Off-Balance-Sheet Activity under Adverse Selection: The European Experience[1]

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Abstract:

The share of off-balance sheet activity (OBSa) in the future of banking business has been questioned by the use of low-quality assets in this activity. Nevertheless, this paper puts forward the adverse selection hypothesis, which counter argues that more stable banks engage in OBSa to a larger extent, and that banks use high-quality assets to engage in OBSa. For this hypothesis: (1) the OBSa-risk relation is not necessarily homogenous across the different risk measures that define a bank's risk position; and (2) banks' counterparties in OBSa are the risk averse, less informed side of an adverse selection problem. As a result, on the one hand, the on-balance sheet assets used by banks to engage in OBSa are the most valuable for risk-averse counterparties; i.e., the safest and most liquid assets. However, on the other hand, investors value more highly off-balance sheet items issued by banks that signal a safe general risk position. We test the adverse selection hypothesis for a sample of banks in the 27 countries of the EU during the period 1996-2005, and check for possible differences between banks in the 15 former State members of the EU and those in the 12 new joiners.

Keywords: Adverse selection, Bank risk, Off-balance sheet.

JEL Class.: D82, G21, G32, O16.

1. Introduction.

Although asset risk cannot be eliminated, financial intermediation can monitor, control and redistribute it. Indeed, intermediation favors economic growth by making use of its scale economies in monitoring, and passing risk, for instance, from more to less risk-averse agents. For the standard theory of financial intermediaries, this principle underlies traditional banking

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business. However, it has also been a key argument used to support the fast and widespread diffusion of off-balance-sheet activity (OBSa) in the last two decades. In fact, the Joint Forum of the Bank for International Settlements (2008: 1) underlines that derivatives allow "credit risk to be more easily transferred and potentially more widely dispersed across the financial market."

In accordance with this argument, the relation between a bank's level of OBSa and its risk position should be unequivocal: The larger the former is, the lower the latter should be. Nevertheless, recent bank failures question the simplicity of this view. Indeed, the plurality of results obtained in the empirical analysis of the OBSa-risk relation suggests that this relation is not straightforward.

The aim of this paper is to put forward —and test for the European Union (EU) banking system— a new hypothesis that sheds some light on the reasons why the OBSa-risk relation seems to have a complex nature. To explain this relation, the literature has proposed hypotheses based on the assumption that OBSa affects a bank's risk position in a homogenous way, whether positively, negatively or neutrally (Berger and Udell 1993) (see the Appendix). However, in tune with standard approaches to banking risk, the risk position of a bank is a complex concept defined by different types of risk —e.g., liquidity, credit or insolvency risk. On this basis, the hypothesis that this paper proposes implies that the general risk position of a bank is not necessarily related to its level of OBSa in a homogenous way; that is, OBSa can be positively related to a particular type of risk, and negatively, to another.

Our hypothesis explains this heterogeneity between OBSa and different risk types as the result of an adverse selection problem that characterizes the relations between a bank and its OBS counterparties. This adverse selection problem implies that high-quality banks engage to a larger extent in OBSa and that banks use high-quality on-balance sheet assets for OBSa. Therefore, subprime-type arguments which associate OBSa and "junk" assets would not be applicable to understand this banking activity. Moreover, under the adverse selection hypothesis, there is not a necessary risk-based argument which justifies why OBSa should be relegated among the non-traditional activities that have increased the share of non-interest income in universal banks' profits (Lepetit *et al.* 2008). In a more specific way, our hypothesis leads to predict that banks' OBSa is positively related to credit and liquidity risk; but is negatively related to risk measures that signal banks' stability, such as measures of insolvency risk or those that proxy portfolio risk by a means-variance approach.

To test the adverse selection hypothesis, we use a 1996-2005 sample formed by individual banks in the 27 EU countries. We test the adverse selection hypothesis for the entire sample and, looking for any possible difference between mature and in-transition economies, for two subsamples: That formed by banks in the 15 former State members of the EU (EU15), and that formed by banks in the 12 new EU joiners (EU12). In our testing process, we check, on the one hand, the nature of the relation between off-balance sheet deals and general risk measures. Specifically, we use the Z-score to capture banks' proximity to insolvency. We also used the two additive components of the Z-score and the capital ratio. On the other hand, we analyze the relation of OBSa with credit and liquidity risk. To carry out this analysis, we use cross-section estimations based on average values and panel data techniques.

For the entire sample, and with no significant differences between the techniques used, our results support the adverse selection hypothesis; that is, OBSa is negatively related to general risk measures, and positively related to credit and liquidity risk. Nevertheless, when former and new State members are separately analyzed, a significant difference arises. The adverse selection hypothesis explains banks' behavior in EU15; but evidence for the banking sector in EU12 supports the theoretical argument known in the literature as "the market discipline hypothesis" (Boot and Thakor 1991, Koppenhaver and Stover 1991, Berger and Udell 1993, Hassan *et al.* 1993). In tune with the fundamentals of the adverse selection hypothesis and those of the market discipline one, this difference implies that investors who engage with banks in OBSa are more risk averse in EU15 than in EU12. In addition, it suggests that, by contrast to banks in EU15, the EU12 banking sector has used low-quality assets for OBSa; i.e., in order to understand the OBSa-risk relation in EU12 during the sample period, a subprime-type argument cannot be ruled out.

This paper extends earlier analysis on the effect of OBSa on banks' risk exposure in several manners. It puts forward and tests the adverse selection hypothesis, which implies three main contributions to the analysis of the OBSa-risk relation. The first of them is that this hypothesis enables us to think of a bank's risk position in relation to OBSa in a composite way. Specifically, it makes it possible to argue that the sign of the OBSa-risk relation might depend on the type of risk considered. The second contribution is that the adverse selection hypothesis enables us to explain the behavior of banks' counterparties in OBSa in terms of a standard adverse selection problem. In this sense, under this hypothesis, investors are assumed to be uninformed, risk adverse individuals; whereas banks are informed agents whose trading decisions depend on their privately held information about the quality of their portfolio. The third contribution of the adverse selection hypothesis is that it modifies the analysis of the OBS market in the sense of setting a framework where high-quality OBS items are traded by high-quality agents.

