 2011 onwards. The RMBS (a) samples contain all AAA rated UK, Italian, and Spanish RMBS. Many observations are dropped from the RMBS (a) samples shortly after January 2012 as Italian and Spanish Sovereign downgrades cause many securities to lose their AAA rating. In RMBS (b), all AAA rated securities at the start of January 2012 are fixed in our sample and so do not drop out when the sovereign downgrade causes them to lose their AAA rating. Similarly the Covered Bonds (a) samples. Similarly, the Covered Bonds (a) samples contain all securities. The Covered Bonds (b) samples contains securities fixed at their January 2012 and June 2012 levels for Spain and Italy respectively; this is, again, to illustrate the loss of observations caused by sovereign downgrades.

Table 4a: Assets by asset sub-class		**Whole sample period**				**2011 onward**			
		Mean	Avg SD	Avg 90% quant	Avg 10% quant	Mean	Avg SD	Avg 90% quant	Avg 10% quant
Covered Bonds	Pfandbriefe	0.32	0.16	0.51	0.12	0.35	0.13	0.52	0.18
	Jumbo Pfandbriefe	0.20	0.11	0.34	0.09	0.25	0.10	0.36	0.14
	Other Covered Bonds	0.40	0.18	0.66	0.19	0.44	0.19	0.72	0.22
ABS	RMBS	0.98	1.00	2.27	0.16	0.77	0.89	1.89	0.11
	CLO	0.96	0.11	1.82	0.42	1.07	0.61	1.82	0.42
	CMBS	0.97	0.83	1.75	0.18	1.03	0.88	1.82	0.14
	ABT	0.58	0.29	0.91	0.28	0.61	0.31	0.93	0.29
	HEL	0.65	0.49	1.27	0.10	0.47	0.39	0.99	0.04
	Auto Loan	0.33	0.23	0.81	0.11	0.31	0.21	0.75	0.10

Table 4b: Assets by country of issuance		**Whole sample period**				**2011 onward**			
		Mean	Avg SD	Avg 90% quant	Avg 10% quant	Mean	Avg SD	Avg 90% quant	Avg 10% quant
Covered Bonds (a)	Spain	0.51	0.19	0.75	0.27	0.68	0.18	0.90	0.44
	France	0.40	0.16	0.61	0.19	0.45	0.19	0.71	0.22
	UK	0.41	0.16	0.62	0.21	0.48	0.18	0.73	0.25
	Italy	0.37	0.11	0.51	0.22	0.62	0.18	0.75	0.34
Covered Bonds (b)	Spain	0.58	0.16	0.76	0.35	0.68	0.15	0.83	0.45
	Italy	0.54	0.11	0.67	0.37	0.73	0.14	0.83	0.47
RMBS (a)	Spain	1.45	1.06	2.76	0.27	1.20	1.07	2.62	0.08
	Italy	1.45	0.58	2.20	0.46	1.55	0.43	2.17	0.34
	UK	0.81	0.92	2.08	0.18	0.49	0.66	1.14	0.09
RMBS (b)	Spain	1.40	0.92	2.49	0.34	1.24	0.85	2.28	0.31
	Italy	1.34	0.78	2.31	0.47	1.34	0.78	2.36	0.43

When one examines data from the beginning of 2011 onwards, the bid-ask averages are no longer so different, especially when one focusses on national markets where ABS are relatively numerous, such as Spain, France, UK and Italy. Indeed, the average ABS bid-ask

spreads for these countries, except for CLOs & CMBS, are comparable in magnitude to those for Covered Bonds.

It is also noticeable that from 2011 onward the 10%-quantiles in Table 4a for RMBS and HEL are noticeably lower than the corresponding quantiles for Covered Bonds, even in the case of German Pfandbriefe. This suggests that the more liquid ABS are more liquid than the most liquid Covered Bonds.

To explore and compare the distributions of bid-ask spreads for ABS and Covered Bonds, we prepared a series of histograms, exhibiting bid-ask spread distributions for given days, evenly spaced through the sample period. These histograms are shown in Figures 6 to 11.

An important differentiator that one might expect would influence both liquidity and risk indicators (such as the bid-ask spread) is the national market or domicile of the securities. For understandable reasons (given that it is an EU-wide regulator, attempting to get agreement between officials from different nations), the EBA does not explore country-effects in its analysis. However, ex ante, one would expect country effects to be powerful, as worries about the growth prospects for different economies and the solvency of their banking sectors and sovereigns evolved over time. Leaving out country effects means that the EBA's analysis suffers from an important 'omitted variables' problem. When it finds for example that differences in the regulation of Covered Bond markets have an influence on liquidity, one wonders whether this simply reflects an omitted country effect.

In Figures 6 and 7, we remove country effects by comparing the distributions of bid-ask spreads for Covered Bonds and RMBS (the category of ABS for which we have most copious data) on five days spaced through our sample period (specifically the start of January in the four years from 2010 to 2013 and the final day of our sample in September 2013) for particular countries, namely the UK and Spain.

In the case of UK data, we see in Figure 6 that, at the start of the sample, Covered Bond spreads were noticeably lower than those of RMBS. However, by the beginning of 2012, most RMBS spreads were clearly lower than those of Covered Bonds, although there remained a tail of less liquid RMBS. By the end of the sample period, again the most liquid securities based on the bid-ask spread measure were RMBS but, leaving aside a small number of very illiquid RMBS, the distributions of spreads for RMBS and Covered Bonds were similar.

From Figure 7, a comparable picture emerges for Spain. RMBS bid-ask spreads are in fact bimodal with some very liquid and some quite illiquid RMBS being evident. At the height of the sovereign debt crisis at the very start of 2012 (just before the 'Draghi effect' had restored calm to the markets) a significant fraction of RMBS were noticeably more liquid than Covered Bonds, although as in Figure 6, a tail of illiquid ABS persisted.[11]

[11] Note that the distributions for January and September 2013 in Figure 7 are for securities that were rated AAA in January 2012.

