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FINANCIAL REPUTATION, MARKET INTERVENTIONS AND DEBT ISSUANCE BY BANKS

A TRUNCATED TWO-PART MODEL APPROACH

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In 2014 all ECB publications feature a motif taken from the €20 banknote.

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Abstract

In this paper we study the impact that financial reputation and official market interventions have on the *timing* and *amount* of debt issuance decisions by banks. To do so, we propose an extension of the two-part modelling framework of Cragg (1971, eq. 7 and 9) to accommodate random effects. We use quarterly information on 70 major listed European banks from 2003Q1 to 2012Q1. Focusing on a wide range of financial reputation indicators, we show that credit ratings are a significant and positive determinant of the timing of uncollateralised debt issuance decisions. Empirical results do no suggest that ratings have a significant impact on the amount of debt placed by banks. Other financial reputation indicators analysed are found to be of second-order relevance on debt issuance decisions. Our results also suggest that central bank liquidity programs may have had a large impact on both the timing and the amount of collateralised debt issuance during the recent financial crisis, but had a negligible impact on uncollateralised debt issuance decisions.

JEL classification: G21, G01, G15
Keywords: Bank debt issuance, collateral, crisis, monetary policy.

Executive summary of the article 'Access to Funding by European Banks and the Financial Crisis'

Over the last forty years financial institutions have progressively found different ways of issuing debt as a source of funding that complement deposits. As the range of debt instruments have enlarged, the financial structure of banks has become more complex and the variety of implications of the funding choices have increased accordingly. Traditional insured debt holdings (deposits) have been progressively accompanied by a substantial expansion of secured and unsecured securitization instruments. Hence, traditional theories that mainly dealt with deposits as the main type of liquidity source which protects relatively uninformed agents have required a major revision.

The most common theoretical framework to analyze the way banks issue debt has been one in which banks face some constraints in deposit supply and access wholesale debt markets to get funding. In this context, debt issuance has been related to key strategic issues for banks such as liquidity generation, risk management, and solvency. Importantly, the rationale for banks to issue debt may also vary depending on whether the economy is facing an upturn or a recession. Related to this fact, bank debt issuance has become a fundamental policy challenge during the financial crisis as the pricing of the securities and the access of banks to the debt markets have been largely conditioned by macroeconomic instability and have been also affected by the related tensions in sovereign debt, in particular in Europe. Hence, there seems to be a wide set of factors affecting bank debt issuance and, importantly, some of them are likely to be interrelated such as liquidity, risk, solvency, business cycle and monetary policy.

Lack of detailed data has not permitted to undertake a comprehensive empirical analysis of the determinants of the bank debt issuance considering such a large set of factors. In this paper, we undertake an analysis of the determinants of bank debt issuance using a unique database that provides detailed quarterly information on 70 major listed European banks from 2003Q1 to 2012Q1. We also identify aggregated issuance volumes by collateralized or uncollateralized type thus allowing to assess bank's tendency to substitute across items in the liability side.

The empirical approach in this paper consists of estimating a 'two-part model' which allows to study separately the decision to issue debt o not, and the decision on the actual volume of issuance, was the decision of financing through market based debt to be taken. In our setting, a two-part model is more satisfactory than the use of sample selection models such as the Tobit model and the Heckman selection model. These sample selection models are designed to deal with the presence of zeros on the dependent variable. However, the zeros in sample selection models reflect 'missing observations' or unobserved data, which is clearly not the case with debt issuance data. When zeros reflect data, two-part models are easier to interpret and should be the preferred choice.

Our results show, as expected, that there is substituibility between deposits and securitized funding both for collateralized and uncollateralized debt. They also appear to suggest that the pattern of substituibility may have changed after the financial crisis, when a higher degree of rigidity for managing and substituting among funding sources is recorded. Additionally, financial soundness indicators are not as relevant for bank debt issuance as expected, although the level of bank solvency is found to be a significant driver of debt issuance and only for large issuance volumes. Financial reputation (market value and ratings) indicators are invariably found to be significant determinants of the issuance of uncollateralized debt but they are only statistically relevant for large volumes of collateralized debt. This highlights the relevance of signalling quality in uncollateralized transactions by making use of ratings or market performance records. Our results also suggest that market volatility in the years prior to the crisis had a negative, large and significant effect on the issuance of collateralized debt.

Overall, the results in our paper reveal that the determinants of bank debt funding vary depending on the economic environment, bank reputation issues, and issuance characteristics. At the same time, the impact of these factors is shown to be very different depending on whether the debt is collateralized or uncollateralized. The collapse of monetary markets with the financial crisis as well as bank solvency and macroeconomic negative outcomes have made debt issuance much more difficult for banks. In this sense our results also show that official (central bank) liquidity as well as government guarantees have become an important driver of banks' access to liquidity during the financial turmoil.

1 Introduction

For the last forty years, financial institutions have found different ways of issuing marketable debt as an alternative source of funding to deposits. Debt issuance has been used both as a tool to manage liquidity risks associated with unexpected deposit withdrawals, and as a source of funding to overcome local deposit supply constraints and exploit valuable investment opportunities, Goodfriend and King (1988). In an ever more competitive economic environment, the bank's ability to issue debt has become critical.