Moreover, our analysis palliates the bias towards US banking system in the research about the OBSa-risk relation. Indeed, to our knowledge this is the first work that specifically studies this relation in the European banking system. In addition, within the European context, we separately analyze the nature of the OBSa-risk relation in EU15 and EU12. The adverse selection hypothesis is particularly useful to interpret the results obtained for these subsamples, since comparing it to the market discipline hypothesis helps to understand why the OBS market is different in these two groups of EU countries.

The rest of the paper is structured in the following way. Section 2 provides a review of the literature on the relation between banks' OBSa and their risk position. The adverse selection hypothesis is explained and compared to the market discipline hypothesis in Section 3. Section 4 outlines the research methodology used. In Section 5, we show and discuss empirical results. Section 6 concludes, and the Appendix summarizes other hypotheses that the literature has proposed to explain the OBSa-risk relation.

2. Literature review.

In a trend of research that has received growing attention in the last decade, the question is how earnings volatility and insolvency risk are affected by extending banking business from intermediation-based activities to fee-based ones. By contrast to what portfolio theory suggests, empirical evidence shows that this type of diversification worsens risk indicators. Demsetz and Strahan (1997) conclude in this regard that, although larger US bank holding companies are more diversified, the risk-reducing potential of diversification is overcome by lower capital ratios and more lending to riskier sectors. In accordance with De Young and Roland (2001), replacing traditional lending activities with fee-based ones increases earnings volatility and total (operating and financial) leverage, what implies increasing also revenues volatility. For the US commercial banking industry, Stiroh (2004) states that the move toward noninterest income is worsening the risk/return trade-off as volatility increases while average returns do not. Similar conclusions are obtained in Stiroh and Rumble (2006) for US financial hoding companies and in Lepetit *et al.* (2008) for the European banking industry.

OBSa has played an important role in the process of diversification in the banking industry. In this sense, the debate about the relation between OBSa and risk is far from new. At the end of the 1990s, after the Asian financial crisis and the bailout of Long-Term Capital Management, Kaufman (1999) pointed out several risks inherent to the growing use of derivatives. In particular, he described how the marketability of previously non-marketable assets exposes trillions of dollars' worth of assets to the changing circumstances of the market, and warned about the "illusion of liquidity", i.e., the belief that anything can be bought and sold at any moment in time at a fee. Two years after Kaufman's paper was published, Murray (2001) tried to refute the arguments that link OBSa to risk-increasing practices. However, he referred to the possibility that securitization might increase earnings volatility and to the risk run by financial institutions that securitize only the relatively risk-free assets in their portfolios.

A key paper in this debate is that by Berger and Udell (1993). Using a set of eight hypotheses as a classifying tool, they reviewed the early 1990s literature on the relation between OBSa and risk in banking institutions. However, as the Appendix shows,[2] if we focus on their empirical predictions about the sign of the OBSa-risk relation, those hypotheses can be regrouped in four broad categories.

The first category is formed by those papers that find evidence of a negative relation between a bank's risk position and its OBSa. Boot and Thakor (1991) show that loan commitments lead to a lower asset portfolio risk because, first, loan commitments are a means to prevent borrowers from increasing asset risk after acquiring a bank loan; and second, banks try to reduce the riskiness of their spot loan portfolio to increase their loan commitment revenue. Using a simultaneous equation approach focused on US large banks in the period 1976-87, Koppenhaver and Stover (1991) show that, in accordance with the market discipline

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[2] Besides the seven hypotheses included in the Appendix, Berger and Udell (1993) refer to the borrower moral hazard hypothesis (Boot *et al.* 1987, Boot and Thakor 1991). For this hypothesis, if loan commitment contracts include an upfront fee that compensates the issuer bank for offering a low enough interest rate, loan commitments would damper borrowers' inclination to increase asset risk after acquiring a standard bank loan. That is, an adequate commitment contract can solve the moral hazard problem that characterizes the borrower-lender relation. The table in the Appendix does not include the moral hazard hypothesis because this theory focuses on the risk profile of loan commitment customers, but it does not establish any clear implication about how banks' OBSa relates to their risk position. Indeed, the main empirical prediction of this hypothesis is that commitment customers are safer than spot loan borrowers. In this sense, Berger and Udell (1993, p. 290) point out that the level of risk of a bank is "weak evidence" for this hypothesis, because "the risks from different types of borrowers cannot be empirically distinguished."

hypothesis, an increase in capital positions has a positive effect on the volume of outstanding standby letters of credit. They also find evidence that outstanding letters of credit are significantly and negatively related to the ratio of loan losses provisions to total loans. For quarterly data of US commercial banks in the 1984-1991 period, Jagtiani *et al.* (1995) use a model of innovation diffusion in the banking industry which leads them to conclude that more creditworthy banks are quicker in adopting standby letters of credit. Specifically, the equity-to-assets ratio and the ratio of nonperforming loans to assets have positive and negative effects respectively on the speed of diffusion. Nevertheless, for other off-balance sheet derivatives, Jagtiani *et al.* (1995) find that capital adequacy and creditworthiness are not statistically significant factors that affect the speed of diffusion. In relation to liquidity risk, Berger and Udell (1993) conclude that, using conventional measures of liquidity, those banks that engage to a larger extent in OBSa are more illiquid by either asset or liability measures.

In accordance with the classification based on the sign of the OBSa-risk relation, the second category includes papers that predict a positive sign. In this sense, the conclusion of Greembaum and Thakor (1988) is that, with asymmetric information and no government intervention, banks securitize better quality assets and finance poorer quality loans with deposits. Using data on US banks from 1983 to 1985 and tobit analysis, Pavel and Philis (1987) find that the lower the primary capital ratio of a bank is, the higher the percentage of loans to assets that are expected to be sold by that bank. For a database formed by 33 US banks for the years 1979 to 1983, Baer and Pavel (1988) find that greater issuance of standby letters of credit is associated with more demanding regulatory capital requirements and with larger bank risk as measured by the ratio of the market value of equity to assets. Jones (2000) provides an exhaustive analysis of how securitization can be used to mask inadequate levels of capitalization in banks. For commercial banks in Canada during the period 1988-98, Dionne and Harchaoui (2003) use the estimated value of the change in securitization activity as an instrument for the estimation of a risk equation. In this equation, the change in credit risk is regressed on different capital adequacy measures. Their conclusion is that higher levels of securitization correspond to worse capital ratios and higher levels of risk. By means of the comparison of US banks that securitize to a sample of US banks that do not securitize, Uzum and Webb (2007) find that the volume of securitization is negatively related to banks' capital ratio, with this result being mainly driven by credit card securitization. In Pennacchi's (1988) model, the link between capital requirements and OBSa depends on banks' comparative advantage.