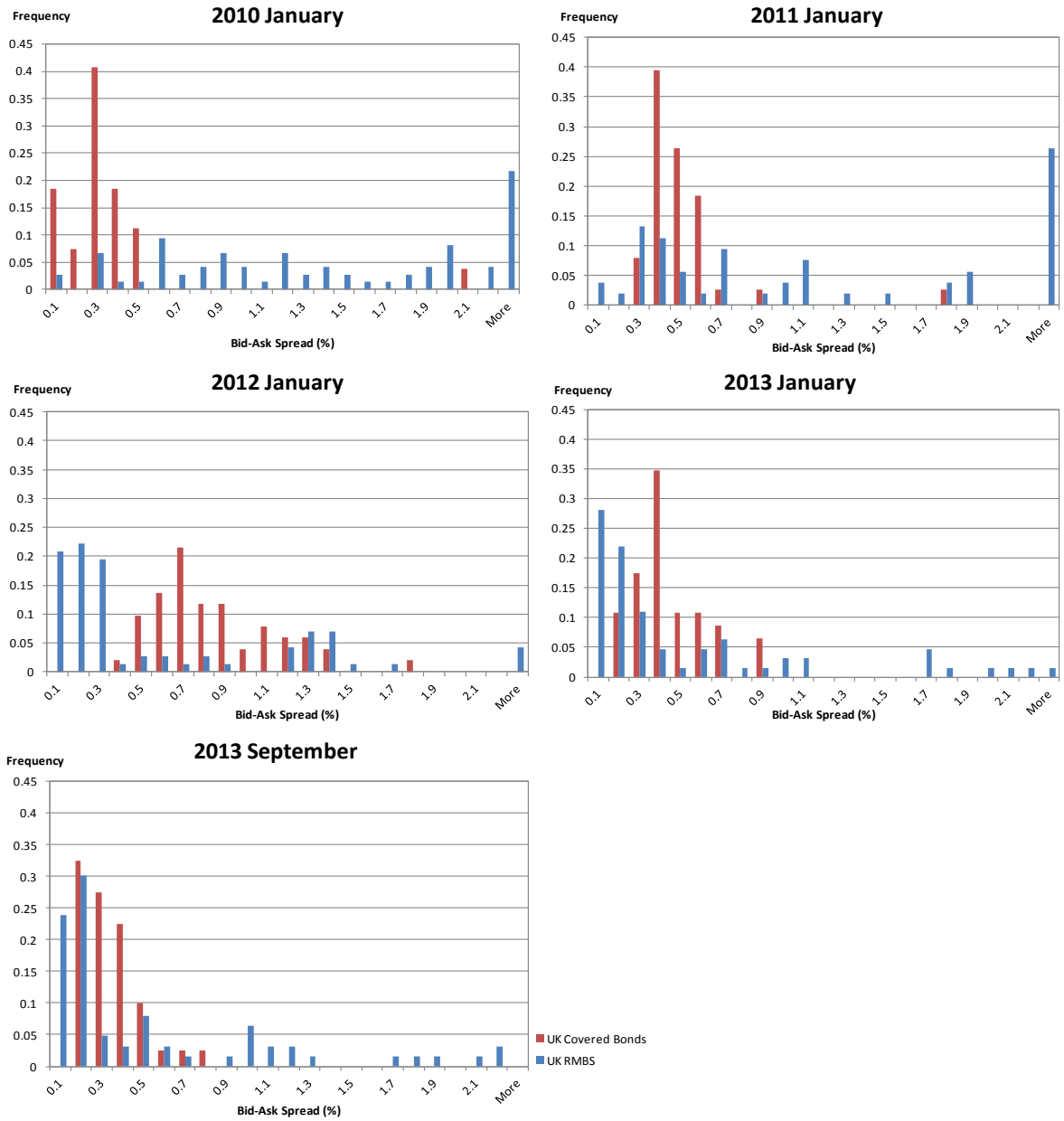

Figure 6 - UK Covered Bonds vs. RMBS: Bid-Ask Spread Distributions: The key message of this figure is that, as the centre of the crisis changed from ABS to sovereigns, bid-ask spreads for UK RMBS tightened until they were narrower than those on UK Covered Bonds. The histograms display the distribution of observed bid-ask spreads for UK Covered Bonds and UK RMBS ABS at five points in time. The 31st of January 2010, 2011, 2012, 2013 and the 31st of September 2013. The x-axis displays ranges of bid-ask spreads and the y-axis displays the frequency at which these ranges of bid-ask spreads occurred. For all five graphs, UK Covered Bonds are red (and on the left) and UK RMBS are blue (and on the right). For example, on the 31st of January 2010, 18% of all UK Covered Bonds spreads were between 0.0 and 0.1%. Similarly, on the same date, 41% of all UK Covered Bonds' spreads were between 0.2 and 0.3%. Finally, for both asset sub-classes, measured at each date, the total frequency should sum to one.

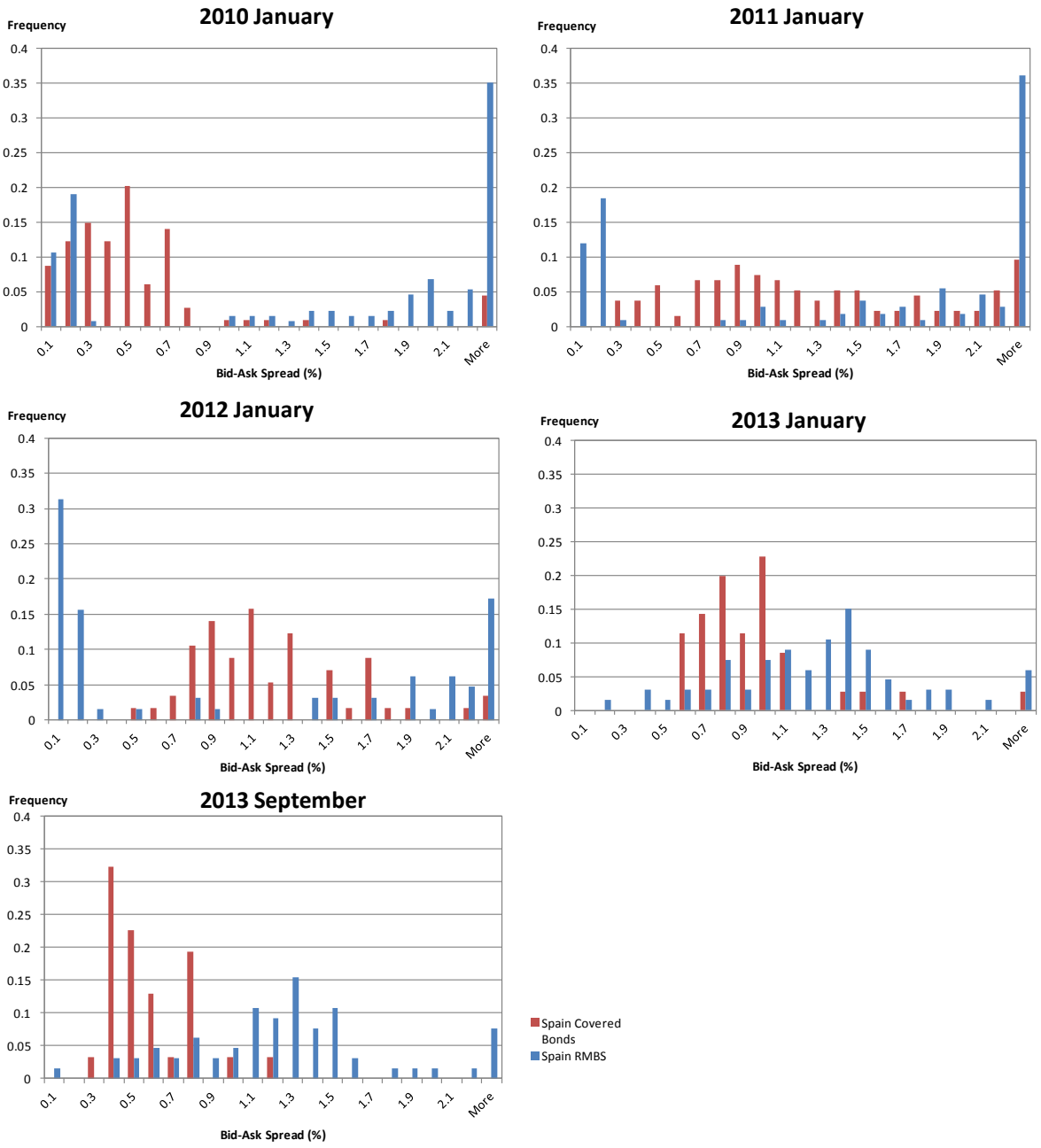

Figure 7- Spanish Covered Bonds vs. RMBS: Bid-Ask Spread Distributions: A key message is that, at the height of the sovereign debt crisis, many Spanish RMBS were more liquid than Spanish Covered Bonds. These histograms display the distribution of observed bid-ask spreads for Spanish Covered Bonds and Spanish RMBS ABS at five points in time: the 31st of January 2010, 2011, 2012, 2013 and the 31st of September 2013. The x-axis displays ranges of bid-ask spreads and the y-axis displays the frequency at which these ranges of bid-ask spreads occurred. For all five histograms, Spanish Covered Bonds are red (and on the left) and Spanish RMBS are blue (and on the right).

We also present results in Table 4b that permit one to compare period averages and quantiles of bid-ask spreads for Covered Bonds and RMBS by country. For the periphery countries, Spain and Italy, we present results prepared on two bases. First, we show results strictly requiring that all securities employed are AAA-rated on the date for which we calculate the means of quantiles. These results are designated "(a)". However, both ABS and Covered Bonds issued in these countries are affected by the ratings agency practice of imposing sovereign ratings ceilings. This means that as the sovereign ratings for these countries fell in the crisis, at a certain point, no Covered Bond or ABS could receive a AAA rating even if its collateral was completely unimpaired.

To evaluate the effects on the bid-ask spread statistics of the sovereign-related downgrades that occurred in 2012, we report results (designated "(b)") for which any Covered Bond or ABS that is AAA-rated at the start of 2012 remains in the sample after that date even if it is downgraded. This has the effect of extending the sample period for Spanish and Italian securities since otherwise AAA-rated securities become unavailable after a certain date in these markets.

The "(b)" results in Table 4b are broadly similar to the "(a)" results. The one estimate that changes significantly is the 10% quantile for RMBS which increases markedly when the sample period is extended as explained above. This might suggest that the liquidity of relatively highly liquid issues deteriorated after the sovereign ratings ceiling began to bite.

Figures 8 and 9 focus on comparisons of distributions of bid-ask spreads for Auto-loan-backed ABS and for Covered Bonds. Auto-loan-backed ABS are an interesting case because the EBA has completely excluded them from consideration as liquid assets and yet from what we saw in Table 4, their spreads appear very tight.

Finally, in Figures 10 and 11, we compare distributions of AA-rated Covered Bonds with AAA-rated RMBS and auto-loan-backed ABS. The comparisons are relevant because under the EBA proposals, Covered Bonds with ratings as low as AA- are included in the EHQLA category if their issue size is large enough whereas no RMBS are included and no Auto-Loan ABS are included even in the lower liquidity category of HQLA. The conclusions suggested by Figures 10 and 11 are that the distribution of bid-ask spreads are comparable across RMBS and Covered Bonds except that RMBS were clearly more liquid during the sovereign debt crisis. Auto-Loan ABS have noticeably higher liquidity than Covered Bonds in this comparison.

As short-dated ABS that are typically bought and held to maturity by investors, Auto-Loan ABS fare poorly in comparisons largely based on transactions data like those performed by the EBA. Yet, it appears that they may readily be sold if their owners decide they need to convert them into cash. Examining Figures 8 and 9, it is apparent that Auto-Loan ABS exhibit comparable liquidity to Covered Bonds. It is also noticeable that, in contrast to RMBS, Auto-Loan ABS lack a tail of illiquid issues. When compared to non-Pfandbriefe Covered Bonds, Auto-Loan ABS show superior liquidity.