In the years that preceded the recent financial crisis, ample liquidity in capital markets, and an explosion of structured financial products, boosted the demand for bank's debt. As a result, banks increased their leverage significantly, lending and investing in longer term and less liquid assets, while refinancing short term debt on a long term basis, see Acharya, Philippon, Richardson, and Roubini (2009). As the financial crisis unfolded, many banks encountered serious difficulties to roll over their debt. In retrospect, it appears that both financial regulators and investors misjudged the risk embedded in certain debt instruments. In this context, the aim of this paper is to study the impact of financial reputation indicators (including ratings) on bank debt issuance by European banks. This issue is highly relevant as the correspondence between financial reputation and leverage indicators is essential to monitor financial stability. We will also study the impact of market interventions (by governments and the central bank) to alleviate funding tensions encountered by banks during the financial crisis.

A number of recent research papers have also studied the relevance of financial reputation to determine bank access to debt markets. For example, Sufi (2009) studied bank loan ratings to evaluate whether third-party rating agencies affect firm financial and investment policy in the United States. He found that bank loan ratings lead to an increase in the use of debt by firms that obtain a rating. Similarly, Huang and Ratnovski (2011) theoretically analysed what they referred to as the "dark side" of bank wholesale funding, namely, the insufficient monitoring of the reputation of the bank by short-term investors, who increasingly rely instead on costless but noisy public information, e.g. the market value of the bank. They suggested that this dark side may result in inefficient liquidations, and create significant risks for "modern" banks that hold assets with readily available, but noisy, public signals on their prices.

Most of the recent research on debt issuance by firms study the dynamics of the ratio between the stock of debt and the total assets. In contrast to these papers, we model the dynamics of the ratio between 'newly issued' debt (if any) and the total assets. This allows us to study two separate decisions made by issuers: the *timing* of their issuance and the *amount* of the issuance. Modelling newly issued debt presents, however, a number of technical challenges. One of these challenges is that debt issuance cannot be negative, and often takes the value of zero. In Statistics, a random variable that displays such characteristics is defined as a semi-continuous random variable, i.e. a random variable that combines a continuous distribution for part of its domain with point masses at a finite number of points (in our case at point zero). Methods to deal with semi-continuous dependent variables in regression analysis were first introduced by Cragg (1971). These are the so called two-part models, and have been commonly used in studies of the demand for medical care, see e.g. Duan, Manning, Morris, and Newhouse (1983). Part-one in these modelling framework is a statistical model for the decision of whether or not to issue debt (timing of issuance) while part-two is a statistical model for the decision of how much to issue (amount of issuance). These two statistical models may not be independent.

Heckman (1974) provided a regression strategy to estimate two-part models (or sample selection models as referred to in that work) that avoided the costly estimation by maximum likelihood methods. His modelling framework was aligned with that in Cragg (1971, eq. 7 and 8). Extensions of the methods in Cragg (1971, eq. 7 and 8) to deal with the problems of panel data were first discussed in Ridder (1990) and Nijman and Verbeek (1992). Both papers employed maximum likelihood methods to estimate two-part models while, Nijman and Verbeek (1992) additionally suggested generalized least-squares estimates which were computationally less demanding. More recently, Olsen and Schafer (2001) suggested computationally efficient methods to approximate the likelihood function that would enable the estimation of two-part models with multiple random effects. In the same vein, the simpler estimation strategy introduced by Heckman (1974) was extended to deal with the complexities of panel data by Wooldridge (1995), Kyriazidou (1997) and Rochina-Barrachina (1999).

A problem commonly encountered when dealing with semi-continuous panel data is that the probability density function underlying the non-zero data, that is in our case the amount of issuance, is commonly assumed to be symmetric and Gaussian. Applied researchers usually rely on the adoption of a monotone increasing transformation (e.g. taking logs) to render the data approximately Gaussian. However, very often this transformation is not fully satisfactory. It was this, that prompted Cragg (1971) to propose a truncated normal distribution in the modelling framework presented in his equations 7 and 9. The truncated normal distribution assumptions appear a sensible and natural extension of the standard Gaussian two-part model, given that the domain of the dependent variable is commonly bounded at zero. One of the contributions of this paper is to extend the two-part modelling framework of Cragg (1971, eq. 7 and 9) to accommodate random effects.

For empirical purposes, we use a unique database that provides detailed quarterly information on 70 major listed European banks from 2003Q1 to 2012Q1. Our identification strategy benefits from the use of a wide range of indicators. Furthermore, we analyse the potential impact of these determinants on issuance of collateralised vs. uncollateralised debt, which considerably enriches the analysis. We focus on large banks as they concentrate a big deal of the debt issuance and because large banks have been identified as those relating more on wholesale and unstable funding and engaging to a larger extent in market-based activities (Laeven, Ratnovski, and Tong (2014)).

The paper has the following structure. Section 2 describes the relationships found in previous studies between financial reputation, market interventions and debt issuance. Our truncated two-part model with random effects is described in section 3. Section 4 provides details of our database. The empirical results are presented in section 5. Finally, section 6 concludes.