Benveniste and Berger (1987) develop a theoretical model that predicts that securitization with recourse improves the allocation of risk sharing among investors and depositors. On the basis provided by this model, they find empirical evidence that riskier banks are more likely to issue standby letters of credit. For James (1988), regulatory capital requirements and fixed-rate deposit insurance exacerbate in the banking industry the underinvestment problem that arises when a firm has excessive risky debt outstanding. This problem can be solved by means of standby letters of credit and loan sales, and it is more pressing for undercapitalized banks. Thus, James (1988) tests the prediction that standby letters of credit and loan sales are more frequently used by banks with greater leverage and a higher default risk of deposits. The underinvestment problem has also been tested by Sharpe and Tuzun (2002) for the Australian banking system.

The works included in the third category are those that describe the OBSa-risk relation as neutral. This is the conclusion reached by Berger and Udell (1993) using quarterly data referred to US commercial banks in the period between 1983 and 1991. Specifically, they regress a long list of risk measures to total assets on six securitization variables. These regressions provide empirical evidence that disintermediation-type securitization (e.g., loan sales without recourse) have virtually no association with risk. Nevertheless, Berger and Udell (1993) point out that off-balance sheet securitization (e.g, standby letters of credit) are strongly positively related to bank risk; particularly, banks with more standby letters of credit show higher failure rates, a higher standard deviation of the ratio of net returns to assets, a lower Z-score, a higher ratio of non-performing loans to assets, and worse equity-to-assets ratios.

In a fourth, separate category, other works suggest that a bank's risk position is a complex notion, so that OBSa might be positively related to certain types of risk and negatively related to other types. To our knowledge, the only work includable in this category is Poramapojn (2009). Analyzing data of US commercial banks and bank holding companies in the period 2001-2008 by means of a simultaneous equation approach, Poramapojn (2009) finds evidence which shows that, on the one hand, there is a positive relation between a bank's level of capitalization and its OBSa, and on the other hand, more OBSa implies a higher ratio of loan loss allowance to total assets.

Besides the type of analysis includable in the categories above, where the main aim is to study the effects of OBSa on a banks' risk position or vice versa, a different stream of research focuses on comparing the risk of OBS items and that of on-balance sheet assets. In this sense, focusing on the comparison of OBS loan commitments with on-balance sheet loans, Avery and Berger (1991) conclude that the former have a slightly better performance on average than the latter, so that either little risk is generated by commitments or the risk generated is offset by rationing or sorting processes that link commitment contracts with safer borrowers. Ambrose *et al.* (2003) examine the ex-post performance of securitized and unsecuritized loans, concluding that higher risk loans are retained in portfolio.

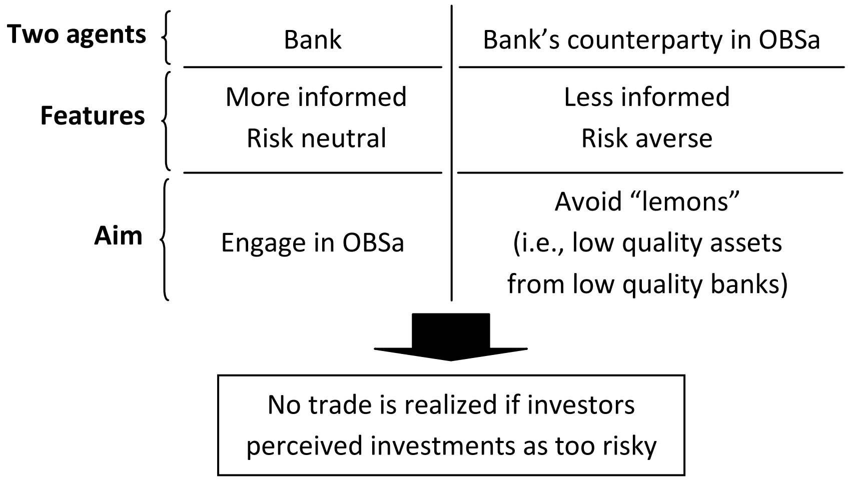
The adverse selection hypothesis that this paper puts forward enables us to extend previous research on the OBSa-risk relation in different ways. On the basis that banks' risk position is a made up of particular risk types, this hypothesis makes it possible to interpret OBSa as a cherry-picking practice in which investors put more value on high-quality OBS items issued by more stable banks. From an empirical view, this paper is the first one that analyzes the OBSa-risk relation in the EU banking system, pointing out the differences between EU15 and EU12.

3. The adverse selection hypothesis.

In a standard adverse selection problem (Akerlof 1970), sellers are risk neutral agents that have information about the quality of traded items, whereas buyers are risk averse agents who lack that information. As a result of this informational asymmetry and due to buyers' attempt to avoid acquiring a "lemon" —i.e., a defective choice— the market might collapse, with no trading being realized.

In accordance with the adverse selection hypothesis, this theoretical scheme describes the relation between banks and investors in the OBS market. As the figure below shows, banks are the risk neutral, informed agent of the problem; whereas OBS counterparties —e.g., an investor who acquires securitized assets issued by a banking institution— play the role of the less-informed, risk-averse agent who tries to avoid selecting a "lemon". Specifically, counterparties in OBSa try to avoid selecting low-quality assets (those with high non-payment probability and low liquidity) from low-quality banks (those with a high probability of bankruptcy). Note that, by contrast to views that identify OBS assets with "junk" assets, this argument implies that counterparties in OBSa are the opposite of risk-neutral agents ready to acquire the risk of which banking institutions want to get rid. The threat of having a market collapse in the OBS market would be realized if the assets and/or the issuers do not have high enough quality as to be perceived as a safe investment by investors.