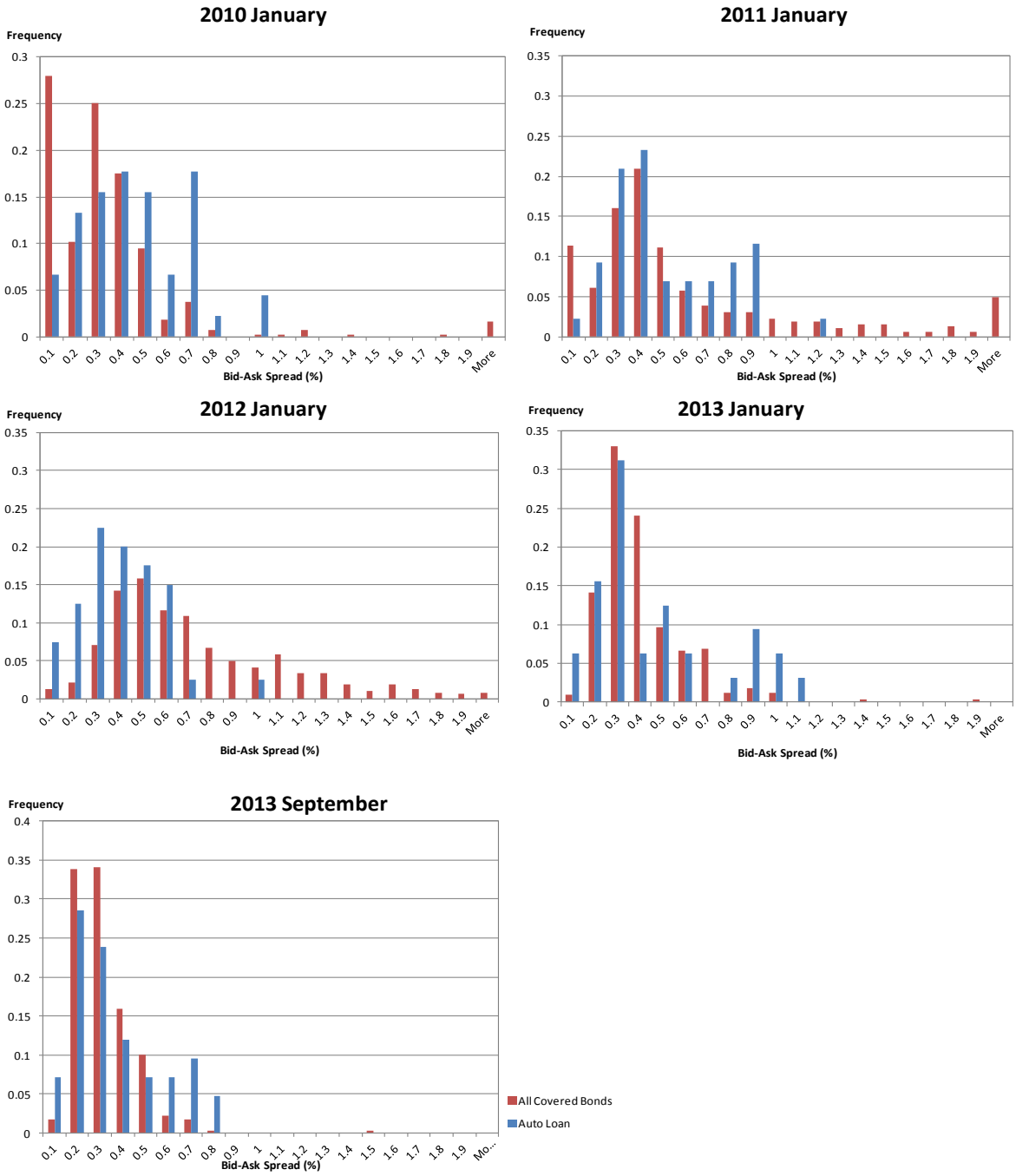

Figure 8 - Auto-Loan vs. All Covered Bonds: Bid-Ask Spread Distributions: The key message is that auto-loan ABS and Covered Bonds have comparable liquidity, The histograms shown here display the distribution of observed bid-ask spreads for All Covered Bonds and Auto-Loan ABS at five points in time: the 31st of January 2010, 2011, 2012, 2013 and the 31st of September 2013. The x-axis displays ranges of bid-ask spreads and the y-axis displays the frequency at which these ranges of bid-ask spreads occurred. For all five graphs, All Covered Bonds are red (and on the left) and Auto-Loan ABS are blue (and on the right).

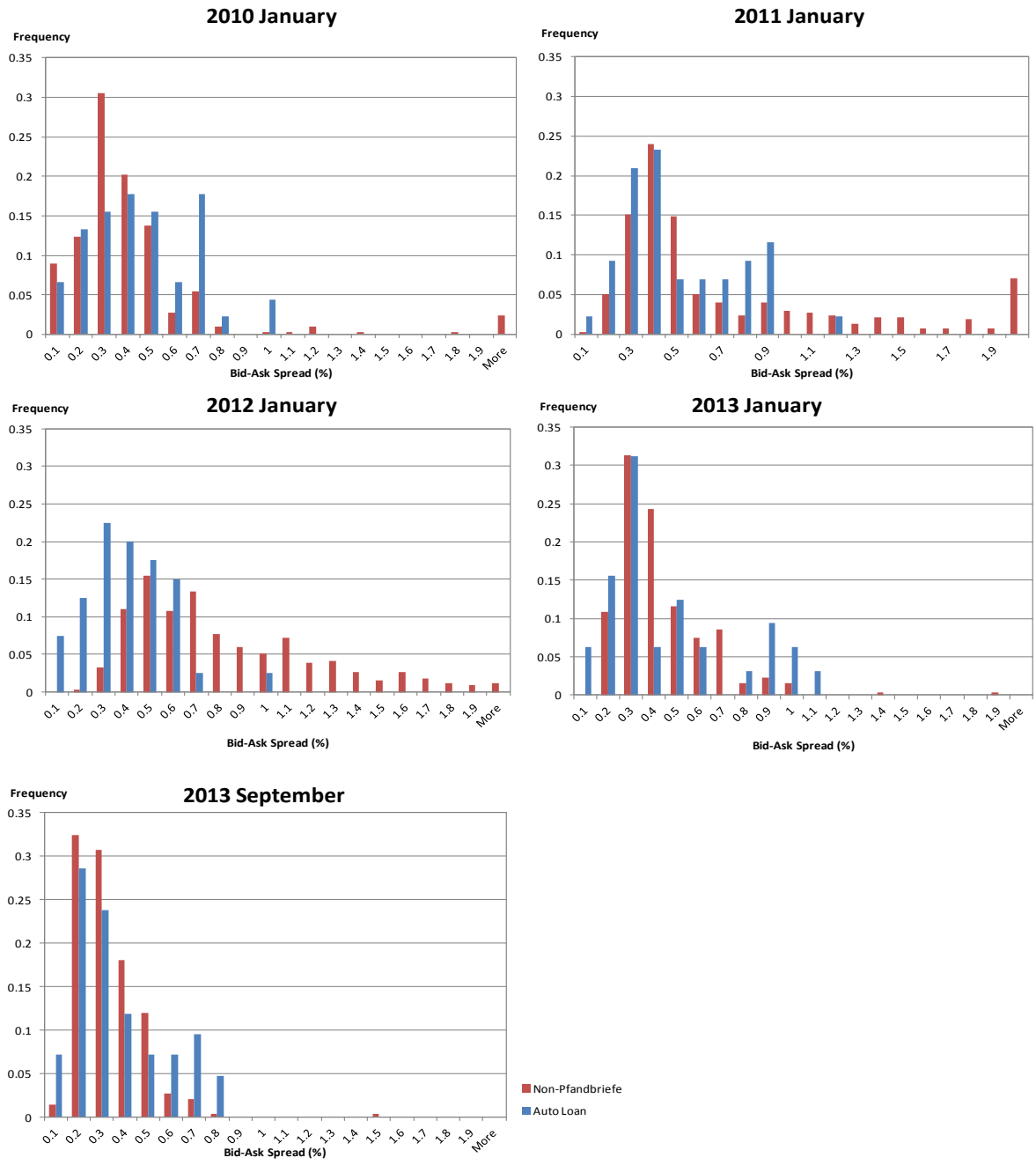

Figure 9 – Non-Pfandbriefe vs. Auto-Loan ABS: Bid-Ask Spread Distributions: The key message is that, when compared to non-Pfandbriefe Covered Bonds, Auto-Loan ABS are superior in liquidity. These histograms display the distribution of observed bid-ask spreads for Non-Pfandbriefe Covered Bonds and Auto-Loan ABS at five points in time: the 31st of January 2010, 2011, 2012, 2013 and the 31st of September 2013. The x-axis displays ranges of bid-ask spreads and the y-axis displays the frequency at which these ranges of bid-ask spreads occurred. For all five graphs, Non-Pfandbriefe Covered Bonds are red (and on the left) and Auto-Loan ABS are blue (and on the right).