2 Financial reputation, market interventions and bank debt issuance

The bank's ability to issue debt is directly related with investor's perception of its financial strength. Measuring the financial strength of a firm is, however, not an easy task for investors. Investors are unlikely to solely trust the balance sheet statements published by a bank when forming their judgement. They will also rely on their own analysis, as well as on the recommendations of rating agencies, analysts' forecasts, and the market valuation of listed banks. Most often the information about the bank is only partial.

Credit ratings have been probably the most commonly adopted indicators of financial reputation, in particular given the role assigned to ratings during the financial crisis. Several contributions have reported a positive causal effect of ratings on the use of debt by firms. The empirical study of Sufi (2009) did not focus on the credit rating of the firm, but rather on the rating awarded to a syndicated loan granted to the firm. He found that the introduction of a syndicated loan rating increased the use of debt by the firm. Interestingly, he also reported that, among the firms for which there was no syndicated loan rating, the impact of the introduction of such a rating on debt usage was higher for those awarded a 'junk' loan rating. As for Tang (2009) it also focus on non-financial firms and study the effect of rating upgrades (following a methodological improvement by Moody's) on debt and other dimensions of firm's financing and investment. The findings suggested that firms enjoying rating upgrades issue more debt, have more capital investments, less cash accumulation, and faster asset growth than downgraded firms. The empirical findings of Huang and Ratnovski (2011), equally suggest that ratings are a relevant signal of financial reputation, although they show that ratings and other indicators (such as bank share prices) are noisy signals that lower the incentives of the providers of wholesale funds to monitor banks. Consistent with this idea Hau, Langfield, and Marques-Ibanez (2013) suggest that compared to other corporations, banks pose a particular challenge for external rating agencies as they are inherently opaque and exposed to a multiplicity of risks. This would eventually compromise the relevance of the bank rating as an indicator of financial reputation. Similarly, Pagano and Volpin (2012) observe that debt issuers have an incentive to negotiate with credit rating agencies a low level of transparency, that is, relatively coarse and uninformative ratings.

As for specific measures of reputation, Fecht, Nyborg, and Rocholl (2011) show that bank characteristics, such as profitability of market value, are also imperfect indicators of the financial strength of a firm and their quality is even more compromised during times of financial distress than ratings. Narayanan, Rangan, and Rangan (2007) suggest that in the absence of bond market reputation, as it is sometimes the case during financial crises, private-debt-market reputation enables commercial banks to win underwriting mandates from their loan clients and allows them to credibly commit to investors against opportunistically using lending information. Financial leverage also qualifies as a potential indicator of financial strength, and one which has been giving ample attention in newly introduced regulation for the supervision of financial institutions. In a world characterised by asymmetric information, changes in the firm's debt-to-equity ratio should have an impact on the firm's borrowing costs, and on the ability of that firm to issue debt. However, the relationship between equity capital, liquidity creation and debt issuance is relatively complex and the predictions of the theoretical models are mixed. In principle, the role of bank equity capital is relevant from the point of view of the banks' liability structure. Diamond and Rajan (2000) suggest equity capital can act as a buffer to protect depositors in times of distress. However, holding excessive equity capital can reduce liquidity creation and the flow of credit. Some studies suggest that higher capital improves banks' ability to absorb risk. In particular, larger capital ratios allow banks to create more liquidity (Bhattacharya and Thakor, 1993; Repullo, 2004, e.g.).

However, some other studies suggest that well-capitalised banks create less liquidity. In particular, (Diamond and Rajan, 2000, 2001) argue that highly leveraged banks are more fragile and are those in needs of more liquidity while well-capitalized banks will need to generate less liquidity. Additionally, anticipating a potential re-sale, liquid buyers expect high returns, reducing their incentive to lend, Diamond and Rajan (2012). Millon-Cornett, McNutt, Strahan, and Tehranian (2011) provide evidence on this negative relationship between capital and liquidity creation. They show that when liquidity dried up during the financial crisis (they cover the period 2007-2009) banks that relied more heavily on core deposit and equity capital financing continued to lend relative to other banks. Banks that held more illiquid assets on their balance sheets, in contrast, increased asset liquidity and reduced lending.

The relevance of ratings and related financial reputation indicators may also depend on the type of debt that the banks decide to issue. In particular, the degree of collateralisation (which is for example typical of covered bonds) may ease access to funding for weaker banks. van Rixtel and Gasperini (2013) provided an overview of bank funding trends in the euro area following the recent global financial crisis and the euro area sovereign debt crisis, and showed, inter alia, that secured instruments became much more prevalent than previously, and that rising debt retention by euro area banks accompanied greater dependence on liquidity provided by the ECB. Recent research, (Purnanandam, 2011; Carbo-Valverde, Rosen, and Rodriguez-Fernandez, 2011), has also shown that the choice between issuing collateralised as opposed to uncollateralised debt may be driven by balance sheet management strategies and the resolution of agency problems.