Figure 1. The adverse selection problem between banks and their OBS counterparties



To avoid this type of no-trade result, the behavior of banks and investors has the following features. First, the on-balance-sheet assets used by banks to engage in OBSa are the most valuable for a risk-averse counterparty; i.e., the safest and most liquid assets. As a result, OBSa worsens the risk position of banks in terms of the default quality and liquidity of their on-balance sheet assets. Indeed, this argument is supported by empirical results that point out that off-balance sheet items are less risky than similar on-balance sheet assets (Avery and Berger 1991, Ambrose *et al.* 2003). Second, as a result of the contingent nature of most OBSa-associated assets, investors value more highly OBS items when the issuing bank signals a lower probability of going bankrupt and, thus, a lower risk of leaving those contingent claims unsatisfied. If we combine these two features, and considering the multiplicity of risks involved in defining a bank's risk position, the consequence is that banks' OBSa is differently related to different risk types. It should be positively related to credit and liquidity risk, but might be negatively related to other measures of risk. Specifically, OBSa might be negatively related to risk measures that signal how safe a banks' portfolio is in general terms or how close to insolvency it is.[3]

The adverse selection hypothesis is closely linked to the market discipline hypothesis (Boot and Thakor 1991, Koppenhaver and Stover 1991, Berger and Udell 1993, Hassan *et al.*

[3] Although Benveniste and Berger (1986) also assume that counterparties of banks’ OBSa are risk-averse, they do not view OBSa as an adverse selection problem. In their model, OBSa is a mechanism that shifts risk from risk-neutral depositors to risk-averse investors. As a result, securitized loans are safer than similar on-balance sheet loans; but, by contrast to the adverse selection hypothesis, riskier banks are more likely than safer banks to substitute securitized loans for loans financed by uninsured deposits.

1993). For the latter, like for the former, given the contingent nature of most OBS items, investors put more value on these items when the issuing bank face a lower insolvency risk. These banks, hence, have more incentives to engage in OBSa to a larger extent. Note that this argument implies that the market discipline hypothesis, like the adverse selection one, assumes that counterparties in OBSa are risk averse. Indeed, this is the reason why both hypotheses predict that OBSa is negatively related to risk measures associated to the possibility of bankruptcy.

However, by contrast to the adverse selection hypothesis, the market discipline hypothesis does not predict a negative significant relation between OBSa and other risk measures —such as liquidity or credit risk. In this sense, the main difference between these two hypotheses is that, in the adverse selection context, investors do not only demand a safe issuer but also safe assets. That is, the main difference is that the adverse selection hypothesis assumes that investors are more risk averse, what entails that they value more highly not just dealing with well-capitalized banks, but also high-quality assets. As a result, when the adverse selection framework is applicable, the incentive to engage in OBSa will be stronger for banks that score better in insolvency and portfolio risk and for those ready to use their high quality on-balance sheet assets for their off-balance sheet deals.

Note that the adverse selection hypothesis is quite different from a subprime-type argument, which identifies OBSa with low-quality assets. Far from selling risk by means of OBSa, the adverse selection hypothesis implies that OBSa is a cherry-picking practice in which banks move high liquid and low risky assets off the balance sheet. By contrast, since the market discipline hypothesis does not assume that the quality of the traded assets themselves is relevant for investors' decisions, it is compatible with subprime-type arguments.

4. Research methodology.

Method: Hypothesis and methodology.

This paper analyzes the relation between OBSa and the risk position of banks in the EU financial industry. Specifically, we test whether this relation can be explained in terms of the adverse selection hypothesis.

For this hypothesis, different types of risk help to define a bank's risk position and counterparties of banks' OBSa are risk-averse. Under these assumptions, the better a bank's general risk position is, the more investors value the contingent claims associated to that bank's OBSa. As a result, the incentives for that bank to engage in OBSa are also larger. However, the better the quality of the assets that a bank uses for OBSa, the higher the value that investors place on those assets. That is, there is an incentive for banks to use liquid and low risk assets for OBSa. Therefore, the adverse selection hypothesis predicts that OBSa is positively related to credit and liquidity risk, but negatively related to general risk measures and to insolvency risk –as proxied by the Z-score, its two additive components, or the equity-to-assets ratio.

To test these predictions, we use a sample of individual banks that covers the 27 EU banking industries in the period 1996-2005. The basic regression model estimated has the following form:

$$A\_RISK_i = \alpha + \beta \cdot A\_OBS_i + \sum_{h=1}^{M} \gamma_h \cdot A\_Z_{hi} + \delta_{ji} \cdot Y_{ji} + \varepsilon_i,$$

where different accounting risk measures are regressed on OBSa, a set of control variables, and to capture for country specific effects, a country dummy. Specifically, A_RISK_i stands for the sample-period average value of different types of risk measures of the i^{th} bank. A_OBS_i is the sample-period average value of the ratio between bank *i*'s OBSa and its total assets. A_Z_{hi} is the average value in the sample period of control variable *h* of bank *i*. The dummy variable Y_{ji} takes value one if bank *i* belongs to country *j*, and zero otherwise. Following standard practice (e.g., Berger and Udell 1993), risk-associated variables appear on the left-hand side of the model, whereas OBSa appears on the right-hand side.

In accordance with the adverse selection hypothesis, the types of risk —i.e. the variable A_RISK_i in our model— that are expected to be negatively related to OBSa, are insolvency risk and overall measures of risk. Insolvency risk is captured by the Z-score (ZS), which indicates the probability of failure of a bank. For bank *i*, the sample-period average ZS is defined as,

$$A\_ZS_i = \frac{A\_EA_i + A\_ROA_i}{\sigma ROA_i},$$

where A_ROA_i is the sample-period average value of the i^{th} bank's return on assets, A_EA_i is the sample-period average value of bank *i*'s equity-to-assets ratio, and σROA_i is the standard deviation of the rate of return on assets over the sample period. ZS increases in profitability (ROA) and capitalization (EA), and decreases in the instability of profits (σROA). Thus, ZS is an indicator of financial stability at the firm level that inversely proxies a bank's probability of failure. That is, a higher value of ZS indicates more bank stability and less overall bank risk.

To check for robustness, we use another general proxy for insolvency risk, the sample-period average value of the i^{th} bank's ratio of equity to total assets, A_EA_i. Additionally, the two additive components of ZS are included in the analysis. The first of them (ZS1) is also another proxy for insolvency risk. It is defined as the average equity-to-assets ratio divided by the standard deviation of the return on assets; i.e., for the i^{th} bank, $A\_ZS1_i = \frac{A\_EA_i}{\sigma ROA_i}$. The second additive component of the Z-score (ZS2) is equal to the average return-to-assets ratio divided by the standard deviation of the return on assets; i.e., for the i^{th} bank, $A\_ZS2_i = \frac{A\_ROA_i}{\sigma ROA_i}$. In accordance with the means-variance approach to portfolio management, this component of ZS is generally considered a measure of banks' portfolio risk and provides a signal of the general risk position of a bank (Lepetit *et al.* 2008).