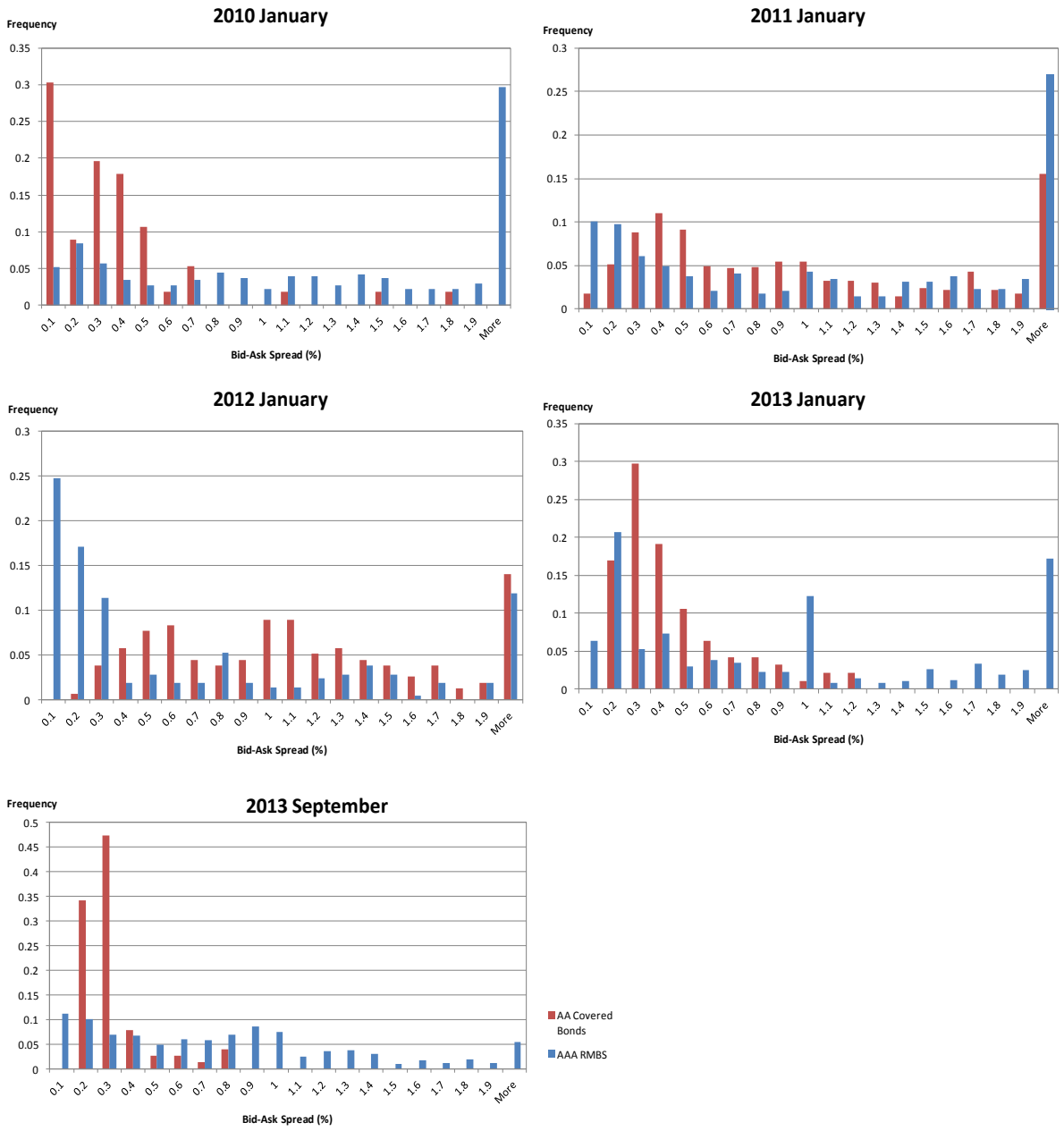

Figure 10 - AA Covered Bonds vs. AAA RMBS: These histograms display the distribution of observed bid-ask spreads for AA Covered Bonds and AAA RMBS at five points in time: the 31st of January 2010, 2011, 2012, 2013 and the 31st of September 2013. The x-axis displays ranges of bid-ask spreads and the y-axis displays the frequency at which these ranges of bid-ask spreads occurred. For all five graphs, AA Covered Bonds are red (and on the left) and AAA RMBS are blue (and on the right).

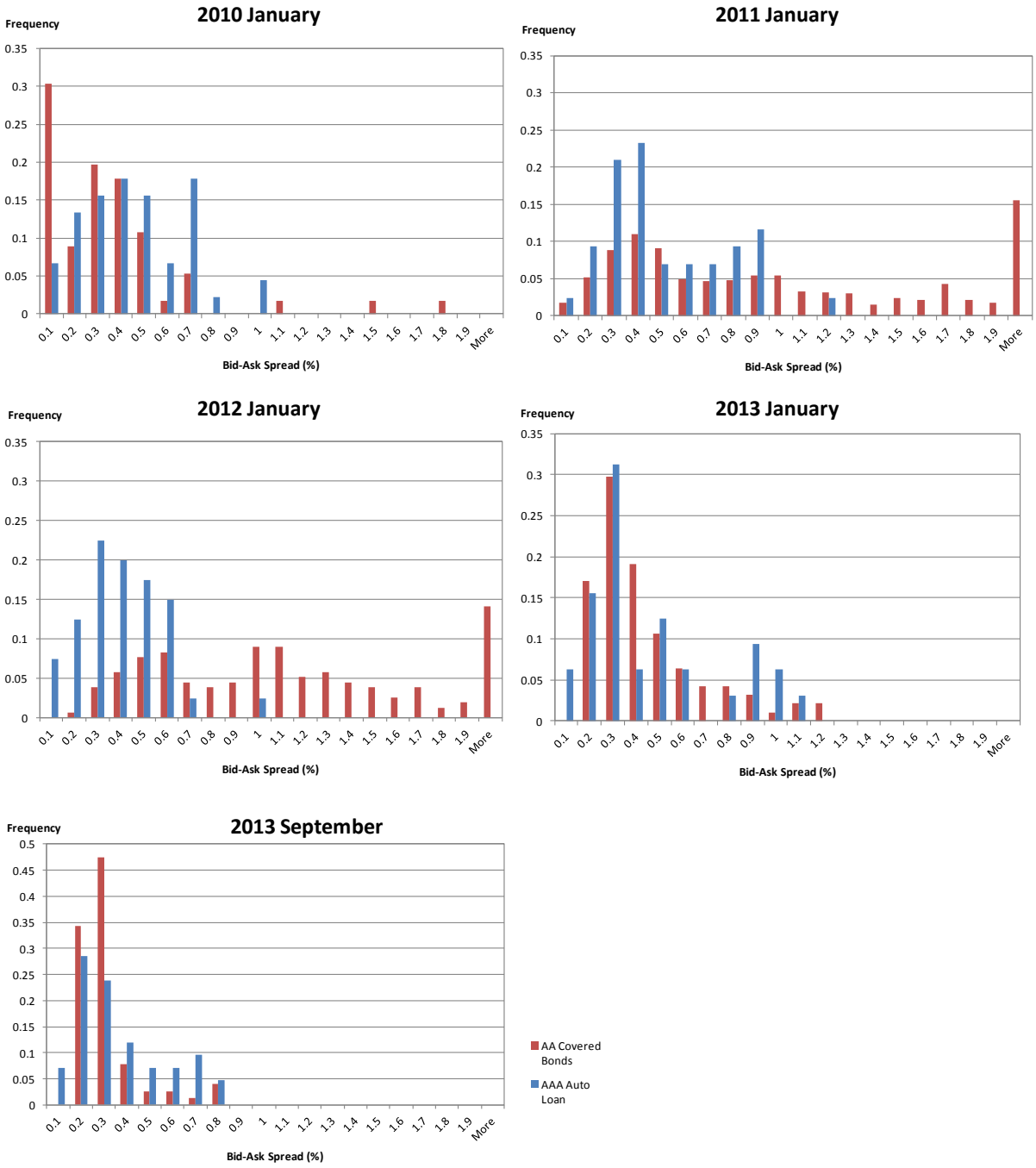

Figure 11 - AA Covered Bonds vs. AAA Auto-Loans: These histograms display the distribution of observed bid-ask spreads for AA Covered Bonds and AAA Auto-Loan ABS at five points in time: the 31st of January 2010, 2011, 2012, 2013 and the 31st of September 2013. The x-axis displays ranges of bid-ask spreads and the y-axis displays the frequency at which these ranges of bid-ask spreads occurred. For all five graphs, AA Covered Bonds are red (and on the left) and AAA Auto-Loan ABS are blue (and on the right).