During the recent financial crisis, investor's perception on the financial strength of banks turned very negative. At the peak of tensions, trading flows in several segments of the financial market were brought to an almost complete halt, and as a result numerous banks experienced acute liquidity problems. This triggered as a response, market interventions to restore banks access to financing. In this paper we will also investigate the impact that market interventions had on easing access to funding. Many of these measures were introduced in the aftermath of the collapse of Lehman Brothers. The collapse of Lehman brought with it the end of investor's acceptance or reliance on the 'too big to fail principle', by which large banks would always count with the assistance of the public authorities in cases of need. European governments response to those events was to reassure markets by intensifying direct measures of support for the banking system. These measures were primarily in the form of guarantee schemes for bank deposits and bonds and direct injections of funds in exchange for equity. In October 2008 the ECB also indicated that the regular weekly so-called 'main refinancing operations' would be carried out with a fixed-rate tender procedure with full allotment, thus providing as much liquidity as the banks requested. These early market interventions proved, however, insufficient to address the ongoing process of financial fragmentation that was taking place in European financial markets. In the spring of 2009, the covered bond market, which contrary to other segments of the corporate debt markets had proved fairly resilient, started to show signs of malfunctioning. With the aim of easing funding conditions for euro area banks, and improving market liquidity in euro area bond markets,the ECB announced on May 2009 the Covered Bond Purchase Programme. Under this programme, and over a one year span, outright purchases of 60 billion euro covered bonds were executed. This programme was reactivated in November 2011 with purchases that amounted to 40 billion euro.

3 A truncated two-part model with random effects

Throughout the paper the following notation will be adopted. $I(\cdot)$ will serve to denote an indicator function which takes the value 1 when its argument is larger than zero and will take the value zero otherwise. $f(x, y\,|z)$ will be used to denote the joint density function of random variables x and y conditioned on z. $\phi(\cdot)$ will be used to denote the density function of a standard normally distributed random variable; $\Phi(\cdot)$ will denote the cumulative distribution function of a standard normal random variable. With a slight abuse of notation we will further use $\mathbf{\Phi}_2(\cdot, \cdot; \rho)$ to denote the cumulative distribution function of a bivariate normal random vector with zero mean, standard deviation equal to 1 and correlation equal to ρ.

3.1 The likelihood

We use the index i to denote observations from a certain bank and the index t to denote time observations. There are two main random variables in this setting, one associated with the *decision* or part one, h_{it}, i.e. banks' decision on whether to issue debt or not, and another associated with the *action* or part two, y_{it}, i.e. the volume of debt finally issued by the bank. The distributional assumptions of these random variables are dependent on two vectors of covariates, $\boldsymbol{x}_{it}$ and $\boldsymbol{z}_{it}$, and on two random effects, ν_i and μ_i. In particular, it is assumed that h_{it} and y_{it} follow a bivariate left-truncated normal distributions, i.e.

$$\begin{bmatrix} h_{it} \\ y_{it} \end{bmatrix} \sim TNID\left(\begin{bmatrix} \bar{h}_{it} \\ \bar{y}_{it} \end{bmatrix}, \boldsymbol{\Sigma} = \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix}, \begin{bmatrix} -\infty \\ c \end{bmatrix}\right) \tag{1}$$

where $\bar{h}_{it} = \boldsymbol{z}'_{it}\boldsymbol{\gamma}+\nu_i$ and $\bar{y}_{it} = \boldsymbol{x}'_{it}\boldsymbol{\beta}+\mu_i$, and $\boldsymbol{\gamma}$ and $\boldsymbol{\beta}$ are parameter vectors of corresponding length with their regressors. The truncation parameter c is only binding for y_{it}, h_{it} is not truncated. In the empirical analysis presented in this paper, the truncation parameter c is equal to zero. Details on the density function of this bivariate truncated normal distribution are left for the appendix. It is worth noting that when $c = -\infty$, then y_{it} and h_{it} are normally distributed with means $\bar{y}_{it}$ and $\bar{h}_{it}$ respectively, and covariance matrix $\boldsymbol{\Sigma}$. Under that setting the model would collapse to a 'standard' two-part model.[1] Under our Probit setting, the parameters associated with the first-part are only identified up to scale, and therefore the variance of h_{it} needs to be normalised to 1. It is further assumed that the random effects are normally distributed and possibly correlated, i.e. $(\nu_i, \mu_i) \sim N(\mathbf{0}, \boldsymbol{\Omega})$.

There are two important additional restrictions, the ones which characterised two-part models, which complete the modelling framework:

1. h_{it} is not observed, only $I(h_{it})$ is observed.
2. y_{it} is only observable or revealed when $I(h_{it}) = 1$.

It follows from the above that we either observe the pair $[y_{it}, 1]$ when $I(h_{it}) = 1$, or the 'incomplete' pair $[\cdot, 0]$ when $I(h_{it}) = 0$. This means, as commented in Wooldridge (2002, pp. 566), that the full maximum likelihood function cannot be computed, only the 'partial' maximum likelihood can be defined. For every observation, it, the 'partial' likelihood conditional on the random effects is given by:

$$p_{it} = \begin{cases} f\left(I(h_{it}) = 0 \,|\nu_i, \mu_i\right) & \text{when } \; y_{it} = 0 \\ f\left(y_{it} \,|I(h_{it}) = 1, \nu_i, \mu_i\right) f\left(I(h_{it}) = 1 \,|\nu_i, \mu_i\right) & \text{when } \; y_{it} \neq 0 \end{cases}$$