Testing the adverse selection hypothesis requires analyzing also the relation of OBSa with credit and liquidity risk —i.e. other risk types that define the variable A_RISK_i. To measure credit risk (CR) we use A_CR_i, which is defined as the sample-period average ratio of bank *i*'s loan loss allowances to its total assets. For liquidity risk (LIQR), we use A_LIQR_i, which is computed as the sample-period average ratio of bank *i*'s liquid assets to total assets.

The following Table synthesizes the signs that the adverse selection hypothesis leads us to expect for the relation between OBSa and the risk types (or their proxies) taken into account in our analysis.

Table 1. Expected sign

Risk type	Exp. sign	Risk measure	Exp. sign
Insolvency risk	-	ZS (inverse measure of insolvency risk)	+
Insolvency risk	-	AE (inverse measure of insolvency risk)	+
Insolvency risk	-	ZS1 (inverse measure of insolvency risk)	+
Portfolio risk	-	ZS2 (inverse measure of portfolio risk)	+
Credit risk	+	CR (direct measure of credit risk)	+
Liquidity risk	+	LIQR (inverse measure of liquidity risk)	-

A large set of variables was initially included in the model to control for possible differences among banks in size (sample-period average value of the natural logarithm of total assets, A_LA_i), profitability (sample-period average return-to-assets and return-to-equity ratios, A_ROA_i and A_ROE_i), business (sample-period average deposits-to-assets ratio, A_DEPA_i), and asset composition (sample-period average of loans-to-assets and fixed assets-to-total assets ratios, A_LOA_i and A_FIXA_i). Nevertheless, since the variance inflation factor for multicollinearity (O'Brien 2007) shows signs of collinearity among these variables, control variables are restricted to A_LA_i. Our results, however, are not altered when the control variables above are introduced without taking into account collinearity issues.

Besides testing the adverse selection hypothesis for the whole EU banking industry, we use the model outlined above to check whether the EU15 and EU12 financial sectors show any significant difference in the relation between OBSa and risk.

In addition, by way of a robustness check, we perform the same analysis but using panel data techniques. This requires to add time and bank-specific effects to our econometric model.

Data.

Our sample includes data concerning commercial, cooperative and saving banks of the 27 EU member countries in the period 1996-2005. Specifically, EU15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom; whereas the EU12 States are Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. The source of our data is Fitch-IBCA's BankScope database, which is currently the most comprehensive data set for European banks. To ensure an adequate level of reliability, data from Bankscope requires considerable editing. First, we focus on unconsolidated accounting data of banks (Bonin *et al.* 2005). Second, banks that failed or were absorbed during the sample period are deleted from the database. To have a sound measure of σROA, banks whose data covers less than a four-year period have also been deleted. Finally, in order to minimize the effects of measurement errors, Tukey's box-plot technique is applied to exclude outliers; that is, for all the relevant variables, we calculate the interquartile range (IQR) between the first quartile (LQ) and the third quartile (UQ), and drop any observation lower than $LQ - 2 \cdot IQR$, or larger than $UQ + 2 \cdot IQR$. After cleaning the database, the sample has been reduced to 18,731 observations.

Table 2.1 displays, for all EU banks in the sample, the descriptive statistics of the variables used in the estimations. As dependent variables of the model we have ZS, CR, LIQR, ZS1, ZS2 and EA. In tune with the standard practice in the analysis of the OBSa-risk relation (e.g., Berger and Udell 1993), the key exogenous variable is the ratio of off-balance-sheet assets to total on-balance-sheet assets, OBS. The only control variable included is bank size, LA. In Tables 2.2 and 2.3, the same information is shown, but for the EU15 and EU12 subsamples.

Table 2.1. Summary statistics: Total sample

Variable	Mean	SD	Min	Max
ZS	28.249	14.727	-1.209	79.967
CR	0.006	0.005	0.001	0.086
LIQR	0.209	0.081	0.010	0.498
OBS	0.128	0.106	0.001	0.499
LA	13.305	1.406	9.181	19.975
ZS1	25.308	13.420	1.005	78.156
ZS2	2.941	1.978	-5.747	21.822
EA	0.8949	0.031	0.030	0.316

Table 2.2. Summary statistics: EU15

Variable	Mean	SD	Min	Max
ZS	28.555	14.589	2.244	79.964
CR	0.005	0.005	0.001	0.059
LIQR	0.211	0.081	0.010	0.394
OBS	0.128	0.106	0.005	0.499
LA	13.316	1.403	9.181	19.975
ZS1	25.580	13.292	1.942	78.156
ZS2	2.975	1.958	0.008	21.822
EA	0.0618	0.028	0.030	0.199

Table 2.3. Summary statistics: EU12

Variable	Mean	SD	Min	Max
ZS	18.025	15.630	-1.208	79.521
CR	0.010	0.012	0.001	0.087
LIQR	0.153	0.123	0.010	0.498
OBS	0.127	0.091	0.001	0.395
LA	12.936	1.453	9.324	16.649
ZS1	16.230	14.480	1.005	76.797
ZS2	1.795	2.314	-5.747	15.2786
EA	0.111	0.071	0.0306	0.316

5. Empirical results.

This section discusses the empirical results obtained from testing the adverse selection hypothesis. In accordance with the econometric model above, Tables 3.1-3.3 report cross-section outcomes from regressing the OBSa-to-assets ratio on different risk measures, a country dummy and a size control variable. In these estimations, except for the standard deviation of ROA, we use sample-period average values at banking firm level. Table 3.1 shows results for the entire EU sample, whereas Tables 3.2 and 3.3 refer to EU15 and EU12 respectively.