SECTION 4 – FUTURE PRICE DISCOUNTS AS WELL AS IMMEDIATE TRANSACTIONS COSTS

In this last section, we take a somewhat different perspective on the problem of comparing the relative liquidity of Covered Bonds and ABS. In our analysis above, like the EBA, we focus on indicators of immediate liquidity, i.e. *current* transactions costs such as bid-ask spreads. In general, however, investors also price into security values their estimates of possible *future* transactions costs. Securities which are likely, in the market's view, to become illiquid during a crisis when transactions costs will be very high will be discounted the most.

Such considerations are clearly important for the LCR. LCR buffers are intended to help banks weather crises either when a bank's own individual access to funding alone is in question (an idiosyncratic liquidity crisis) or, more generally, when liquidity is scarce in the market as a whole (a more systemic liquidity crisis). From a public policy perspective, the latter situation is clearly graver. Securities that become illiquid in situations of systemic liquidity shortages should be regarded as less eligible for LCR-like buffers.

On *a priori* grounds, one may think that securities secured against banking assets are likely to be problematic during liquidity crises, since such crises commonly involve banks. Both Covered Bonds and ABS may therefore be seen as vulnerable. However, the EBA's approach does not reflect this. For example, the EBA rejects equities and gold as liquid assets on the basis of their current high volatility without allowing for the advantage that these assets (particularly gold) are less likely to be distressed at times of liquidity scarcity. Between Covered Bonds and ABS, one may consider that the former are more subject to illiquidity in the direst type of crisis when bank finances are weak and sovereign support loses credibility (as occurred in some countries in 2011).

In valuing an asset now, market participants will allow for the discounted costs of future (rather than current) transactions costs. Since sales may occur in crisis periods, their size may be substantial. (Transactions costs in crises may be large and subject to significant risk premiums.) Such discounts for future transactions costs reduce both the bid and ask prices of securities. By investigating the level of such discounts and how they behave over time, we can obtain a perspective on how concerned the market has been about transactions costs for different asset classes in periods of crisis.

To perform such an investigation for Covered Bonds and ABS, for each month end over the sample period, we fit a term structure of credit spreads for the two asset classes. Using the average market spreads for AAA-rated securities on the given days, we calculate the price the security would have if its cash flows were discounted using Treasury yields plus the estimated market spreads, which we refer to as "model prices".

For each of the month-end days, we then regress the difference between the prices and model prices on the bid-ask spreads. This shows how securities that have high bid-ask spreads were discounted. Note that concerns about the future marketability of a security will depress both bid and ask prices. The discount will be substantial if investors are concerned that a security will be illiquid in a future crisis when they may wish to sell.

The first step in this analysis is to fit term structures of spreads to cross sectional data on ABS and Covered Bonds for different rating categories. We employ the method developed by Perraudin and Wu (2011) which consists of estimating credit spreads by discounting cash

flows (adjusted initially using Treasury yields). The credit spreads are parameterised using a risk-adjusted transition matrix. These techniques are explained in Appendix 2 below.

The cash flows for Covered Bonds are easy to deduce from coupon and maturity information as these generally have a bullet-type payment structure. Inferring cash flows for ABS is more complicated because they are often subject to prepayment. We use industry standard approaches, employing estimates of Constant Prepayment Rates (CPRs) and Weighted Average Lives (WALs) provided by Standard & Poor's for the securities in our sample for each day of our sample period.

Figures 12, 13 and 14 contain plots of spreads for AAA-rated Covered Bonds and ABS over our sample period. These are an intermediate output of our analysis but are still somewhat interesting as they show how spreads (reflecting both credit and liquidity discounts) evolved in these markets over the sample period. The Covered Bond spreads peak just before the Draghi intervention. Pfandbriefe spreads show an inverted term structure which is what one might expect when the market is concerned about a crisis that is viewed as short-lived. The non-Pfandbriefe spreads exhibit a much flatter term structure suggesting that risks were seen as longer lived.

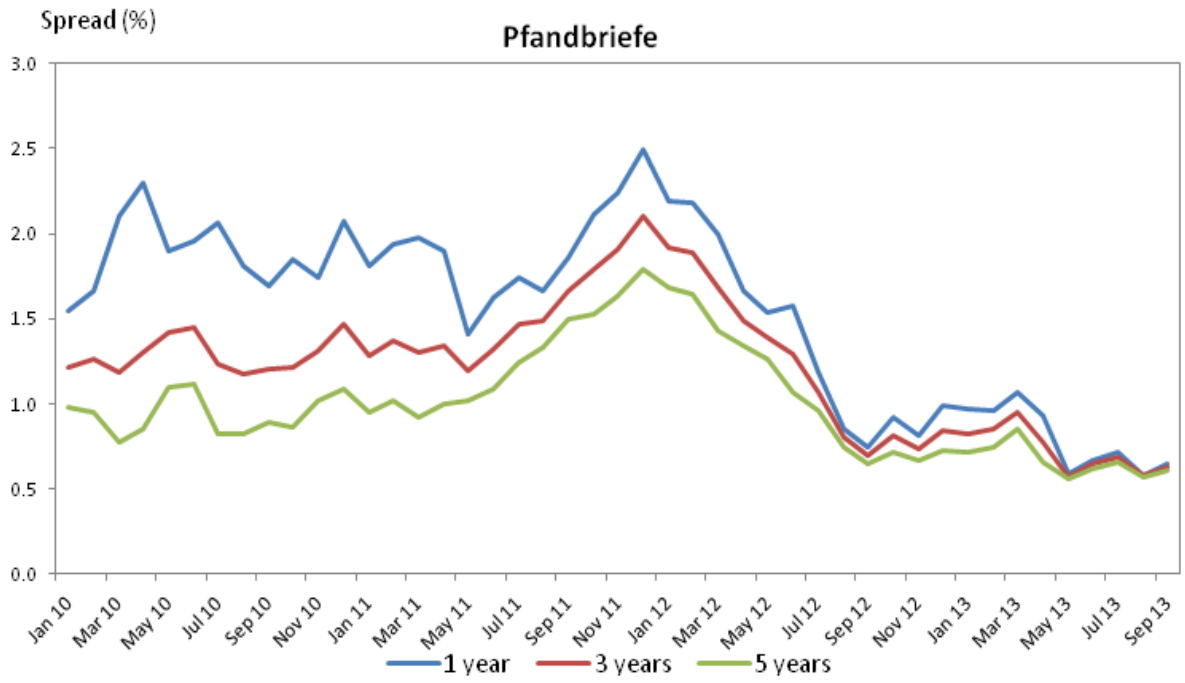

Figure 12 - Pfandbriefe Spreads: This figure shows the estimated evolution of spreads for AAA-rated Pfandbriefe with three different maturities between January 2010 and September 2013. The y-axis measures the estimated spread, calculated as described in the text (and as described in further detail in Appendix 2). This is plotted against time (on the x-axis). Spreads are estimated for one, three, and five year maturities. For example we estimate that in January 2010, the spread on a five year AAA Pfandbriefe was 1%.

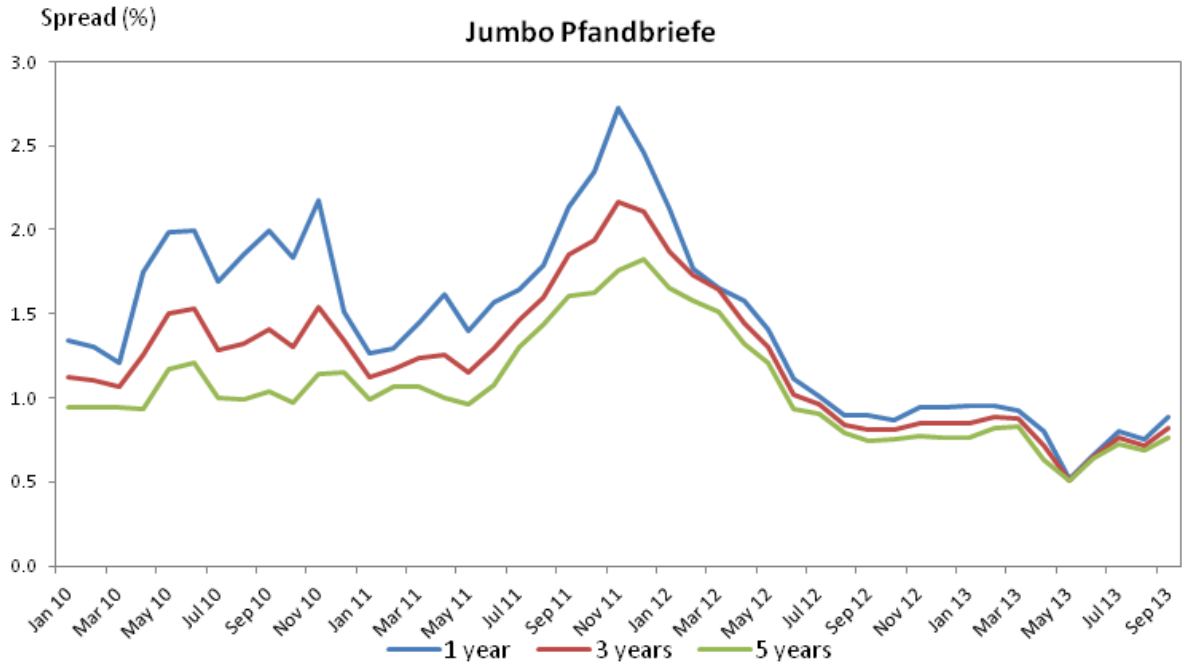

Figure 13 - Jumbo-Pfandbriefe Spreads: This figure shows the estimated evolution of spreads for AAA-rated Jumbo Pfandbriefe of three different maturities between January 2010 and September 2013. The y-axis measures the estimated spread and is plotted against time (on the x-axis). Spreads are estimated for one, three, and five year maturities.