Using results reported in the Appendix, it follows that:

$$p_{it} = \begin{cases} \Phi\left(\frac{\bar{y}_{it}-c}{\sigma}\right)^{-1} \boldsymbol{\Phi}_2\left(-\bar{h}_{it}, \frac{\bar{y}_{it}-c}{\sigma}; -\rho\right) & \text{when } \; y_{it} = 0 \\ \Phi\left(\frac{\bar{y}_{it}-c}{\sigma}\right)^{-1} \frac{1}{\sigma}\phi\left(\frac{y_{it}-\bar{y}_{it}}{\sigma}\right) \Phi\left(\frac{\bar{h}_{it}+\rho\sigma^{-1}(y_{it}-\bar{y}_{it})}{\sqrt{1-\rho^2}}\right) & \text{when } \; y_{it} \neq 0 \end{cases}$$

[1]Note that sometimes in the econometric literature, researchers use the term two-part model to refer to a slightly more constrained version of the 'standard' two part model. In particular, ρ would be set to zero. When ρ is not set to zero, as in what we call our 'standard' two-part model, econometricians tend to use the term sample-selection model. We do not make such distinction in this paper, and follow the naming convention which is more commonly adopted by applied statisticians working across different fields.

The partial likelihood function is finally defined as:

$$L = \prod_{i=1}^{N} \int_{\nu} \int_{\mu} \prod_{t=1}^{T} p_{it} f\left(\nu_i, \mu_i\right) d\nu_i \; d\mu_i \tag{2}$$

Unfortunately, the integrals in (2) are not analytically tractable and need to be computed by means of quadrature methods.

3.2 Conditional expectations and marginal effects

It follows from results presented in the appendix, that the expected probability of issuing debt at time t by bank i, and the expected volume of issuance at time t, when bank i has agreed to issue, are given respectively by:

$$E\left(I\left(h_{it}\right)=1\right) = \Phi\left(\frac{\bar{y}_{it}-c}{\sigma}\right)^{-1} \Phi_2\left(\bar{h}_{it}, \frac{\bar{y}_{it}-c}{\sigma}, \rho\right)$$

$$E\left(y_{it}\left|I\left(h_{it}\right)=1\right.\right) = y_{it} + \boldsymbol{\Phi}_2\left(\bar{h}_{it}, \frac{\bar{y}_{it}-c}{\sigma}; \rho\right)^{-1} \sigma \left\{ \rho\phi\left(\bar{h}_{it}\right) \Phi\left(\frac{\sigma^{-1}\left(\bar{y}_{it}-c\right)-\rho\bar{h}_{it}}{\sqrt{1-\rho^2}}\right) + \phi\left(\frac{\bar{y}_{it}-c}{\sigma}\right) \Phi\left(\frac{\bar{h}_{it}-\rho\sigma^{-1}\left(\bar{y}_{it}-c\right)}{\sqrt{1-\rho^2}}\right)\right\}$$

These expressions allow to compute 'marginal effects', ME_{it}, and 'average treatment effects', ATE_{it} in the standard fashion as:

$$ME_{it} = \int_{\nu}\int_{\mu} \frac{\partial E\left(\cdot\left|\boldsymbol{z}_{it}, \boldsymbol{x}_{it}, \mu_i, \nu_i\right.\right)}{\partial x_{it}^{j}} f\left(\mu_i, \nu_i\right) d\mu_i d\nu_i$$

$$ATE_{it} = \int_{\nu}\int_{\mu} \left[E\left(\cdot\left|\boldsymbol{z}_{it}, \boldsymbol{x}_{it}^{b}, \mu_i, \nu_i\right.\right) - E\left(\cdot\left|\boldsymbol{z}_{it}, \boldsymbol{x}_{it}^{a}, \mu_i, \nu_i\right.\right)\right] f\left(\mu_i, \nu_i\right) d\mu_i d\nu_i$$

where the expectation is to be filled with the formulas for the conditional expectations given above. $\boldsymbol{x}_{it}^{b}$ and $\boldsymbol{x}_{it}^{a}$ are defined in accordance with the 'treatment'. For example, for a qualitative dummy variable taking the value of either zero or one, $\boldsymbol{x}_{it}^{b}=1$ and $\boldsymbol{x}_{it}^{a}=0$. Analytical expressions for the partial derivatives as functions of cumulative normal distributions can also be worked out.

3.3 Some simplifying modelling assumptions

Of course were some of the assumptions relaxed the expression of the maximum likelihood function would be less cumbersome. In particular, when either there is no truncation, i.e. $c = -\infty$, or when the noise terms are not correlated, i.e. $\rho = 0$, then the computational difficulties of the truncation model are significantly reduced. Three cases are of particular interest.

No truncation. When there is no truncation, the analytical expressions for p_{it} are simpler. This follows from noting that when $c = -\infty$,

$$\Phi\left(\frac{\bar{y}_{it}-c}{\sigma}\right) = 1 \text{ and } \mathbf{\Phi}_2\left(\bar{h}_{it}, \frac{\bar{y}_{it}-c}{\sigma}; \rho\right) = \Phi\left(\bar{h}_{it}\right)$$

However, as for our less restricted version of the model, the integrals in (2) remain analytically intractable and need to be computed by means of quadrature methods.