For the 27 EU State members, as shown in Table 3.1, results are consistent with the adverse selection hypothesis. Specifically, more OBSa is associated with less insolvency and portfolio risk, but with more credit and liquidity risk. That is, using the framework provided by the adverse selection hypothesis, these results can be explained because, given that counterparties of banks' OBSa are risk averse, the incentive to engage in this activity are larger for more solvent banks that are better located in the return-volatility space. Nevertheless, a second requirement is needed to not reject the adverse selection hypothesis. Recall in this regard that the argument goes like this: OBSa takes place in an adverse selection context where the role of the informed agent is for banks and that of the uninformed, risk-averse agent is for banks' counterparties. Therefore, to overcome the effects of this informational asymmetry and by contrast to the market discipline hypothesis, the adverse selection hypothesis requires also that banks use less risky and more liquid assets for OBSa.

Particularly, in tune with the results in Table 3.1, the positive and statistically significant coefficients obtained when regressing *A_OBS* on the sample-period average value of the three insolvency measures used indicate that banks that face less overall default risk engage in OBSa to a larger extent. Recall in this regard that ZS, ZS1 and EA are inverse proxies of insolvency risk; i.e., the higher their value is, the more stable a bank is. It is worth noting that the coefficients associated to *A_ZS* and *A_ZS1* in Table 3.1 are particularly high and close. In a similar way, ZS2 is also an inverse proxy, but for banks' portfolio risk. Hence, the positive and statistically significant coefficient that relates *A_ZS2* to *A_OBS* suggests that an asset portfolio which generates high return with low volatility leads banks to engage in OBSa more actively.

As shown in Table 3.1, empirical results are also consistent with the second requirement associated to the adverse selection hypothesis. In particular, *A_OBS* is positively and significantly related to *A_CR*, and negatively and significantly related to *A_LIQR*; that is, more

OBSa implies, on average, a higher ratio of loan-loss-allowances to total assets and a lower ratio of on-balance sheet liquid assets to total assets.[4]

Table 3.1. Cross-section estimations: Total sample						
	Insolvency risk and general risk measures				Credit and liquidity risk	
	A_ZS	**A_EA**	**A_ZS1**	**A_ZS2**	**A_CR**	**A_LIQR**
A_OBS	132.033** (67.478)	0.0357* (0.008)	120.301** (65.443)	11.732* (3.966)	0.0452*** (0.018)	-0.147* (0.025)
A_LA	-11.282* (4.374)	-0.008* (0.001)	-10.276* (4.243)	-1.005* (0.257)	-0.012* (0.002)	-0.011* (0.002)
Country dums.	Y	Y	Y	Y	Y	Y
R^2	18.51	53.81	17.45	12.64	12.88	31.55

*, **, *** significant at the 1%, 5% and 10% levels respectively.

When sample countries are split into former and new EU State members, we find that the adverse selection hypothesis is able to describe banks' practices in EU15 (Table 3.2), but not in EU12 (Table 3.3). Specifically, when results for the whole sample are compared to those concerning EU15, the sign and statistical significance of coefficients is the same. However, for EU12, the coefficient of *A_OBS* in the regressions on *A_CR* and *A_LIQR* is insignificant; whereas it is positive and significant in the regressions on *A_ZS*, *A_EA*, *A_ZS1* and *A_ZS2*.

Accordingly, in both EU15 and EU12, OBSa is larger in banks that are further away from insolvency and show a low portfolio risk; i.e., in those banks with high ZS, ZS1, ZS2 and EA. However, by contrast to the banking industry in EU15, the counterparties of banks' OBSa in EU12 do not seem to be concerned about the quality of the assets used in OBSa. This suggests that, for the new joiners to the EU, the market discipline hypothesis provides a better explanation of banks' OBSa than the adverse selection hypothesis. Therefore, in tune with this hypothesis, for the sample period, investors in EU12 have been less risk averse than in EU15. This conclusion is also supported by the fact that, for EU15, the coefficient of *A_OBS* in the regressions on *A_ZS* and *A_ZS1* doubles in magnitude the value of that coefficient for EU12 (147.983 vs. 72.170 and 136.515 vs. 60.180, respectively). In addition, the difference between the level of risk aversion of investors in the OBS market of EU15 and EU12 is backed by the mean values of the variables used in our analysis. As Tables 2.2 and 2.3 show, the level at

[4] On the assumption that banks with high levels of OBSa still have superior ability to engage in additional OBS operations, the fact that *A_OBS* and *A_LIQR* are negatively related is also consistent with the liquidity hypothesis (see the Appendix).

which EU15 and EU12 banks get involved in OBSa in relation to their size is on average very close (0.128 vs. 0.127). However, except for the asset-to-equity ratio, all the average values of the risk indicators are worse for the EU12 banking system. In particular, banks in the new EU joiners have lower mean values of ZS (18.025 vs. 28.555), ZS1 (16.230 vs. 25.580), ZS2 (1.795 vs. 2.975), and LIQR (0.153 vs. 0.211), and a higher value of CR (0.010 vs. 0.005).

These differences between EU12 and EU15 are related to the fact that EU12 is formed by emerging economies. As a result of the deep process of transformation that these economies have been undergoing, they provide a wide range of investment opportunities with the possibility of obtaining high returns; but at the cost of assuming higher risk than in mature economies. This combination of high returns and high risk requires that the investors willing to be counterparties of banks' OBSa in EU12 have less risk aversion than investors in EU15. In addition, the fact that EU12 investors seem to lack concern about the quality of the assets traded suggests that the OBS market in EU12 might have been contaminated by low-quality assets, what would make applicable a subprime-type argument to this market for the sample period.

Except for the regressions of *A_OBS* on *A_ZS*, *A_ZS1* and *A_ZS2* in the EU12 subsample, the control variable size is statistically significant and negative in all the rest of regressions carried out. Hence, large banks with a similar degree of OBSa are more insolvent, face more default risk, and are less liquid, but suffer less relative loan loss allowances.

Table 3.2. Cross-section estimations: EU15

	Insolvency risk and general risk measures				Credit and liquidity risk	
	A_ZS	**A_EA**	**A_ZS1**	**A_ZS2**	**A_CR**	**A_LIQR**
A_OBS	147.983** (78.290)	0.031* (0.008)	136.515*** (75.934)	11.465* (4.587)	0.007*** (0.044)	-0.183* (0.028)
A_LA	-11.861* (4.638)	-0.007* (0.001)	-10.778* (4.498)	-1.083* (0.272)	-0.013* (0.003)	-0.010* (0.001)
Country dums.	Y	Y	Y	Y	Y	Y
R^2	17.8	56.4	16.8	12.48	12.71	30.99

*, **, *** significant at the 1%, 5% and 10% levels respectively.