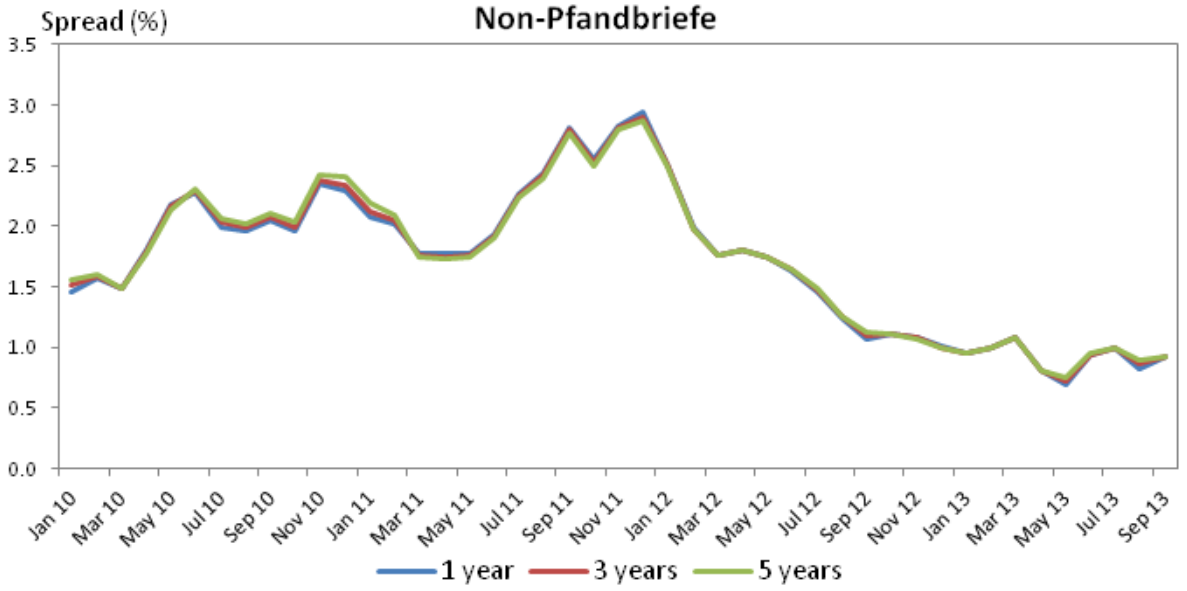

Figure 14 - Non-Pfandbriefe Spreads: This figure shows the estimated evolution of spreads for AAA-rated Non-Pfandbriefe Covered Bonds of three different maturities between January 2010 and September 2013. The y-axis measures the estimated spread and is plotted against time (on the x-axis). Spreads are estimated for one, three, and five year maturities.

It is not straightforward to fit term structures for individual ABS sub-categories because of lack of data, so we focus only on Euro-denominated RMBS. Figure 15 shows time series plots of RMBS spreads for different maturities. Again, there is some progression of spreads in maturity and again the spreads peak around the time of the Draghi intervention although

they show some volatility in the spring of 2012 before finally declining in the summer of that year.

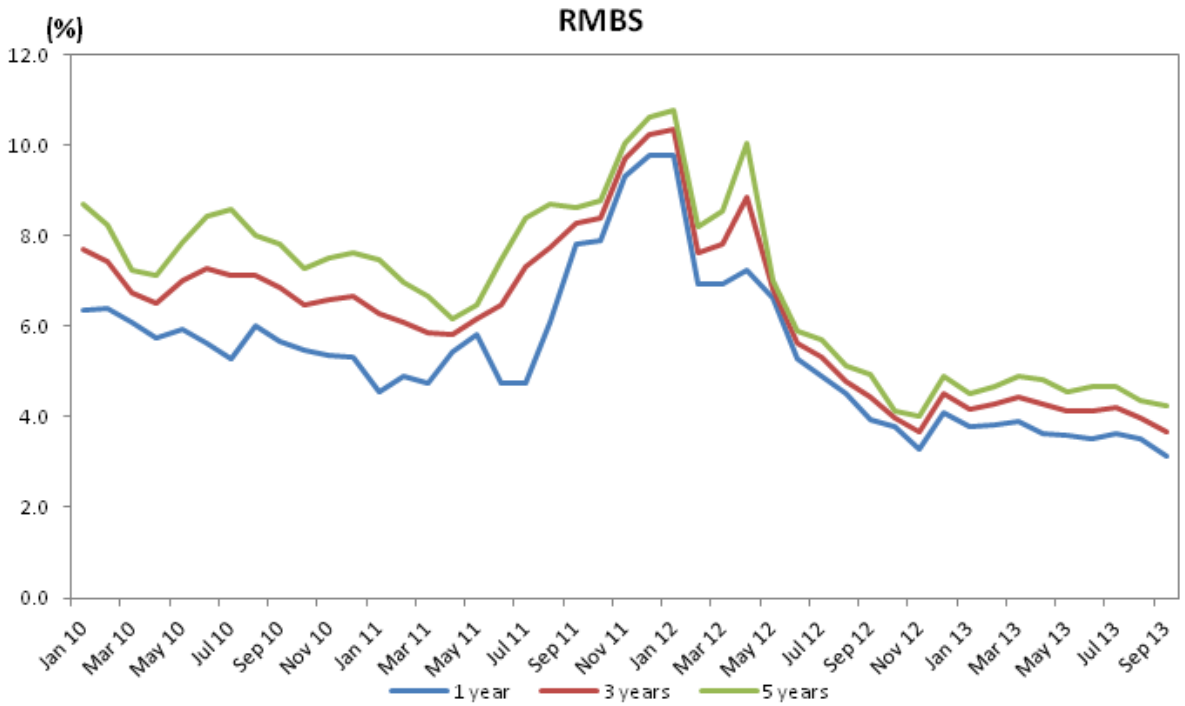

Figure 15 - ABS Spreads: This figure shows the estimated evolution of spreads for AAA-rated Euro-denominated RMBS of three different maturities between January 2010 and September 2013. The y-axis measures the estimated spread and is plotted against time (on the x-axis). Spreads are estimated for one, three, and five year maturities.

To extract estimates of the portion of spreads that is attributable to liquidity, for each security and for each month-end day in our sample period, we calculate the gap between the actual price of the security and the price implied when one employs the AAA-spreads estimated as just explained. This price gap may be seen as the price discrepancy between the actual security price observed in the market and the price the security would have if valued using the spreads employed by the market, on average, for securities of that rating and class.

We then regress the price gaps on the bid-ask spread (as a measure of liquidity). The liquidity price effect is finally calculated by taking the product of (i) the resulting regression coefficient and (ii) the gap between the 10% and 90% quantile of the bid-ask spreads. This measure shows the discrepancy in pricing between high and low liquidity bonds. The approach we take (of performing regressions of gaps between market process and prices based on fitted spreads) effectively controls for both rating and maturity. Details of our approach may be found in Appendix 3.

Figures 16, 17 and 18 all show illiquidity effects over the sample period for Covered Bonds collectively, as well as for non-Pfandbriefe Covered Bonds and RMBS. The results in Figure 16 show substantial differences between Pfandbriefe (standard and jumbo) and other covered bonds. Again, the Draghi effect is very evident.

In Figure 17, we break down the non-Pfandbriefe results by country. The illiquidity discounts are greatest for Spanish securities. There is major volatility in discounts in the spring of 2011. The timing is different for France and Britain for which the peak discounts occur late in 2011.

The liquidity discounts for AAA-rated RMBS are substantial and similar in size to Spanish Covered Bonds. The emergence of liquidity discounts occurs later, however. We interpret this as showing that, as RMBS spreads narrow in 2011, the narrowing occurs first for liquid issues, causing a significant gap to open up between liquid and illiquid RMBS.