No truncation and $\rho = 0$. Once more, the analytical expressions of p_{it} less cumbersome. This follows from noting that when $\rho = 0$ then $\mathbf{\Phi}_2(s, t; \rho) = \Phi(s)\Phi(t)$. Furthermore, by adopting a split of the joint density of the random effects (as the product of the conditional and the marginal distributions, see (B-6) in the appendix), the likelihood in (2) can be written as:

$$L = \prod_{i=1}^{N} \int_{\nu_i} S(\nu_i) \left\{ \prod_{t=1}^{T} \Phi\left(-\bar{h}_{it}\right)^{1-I_{it}} \Phi\left(\bar{h}_{it}\right)^{I_{it}} \right\} f(\nu_i)\, d\nu_i$$

and where:

$$S(\nu_i) = \int_{\mu_i} \prod_{t=1}^{T} \left[\frac{1}{\sigma}\phi\left(\frac{y_{it}-\bar{y}_{it}}{\sigma}\right) f(\mu_i | \nu_i) \right]^{I_{it}} d\mu_i$$

where, and with a slight abuse of notation, we have defined an indicator function I_{it} which takes the value of 0 if $y_{it} = 0$ and takes the value of 1 otherwise. Interestingly, the integral in $S(\nu_i)$ is tractable. Its solution is shown in the appendix in equation ().

No truncation, $\rho = 0$ and $\mathbf{\Omega}$ is a diagonal matrix. When the noise terms are not correlated, and the random effects are not correlated, then the likelihood can be split in two parts as follows:

$$L = L_1(\boldsymbol{\gamma})\, L_2(\boldsymbol{\beta}, \sigma_\varepsilon) \tag{3}$$

where dependence on the parameters has been formally stated, with:

$$L_1(\boldsymbol{\gamma}) = \prod_{i=1}^{N}\int_{\nu_i}\left\{\prod_{t=1}^{T_i}\left[\Phi\left(-\bar{h}_{it}\right)\right]^{(1-I_{it})}\left[\Phi\left(\bar{h}_{it}\right)\right]^{I_{it}}\right\}\frac{1}{\sigma_\nu}\phi\left(\frac{\nu_i}{\sigma_\nu}\right)d\nu_i$$

$$L_2(\boldsymbol{\beta},\sigma) = \prod_{i=1}^{N}\int_{\mu_i}\left\{\prod_{t=1}^{T_i}\left[\frac{1}{\sigma}\phi\left(\frac{y_{it}-\bar{y}_{it}}{\sigma}\right)\right]^{I_{it}}\right\}\frac{1}{\sigma_\mu}\phi\left(\frac{\mu_i}{\sigma_\mu}\right)d\mu_i$$

where once more we use the indicator function I_{it} that takes the value of 0 if $y_{it} = 0$ and takes the value of 1 otherwise; we use T_i to define the number of available observations of a cluster i. It thus follows that parameter estimation can be implemented in a simple two step approach. In effect, L_1 is the likelihood of a Probit model with random effects, and thus estimation of $\boldsymbol{\gamma}$ can be accomplished by means of standard software. Estimation of $\boldsymbol{\beta}$ and σ_ε, can be equally computed with standard sofware as it is nothing but a linear panel model with random effects estimated over those observations which are not zero.

4 The data, endogeneity and treatment of outliers

Our sample contains data from 70 major listed European bank holdings for which quarterly balance sheet data over the 2003Q1-2012Q1 period are available. Focus on major listed bank holdings ignores a large segment of the banking industry in Europe. However, use of timely and reliable balance sheet data would be compromised otherwise. Quarterly data also allow to better identify financing tensions associated with certain market and economic conditions. Focus on holdings, rather than individual subsidiaries is also justified by the fact that there would be difficulties in attributing to a certain subsidiary firm the debt issued by the holding, as it is common for European banks to use special purpose entities to issue debt. Additionally, bank holding companies with subsidiaries often operate under their own internal capital markets and using consolidated statements addresses this issue. Besides, these large banks are listed institutions and this allows us to compare credit ratings to other indicators of financial reputation such as the value of shares, and share price volatility. A full list with the names of the banking holdings is provided in Table 1.

4.1 Collateralised and uncollateralised debt issuance

Issuance volumes data are taken from Dealogic DCM.[2] We have aggregated issuance volumes by collateralised or uncollateralised type. Collateralised issuance relates to covered bonds,

[2]Issuance volumes are retrieved using the issuer parent identifier of the Dealogic DCM database. But for a few exceptions, the chosen banking groups have remained relatively stable in composition during the

mortgage-backed securities and asset-backed securities. Uncollateralised issuance relates to short and medium term notes, corporate bonds and preferred shares. Volumes have been divided by total assets in the regression analysis presented below, and are thus in units comparable across banks.