Table 3.3. Cross-Section Estimations: EU12						
	Insolvency risk and general risk measures				Credit and liquidity risk	
	A_ZS	**A_EA**	**A_ZS1**	**A_ZS2**	**A_CR**	**A_LIQR**
A_OBS	72.170** (30.199)	0.0622*** (0.034)	60.180** (28.133)	11.990* (3.426)	-0.051 (0.035)	-0.015 (0.075)
A_LA	-4.314 (3.666)	-0.026* (0.004)	-4.537 (3.416)	0.223 (0.416)	-0.009** (0.009)	-0.016*** (0.009)
Country dums.	Y	Y	Y	Y	Y	Y
R^2	12.00	30.69	11.44	16.70	21.75	20.14

*, **, *** significant at the 1%, 5% and 10% levels respectively.

To check the robustness of our conclusions, we have re-estimated the model using panel data techniques (see Boyd *et al.* 2006). To perform these estimations, we have included year and country fixed effects in an unbalanced panel regression model. As suggested by Greene (2000) and Baltagi (2001), OLS assumptions might not hold when unbalanced panel regressions are used; in particular, the assumption of no correlation between error terms. Nevertheless, the Lagrange multiplier test suggests that there is no significant autocorrelation between error terms. In addition, heteroskedastic consistent estimations do not modify results in a relevant way. To calculate the numerators of ZS, ZS1 and ZS2 in a particular year (i.e., returns-to-assets ratio, equity-to-assets ratio, or the sum of them), we have used banking-level data for that year. However, the standard deviation of the rate of return on assets has been calculated using multi-year observations.

The results obtained for the whole sample using panel data regressions are displayed in Table 4.1, whereas those for EU15 and EU12 are shown in Tables 4.2 and 4.3 respectively. Overall, the sign and statistical significance of the parameters reported in these three tables are very similar to the corresponding ones in Tables 3.1-3.3.

Table 4.1. Panel data estimations: Total sample						
	Insolvency risk and general risk measures				Credit and liquidity risk	
	ZS	**EA**	**ZS1**	**ZS2**	**CR**	**LIQR**
OBS	80.908* (16.464)	0.0342* (0.003)	74.624* (15.872)	6.284* (1.106)	0.039* (0.016)	-0.227* (0.011)
LA	-5.032* (4.374)	-0.008* (0.001)	-4.825* (4.243)	-0.207* (0.079)	-0.009* (0.001)	-0.006* (0.000)
Country fixed efs.	Y	Y	Y	Y	Y	Y
Time fixed efs.	Y	Y	Y	Y	Y	Y
R^2	15.70	56.51	13.70	14.26	17.50	25.47

*, **, *** significant at the 1%, 5% and 10% levels respectively.

Table 4.2. Panel data estimations: EU15						
	Insolvency risk and general risk measures				Credit and liquidity risk	
	ZS	**EA**	**ZS1**	**ZS2**	**CR**	**LIQR**
OBS	82.283* (18.025)	0.027* (0.002)	75.082* (17.377)	7.201* (1.209)	0.041** (0.017)	-0.283* (0.012)
LA	-4.509* (1.387)	-0.007* (0.002)	-4.299* (1.337)	-0.209** (0.092)	-0.013* (0.001)	-0.014* (0.001)
Country fixed efs.	Y	Y	Y	Y	Y	Y
Time fixed efs.	Y	Y	Y	Y	Y	Y
R^2	15.7	60.06	13.8	14.37	12.08	26.76

*, **, *** significant at the 1%, 5% and 10% levels respectively.

Table 4.3. Panel data estimations: EU12						
	Insolvency risk and general risk measures				Credit and liquidity risk	
	ZS	**EA**	**ZS1**	**ZS2**	**CR**	**LIQR**
OBS	42.578* (13.090)	0.050* (0.018)	39.169* (12.314)	3.368* (1.158)	-0.058* (0.029)	-0.061 (0.048)
LA	-5.798* (1.617)	-0.029* (0.004)	-5.842* (3.416)	-0.822 (1.002)	-0.006*** (0.003)	-0.017* (0.006)
Country fixed efs.	Y	Y	Y	Y	Y	Y
Time fixed efs.	Y	Y	Y	Y	Y	Y
R^2	9.95	31.22	19.87	17.80	8.79	17.29

*, **, *** significant at the 1%, 5% and 10% levels respectively.

Indeed, as when cross-section data is used, the empirical evidence provided by panel-data techniques gives support to the conclusion that the adverse selection hypothesis explains banks' behavior in the whole sample and the EU15 subsample. In particular, Tables 4.1 and 4.2 indicate that, for banks in the whole sample and EU15, OBS is significantly and positively related to ZS, ZS1, ZS2 and EA, but is significantly and negatively related to CR and LIQR. As regards the EU12 subsample, Table 3.3 shows that, as in the cross-section analysis, OBS is significantly and positively related to insolvency and portfolio risk (i.e., ZS, ZS1, ZS2 and EA), and that the coefficient of LIQR is not statistically significant. However, by contrast to cross-section estimates, the coefficient of CR becomes significant. The negative sign of this coefficient means that investors in EU12 accept that banks use assets with a higher default risk for OBSa. Since this implies that those investors are less risk averse than what the adverse selection hypothesis requires, panel-data analysis gives even stronger support to the conclusion that the market discipline hypothesis is a better explanation for the EU12 banking industry and reinforces the possibility of using a subprime-type argument to explain the OBS market in these countries.

In addition, similarly to the results obtained for cross-section analysis, the coefficient of the control variable for size is statistically significant and negative in all the panel-data regressions. This suggests again that large banks are those with less credit risk but more insolvency and liquidity risk.

To assess the reliability of our results, we have employed additional robustness checks. In particular, given the dominance of German banks in the EU banking system, we have run the model again excluding them from the sample. The model has also been re-estimated accounting for differences in the macroeconomic environment of EU countries. Overall, the main results in Tables 3.1-3.3 are robust to these modifications in the sample selection and the explanatory variables. Finally, by contrast to our general model and to Berger and Udell (1993), estimations have been repeated with risk variables on the left-hand side of the regression equation, and OBSa, on the right-hand side. Since some of the risk measures used are performance indicators that reveal past risk-taking behavior, these estimations have been carried out with those measures lagged forward one year. However, this change does not cause any significant modification of the results.