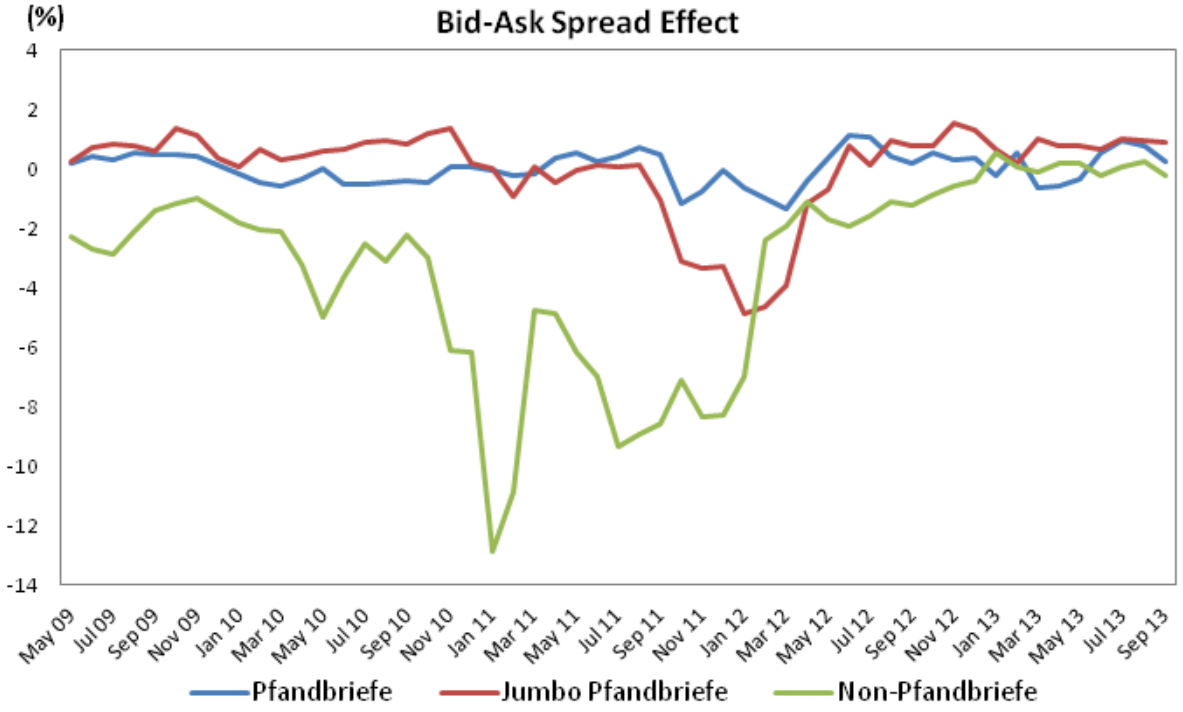

Figure 16 - Covered Bond Liquidity Price Effect: This graph shows the evolution over time of the liquidity price effect for the three different Covered Bond sub-classes. The liquidity price effect is calculated by regressing the price gaps on the bid-ask spread and then taking the product of (i) the resulting regression coefficient and (ii) the gap between the 10% and 90% quantile of the bid-ask spreads. The liquidity price effect is displayed on the y-axis and is plotted against time (on the x-axis). Results are displayed for Pfandbriefe, Jumbo Pfandbriefe, and Non-Pfandbriefe Covered Bonds.

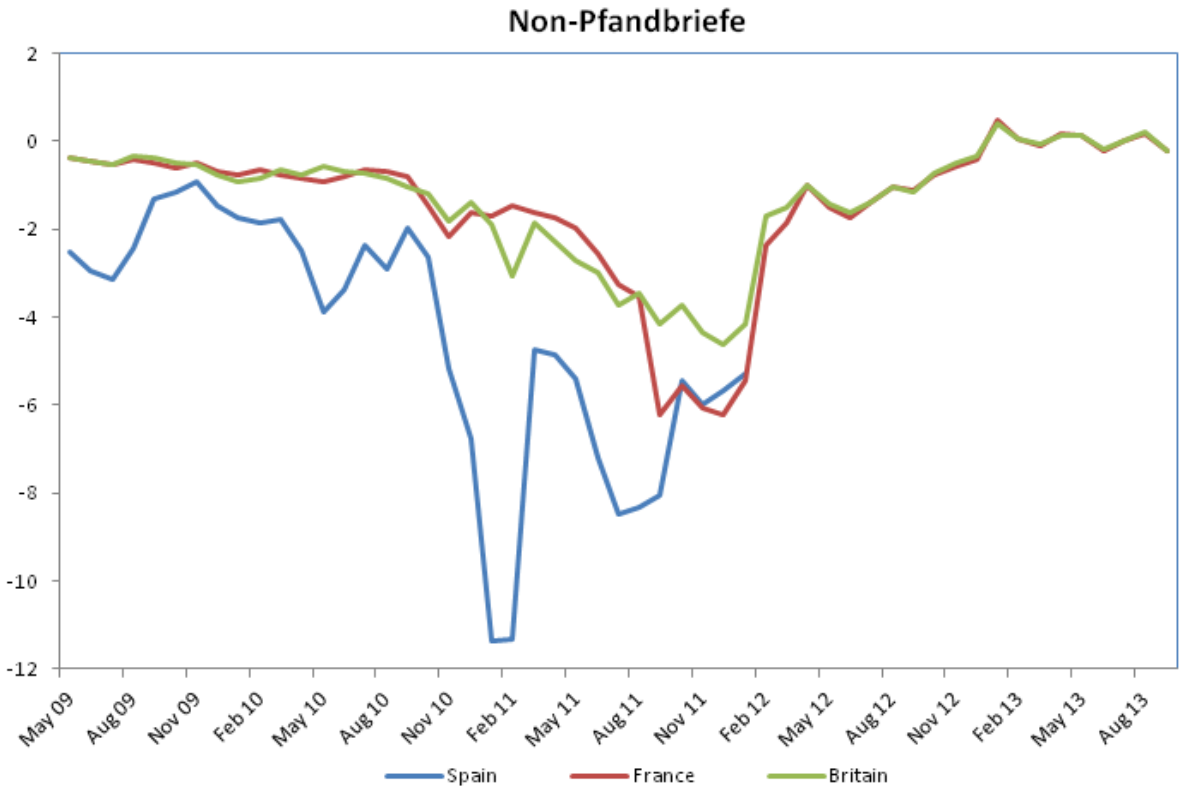

Figure 17 - Non-Pfandbriefe Liquidity Price Effect by Country: This graph shows the evolution over time of the liquidity price effect for Non-Pfandbriefe Covered Bonds, issued in three locations: Spain, France, and Britain. The liquidity price effect is displayed on the y-axis and is plotted against time (on the x-axis).

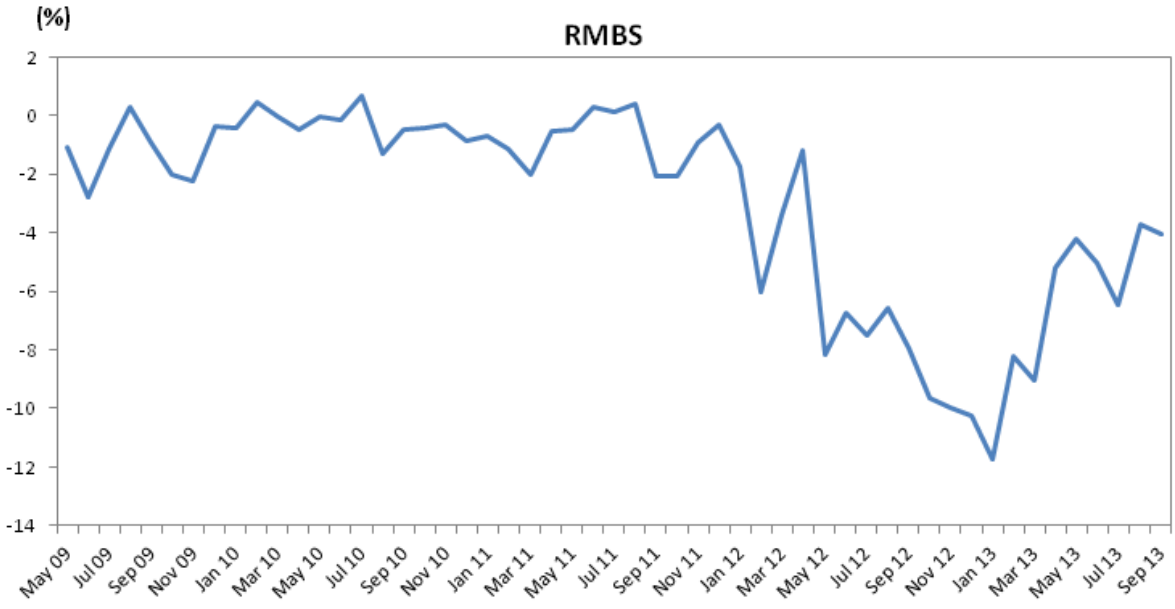

Figure 18 - Euro RMBS Liquidity Price Effect: This graph shows the evolution over time of the liquidity price effect for RMBS. The liquidity price effect is displayed on the y-axis and is plotted against time (on the x-axis).