Figure 1 displays the distribution of the ratios of collateralised and uncollateralised debt issuance to bank's total assets. Issuance ratios, reached on occasions very large values, sometimes in excess of 5%, although such issuance volumes were very rare, and were primarily associated with issuance activity under government guarantee schemes, and were as part of the financial assistance programmes launched by the European governments during the financial crisis. As mentioned in the introduction, a large proportion of the observations are zero, and for those observations which take a positive value, the distribution of the data appears heavily skewed.[3]

4.2 Financial reputation indicators

The financial reputation of the bank is proxied by five main indicators: the core tier 1 capital ratio, *tier 1 ratio*; return on equity, *ROE*; changes in the market valuation of the bank in the stock exchange, *market value*; the volatility of the share price of the bank in the stock exchange, *volatility*; and the credit rating of the bank from major rating agencies. For the balance sheet data, i.e. *tier 1 ratio* and *ROE*, use has been made of the consolidated balance sheet records of the Worldscope database. Financial market data, i.e. *market value* and *volatility*, are taken from Thomsom Reuters Datastream.[4] The inclusion of the capital ratio aims to capture the fact that less leveraged banks might be in a better position to tap financial markets than those with excessive leverage and thus perceived by potential lenders as more risky.

Credit ratings have been collected from Fitch, Moody's and Standard and Poor's. Use has been made of the worse of the three ratings when more than one rating was available. We have grouped the rating types into three main grades: *Prime rating*, *Good rating* and *Non-investment rating*. A *Good rating* grade is assigned for ratings classified between BBB^{-}

sample. Therefore, issuance volumes for the parent identifier should provide a reliable picture of issuance by the banking group. However, there were some notable exception to the composition rule over the sample that had to be addressed on an individual basis.

[3]Statistical tests conducted, although not reported in this paper, on the positive values of the ratios of collateralised and uncollateralised issuance, reject the null hypothesis of normality. The data remains heavily skewed and with non-normal kurtosis when subject to a logarithm transformation.

[4]Volatility is computed as the quarterly standard deviation of the daily changes in the share price.

and A^- in the Fitch and Standard and Poor's ratings, or in between *Baa*3 and *A*3 in the Moody's ratings. Those above will be classified as *Prime rating* and those below as *Non-investment Rating*.

4.3 Market intervention indicators

During the recent financial crisis, central banks and governments implemented a number of measures in support of the banking sector. On the one hand, central banks were ready to provide liquidity assistance to banks which faced difficulties raising funds. It seems thus sensible to include some proxies for the impact of those policy actions. In particular, we will include the ratio of the total assets of the central bank to nominal GDP, *TACB*, as a proxy for liquidity assistance.[5] For euro area countries, we further include two additional key dummy variables, one to account for the period over which fixed rate full allotment in regular liquidity providing open market operations was granted to banks, *FRFA*, and another to proxy for the period over which the 'covered bond purchase programme', which resulted in purchases of covered bonds by the ECB with the intention of alleviating tensions in covered bond markets, was active, *CBPP*.[6] On the other hand, governments were often ready to assist banks by acting as guarantors of their debt. Government support is thus reflected in our analysis with an indicator variable showing if debt has been issued with a government guarantee, *Govguar*.

4.4 Other control variables

Other control variables will be employed in our empirical analysis. The first two are associated with bank characteristics which may be relevant to explain issuance: *deposit ratio* and *loan ratio*. Our aim when including these variables is to distinguish issuance patterns across different types of banks or 'bank business models'. For example, banks that have easier access to deposits may pursue less aggressive debt issuance policies, tapping financial markets less frequently.[7]

[5]For euro area countries, the ratio of total assets of the central bank to nominal GDP is computed for the euro area as a whole using ECB data; for the other EU countries, total assets are taken from published series by the central bank, while nominal GDP is taken from the IFS database.

[6]The fixed rate full allotment policy of the ECB has been in place since October 2008. The 'Covered Bond Purchases Programme' was active from June 2009 to June 2010 in its first phase, and reactivated from early November 2011 onwards, with bond purchases amounting to 60 billion euro and 40 billion euro in its first and second phases respectively. The dummies used to proxy for these policies take the value of 1 when active and a value of zero when not active. Ratios and growth rates are measured in percentage terms.

[7]For certain banks, and over certain periods, bi-monthly reported records have been transformed into quarterly records by splitting the flow data in half over the quarters. Additionally, gaps in the reporting of some quarters for some banks have been filled by linear interpolation. The data has also been checked and clean for reporting errors.

Another set of controls relate to the economic and financial environment as proxied by a series of macroeconomic indicators: GDP growth, *GDP* and inflation, *CPI*. We also consider the stance of monetary policy as proxied by the standard short term interbank rate, r and the long term government bond yield, *yield* is also a key reference rate for banks when raising funds.[8] Of course, this variable will also reflect the impact of the tensions in euro area sovereign debt markets during the financial crisis. The interpretation of the coefficients associated with the short-term interest rate (r) and the sovereign yield is not straightforward, and is a priori ambigous. These rates represent benchmarks for pricing the bond, that is, the higher these rates are, the lower the price of the bond issued by the bank and thus the higher its demand and the lower its supply. Therefore, from the perspective of the bank, the higher these rates, the less inclined they are to issue, while from the perspective of the investors, more ample demand for these bonds there will be, and the easier for the bank to place the debt.