6. Conclusion.

By contrast to alternative explanations that define the OBSa-risk relation in a straightforward way, the adverse selection hypothesis claims that banks' OBSa maintains a non-univocal relation with their risk position. For this hypothesis, on the one hand, more OBSa requires controlling overall risk measures such as the proximity to default, the level of solvency or the asset-portfolio quality. However, on the other hand, more OBSa implies moving high quality and more liquid assets off the balance sheet; that is, it entails more credit and liquidity risk. The explanation of this apparent contradiction is that OBSa is not used to look for investors ready to acquire that portion of risk of which banks want to get rid, but to look for risk averse investors that place a high value on relatively safe assets issued by relatively safe institutions.

This ambiguity of the OBSa-risk relation is reflected in the empirical implications of the adverse selection hypothesis. Specifically, this hypothesis predicts that a bank's OBSa is expected to be negatively related to some types of risk (insolvency and portfolio risk) and positively related to other types (liquidity and credit risk). This paper tests these empirical predictions for the whole EU banking system in the period between 1996 and 2005, and for two subsamples formed by the 15 former State members of the EU and by the 12 countries that have recently joined the EU. Under cross-section analysis, using panel data techniques, and subjecting the results to different robustness tests, estimations for the entire sample and for the EU15 subsample support the adverse selection hypothesis as an explanation of banks' OBSa. However, the market discipline hypothesis —well-known in the literature since the beginning of the 1990s— is more correct to explain OBSa in the EU12 subsample, what suggests that counterparties in OBSa are less risk averse in EU12 than in EU15. This is coherent with the fact that a lower degree of risk aversion is required to invest under the combination of high returns and high volatility that characterizes emergent economies such as those of the new EU joiners.

An implication of the adverse selection hypothesis is that subprime-type arguments which relate OBSa to securitizing high-risk assets are not applicable to the EU case in the sample period —at least, to the EU15 subsample. By contrast, and in accordance with empirical analysis that points out that OBS-associated assets have lower ex-post default rates that those retained in portfolio, EU banks seem to have tended to use their higher quality assets for OBSa. As a result of this cherry-picking practice, relatively riskier assets are let on the balance sheet of the EU banks that more actively deal off-balance sheet. Nevertheless, this practice has the positive effect of reducing contagion risk associated to (intra-European) OBSa. Moreover, since those banks that have engage in OBSa to a larger extent score better in terms of solvency and overall portfolio risk, the risk of facing a chain of bankruptcies caused by OBSa is also palliated in the EU banking system.

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Appendix.

The following table synthesizes the hypotheses that the banking literature has proposed to understand the OBSa-risk relation. Closely based on Berger and Udell (1993), this table also includes the categories that regroup those hypotheses in accordance with the sign that they predict for the relation between OBSa and risk.

Category	Hypothesis	Theoretical argument	Empirical prediction	Pioneering papers
Negative relation OBSa-risk	Market discipline	Given the contingent nature of OBSa-associated assets and the risk aversion of banks' counterparties in OBSa, investors place more value on those assets if they are issued by banks with low bankruptcy risk	Banks with lower bankruptcy risk engage in OBSa to a larger extent	Berger 1991, Boot & Thakor 1991, Koppenhaver & Stover 1991
	Liquidity[5]	OBSa causes bank assets to be marketable. Hence, on the assumption that banks with high levels of OBSa still have superior ability to engage in additional OBS operations, increasing OBSa makes banks more liquid	OBSa reduces banks' liquidity risk. However, more OBSa is consistent with higher values of conventional measures of liquidity risk	Berger & Udell 1993
Positive relation OBSa-risk	Collatera-lization	In Benveniste & Berger (1987), OBSa improves risk allocation among risk-averse investors and risk-neutral depositors: Safe assets are sold to the former by means of securitization with recourse, whereas the latter purchase banks' deposits. In James (1988), OBSa can be used as an alternative source to fund sound investment projects by banks with excessive risky debt outstanding	More OBSa increases risk	Benveniste & Berger 1987, James 1988
	Moral hazard	Fixed-rate deposit insurance gives incentives to banks to use relatively low-risk assets for OBSa, whereas riskier assets are maintained on-balance sheet	More OBSa increases risk	Benveniste & Berger 1987, Thomas & Woolridge 1991
	Regulatory tax[6]	OBSa can be used to avoid "regulatory taxes" (e.g., risk-based capital requirements), so that legal requirements are artificially satisfied	Riskier banks engage in OBSa to a larger extent. In addition, the level of OBSa changes if "regulatory taxes" are modified	Greenbaum & Thakor 1987, Pavel & Philis 1987, Baer & Pavel 1988, Pennacchi 1988

[5] The liquidity hypothesis does not provide an explanation of the relation of banks' OBSa with their risk position in general terms, but with liquidity risk.

[6] The regulatory tax hypothesis has been included in the category of the hypotheses that predict a positive sign between risk and OBSa due to the following reason. After pointing out that there is no consensus about the implications of increasing regulatory taxes over risk-taking behavior, Berger and Udell (1993, p. 239) state that, "we would expect a positive cross-sectional relationship between leverage risk and securitization because high leveraged banks would have been forced to move assets off the balance sheet to avoid increased capital requirements."

	Comparative advantage	To profit from their comparative advantage, banks focus on a particular type of activity. This can have a negative effect on risk —e.g., banks might become relatively more illiquid or might face higher deposit costs. To hedge this increasing risk, banks would engage in OBSa to a larger extent	Riskier banks engage in OBSa to a larger extent	Pavel & Philis 1987, Pennacchi 1988
Neutral relation OBSa-risk	Monitoring technology	Innovations in monitoring technology result in an increase of the volume of loans that can be securitized without recourse, and in a shift in borrowing patterns away from bank-held debt and towards other forms of finance. However, banks remain as specialists in lending to borrowers with information problems	The amount of disintermediation-type securitization (e.g., loan sales without recourse) is independent of bank risk.	Berger and Udell 1993
Complex relation OBSa-risk	Adverse selection	OBSa is characterized by an adverse selection problem where investors are uninformed, risk-averse agents, and banks are informed agents whose decisions depend on their privately held information	OBSa is positively related to portfolio and insolvency risk, but negatively related to liquidity and credit risk	This paper