SECTION 5 – CONCLUSIONS

This paper aims to provide a new perspective on the relative liquidity of two important European asset classes, Covered Bonds and ABS. We focus on evidence from bid-ask spread data, a data source neglected in the recent EBA analysis of asset class liquidity.

We present simple, transparent calculations of bid-ask spread distributions and then a more elaborate set of calculations that illustrate the contribution of market worries about future crisis-period transactions costs to individual security discounts.

Both approaches suggest that Covered Bonds and ABS are not as different as the EBA has claimed. The more liquid ABS exhibit greater liquidity than Covered Bonds do. In general, in the sovereign crisis period around 2011, Covered Bonds appear to have been less liquid than ABS. One category of short-dated, non-mortgage-related ABS, auto-loan-backed ABS, ranked very low for liquidity by the EBA, has tight spreads and so appears comparable to the most liquid Covered Bonds.

Taken together, we believe that our analysis suggests a different picture of the relative liquidity of asset classes than that presented by the EBA (2013b).

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APPENDIX 1: BLOOMBERG GENERIC (BGN) AND STANDARD AND POOR'S BID-ASK SPREAD DATA

Bloomberg uses its own proprietary formula to calculate this bid-ask spread. This formula utilizes quotes provided by a proprietary set of contributors. The calculated bid-ask spreads are known as the Bloomberg Generic (BGN) bid-ask spreads and should be considered indicative not binding.

The definition of BGN provided by Bloomberg is as follow:

> *"The BGN pricing source is different than the Composite in that it does not just take the best bid/offer from selected contributors. Instead each contributor is assigned a quality score based on numerous factors including update frequency and spike frequency. The algorithm then uses this information to generate better prices and more accurate spreads. It also respects local market trading hours, this is because typical contributions outside of market trading are poor. We will always adjust these trading hours for particular currency pairs to be set for hours where we feel contributions are good."*
>
> *Bloomberg Generic Price (BGN) is Bloomberg's market consensus price for corporate and government bond. Bloomberg Generic Prices are calculated by using prices contributed to Bloomberg and any other information that we consider relevant. Bloomberg does not make a market in any of the securities that we price. The actual methodology we use is proprietary and depends on the type of pricing and the markets involved. The goal of the methodology is to produce "consensus" pricing. To the extent that we are not comfortable that a bond can be assigned a consensus price at any time, we will mark it "not priced". We constantly and vigorously review the performance of the system and alter it as we determine necessary to achieve our goal."*

BGN data has been used in a number of academic studies of liquidity, including, for instance: Bao, Pan and Wang (2010), Chen, Lesmond and Wei (2007) and Longstaff, Mithal, and Neis (2005).

The Standard & Poor's bid-ask spread data we employ is again based on a proprietary algorithm (including inspection and adjustment by analysts) that combines price quotes supplied to Standard & Poor's by multiple banks with the objective of obtaining market consensus bid and ask prices.

APPENDIX 2: SPREAD TERM STRUCTURE FITS

This appendix provides information on the transition-matrix approach to fitting defaultable debt spread term structures for different ratings categories.

Consider a set of bonds with ratings from the set {1, 2, …, J} and prices B_i, i = 1, 2,…, N.

$$B_i = \sum_{j=1}^{J_i} C_{i,j} \exp\left[-\left(r_{\tau_{i,j}} + S^{(r)}_{\tau_{i,j}}\right)\tau_{i,j}\right]$$

where $C_{i,j}$ for j = 1, 2,…, J_i are the cash flows of bond i and the $\tau_{i,j}$ are the cash flows dates for j = 1, 2, …, J_i.

Suppose that the τ dates are discretised so that the $\tau_{i,j}$ are all integers and that ratings evolve accordingly to a Markov chain with transition matrix[12] M. The transition matrix has the following shape:

$$M = \begin{pmatrix} \theta_{1,1} & \theta_{1,2} & \cdots & \theta_{1,R} & \theta_{1,D} \\ \theta_{2,1} & \theta_{2,2} & & \theta_{2,R} & \theta_{2,D} \\ \vdots & & \ddots & \vdots & \\ \theta_{R,1} & \theta_{R,2} & \cdots & \theta_{R,R} & \theta_{R,D} \\ 0 & 0 & & 0 & 1 \end{pmatrix}$$

where $\theta_{i,j}$denotes the probability of a bond moving from rating i to rating j in one year, for j, i = {1, 2, …, R}. The last column and row of the transition matrix M represent the probability of defaulting and it is denoted by $\theta_{i,D}$ for i = {1, 2, …, R}.

The default probabilities at horizons 1, 2, …, 30 years are the right hand column of powers of M. Let $\theta^{(j)}_{i,D}$ be the right hand column of the j^{th} power of M, for j = {1, 2, …, 30}and for i = {1, 2, …, R}. The survival probability of a bond at time j conditional on rating i at time zero, denoted by $P^{(j)}_i$, is denoted as follows:

$$P_i^{(j)} = 1 - \theta_{i,D}^{(j)}$$

Given a time homogenous transition matrix M, we can price a bond i as,

$$\widetilde{B_\iota} = \sum_{j=1}^{J_i} C_{i,j} \exp[-r_j j]\left[\gamma + P_i^{(j)}(1-\gamma)\right]$$

Where γ is the expected recovery rate and it is constant across all rating categories; and r_j is Treasury zero-coupon interest rate for a bond with maturity j.

[12] The transition matrix is assumed to be in annual terms.

If M is parameterized in a suitable manner, $M = M(\tilde{\theta})$, we can minimized the sum of the squared differences between the model and the observed prices over the vector $\tilde{\theta}$. To enforced appropriate properties for $M(\tilde{\theta})$, we parameterize it as:

$$M(\tilde{\theta}) = \begin{pmatrix} 1 - \Phi(\tilde{\theta}_{1,2}) - \hat{\Phi}_1 & \Phi(\tilde{\theta}_{1,2}) & 0 & \cdots & \hat{\Phi}_1 \\ \Phi(\tilde{\theta}_{2,1}) & 1 - \Phi(\tilde{\theta}_{2,2}) - \Phi(\tilde{\theta}_{2,3}) - \hat{\Phi}_2 & \Phi(\tilde{\theta}_{2,3}) & \cdots & \hat{\Phi}_2 \\ \vdots & \vdots & \vdots & \ddots & \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

where,

$$\begin{bmatrix} \hat{\Phi}_1 \\ \hat{\Phi}_2 \\ \vdots \\ \hat{\Phi}_R \end{bmatrix} = \begin{bmatrix} \Phi(\tilde{\theta}_{1,D}) \\ \Phi(\tilde{\theta}_{1,D}) + \Phi(\tilde{\theta}_{2,D}) \\ \vdots \\ \sum_{i=1}^{R} \Phi(\tilde{\theta}_{i,D}) \end{bmatrix}$$

Here, Φ(.) represents the cumulative standard normal distribution. We present the algorithm to estimate the parameters $\tilde{\theta}$ in the next section. The constraints for the problem are that the elements on the diagonal are less or equal to 1.

This approach to fitting term structures may be thought of as one of parameterising a ratings-based credit derivative pricing model such as those of Jarrow, Lando, and Turnbull (1997) and Kijima and Komoribayashi (1998). These models assume that time-varying (rather than time-homogeneous, as in our case) ratings transition matrices are fitted to market price data and then the inferred risk-adjusted processes may be used to price more complex credit derivative contracts. In the context of this paper, we prefer to think of our approach as an interpolation technique for ordered credit spreads rather than as an implementation of a theoretical model.

APPENDIX 3: ILLIQUIDITY DISCOUNT EFFECT ESTIMATION

This appendix explains how we estimate the illiquidity discount effect of traded bonds by studying the relation between price discount and bid-ask spread in a time-series fashion.

For a given trading day, we apply regression of price discount on the bid-ask spread as follow:

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$$

Here y_i is the price discount (market price - model price) for bond i, and the face value of all bonds are assumed to be equal to 100;

x_i is the averaged bid-ask spread of bond i over period between the adjacent price observation days. In this study we obtain price discount on a monthly basis therefore the bid-ask spread is constructed by averaging the daily bid-ask spread over the last one month;

β_0 and β_1 are the coefficients to be estimated;

To exhibit the difference between the pricing of bonds of high and low liquidity, we then obtain the low and high quantile value of the bid-ask spread, x_i, and calculate the illiquidity discount effect, S, for a given day:

$$S = \beta_1 \times (Q_H - Q_L)$$

Q_H: high quantile (e.g. 90%) value of x_i;

Q_L: low quantile (e.g. 10%) value of x_i;

The regression analysis and discount effect calculation are conducted for all the observation days.

Note that one can segment bid-ask spread into different interested groups to obtain discount effect over different sub-samples.