4.5 Endogeneity and outliers

Some of the explanatory variables may be considered endogenous, as they may impact on the issuance ratio while possibly also being directly affected by that ratio. In particular, debt issuance expands the balance sheet of the bank and thus can affect the deposit, loan and/or capital ratios, which are all defined with respect to total assets. Debt issuance mechanically reduces the capital to assets ratio, but may reduce or increase the deposit to loans ratio. How precisely the latter is impacted by debt issuance decisions will depend on the use of the money raised (i.e. whether it is used to fund further loans or alternative investments), and on the ability of the bank to capture through deposits some of the money employed, either as loans or as alternative investments. To address the endogeneity problem, we replace the *deposit ratio*, *loan ratio* and *tier 1 capital* with mean lag values over the previous four quarters. For the deposit and loan ratio, this avoids the correlation problem for the contemporaneous ratio, and by using the average it may better define a variable which serves to identify a certain 'characteristic of the bank'. By using the average of past lags also for the capital ratio, we implicitly assumed that markets focus on a certain 'track record', and thus build their good reputation in terms of leverage over a certain period of time.

[8]GDP and CPI growth rates, and government bond yields are taken from the International Financial Statistics Dataset of the IMF. For the short term interbank rate, the 3-month Euribor rate is used for euro area countries, while the 3-month interest rate from the OECD Main Economic Indicators database is used for the United Kingdom, Denmark and Sweden respectively.

Some descriptive statistics for the data are shown in Table 2. Once the data were adjusted for reporting errors, there still remained some abnormal values for some of the indicators. Financial market data are, not surprisingly, that displaying most sample heterogeneity, with changes in stock prices, or changes in return on equity displaying large extreme values at both ends of the distribution, see Table 2. There are also some instances of abnormally large amounts of debt issuance. These were in some cases associated with large funding gaps in the balance sheet of certain banks which triggered government plans for the recapitalisation of the banks. We have chosen to remove these abnormally high values from the sample to potentially avoid distorting the estimation results. In particular, observations for which the value of the regressor exceeded in more than 4 standard deviations the sample are excluded. Additionally, observations where the volume of issuance is larger than 5% of the balance sheet are equally removed. This resulted in the loss of 40 observations in a sample of around 1500 observations.

5 Estimation Results

The sample under study spreads across two very different periods: 2003Q1-2007Q2 and 2007Q3-2012Q1. It is thus sensible to treat them separately in our analysis in order to account for structural changes.[9] The period 2003Q1 to 2007Q2 matches the expansion phase of the business cycle for most European economies in our sample. It is also characterised by a period of strong lending activity by banks, when according to some studies, see Marques-Ibanez and Gambacorta (2011) and Carbo-Valverde, Marques-Ibanez, and Rodriguez-Fernandez (2011), credit standards in bank lending to households and non-financial corporations were overly relaxed, and buoyant securitisation activity lead banks to have easy access to funding in markets. The period 2007Q3 to 2012Q1 matches not only the contraction phase of the business cycle, but in effect the largest contraction of real activity since the Second World War. During this second period, which will be referred to as the financial crisis period, access to funding was more restrictive and lending standards by banks were significantly tightened. The provision of liquidity by central banks became also a more prominent source of funding relative to privately generated liquidity.

[9]Indeed the null hypothesis of no change in regime is clearly rejected when using a random effects Probit model. Furthermore, the comparison of results for the estimated coefficients across the two samples reported in the tables below confirm that the main determinants of debt issuance decisions, and thus leveraging by banks, have changed since 2008.

5.1 Part-one estimation results

The empirical findings point to some similarities but also to a differentiated role of regressors associated with financial reputation in determining issuance of collateralised and uncollateralised debt. We find that financial reputation, when proxied by the prime rating regressor, is a significant determinant of both collateralised and uncollateralised debt issuance, but only after the financial crisis emerged.[10] As expected, the impact of the rating on the probability of issuing is larger for uncollateralised debt (1.51) than for collateralised debt (0.73) and both coefficients are significant at the 5 percent level. Somehow unexpectedly, the 'tier 1 ratio' and 'ROE' turn out to be immaterial in guiding the timing of debt issuance decisions. This is not, however, totally unexpected for the case of collateralised debt, as the ability to issue debt may depend more strongly on the quality of the collateral than on the quality of the bank finances themselves. The signs associated with changes in 'market value' and the 'volatility' of the share price appear slightly counterintuitive. These regressors are not significant prior to the financial crisis. However, during the financial crisis periods, the reported coefficients suggest that banks which suffered a heavier penalty in stock market valuation, and experienced higher volatility in their stock valuation had a higher propensity to tap debt markets.

Regarding variables associated with market interventions, central bank liquidity assistance, as proxied by the total assets of the central bank to nominal GDP (TACB), appears to have a negative effect on the propensity to issue both collateralised and uncollateralised debt. This suggests that central bank liquidity may have been a substitute for debt issuance by banks. This result is, however, only statistically significant for the pre-crisis period. The variable FRFA had only a positive and significant effect on the issuance of collateralised securities. This suggests that the full allotment policy introduced by the ECB possibly favoured secured issues vs. uncollateralised ones. This evidence is further supported by the estimated coefficients of the variable CBPP, showing the impact of the covered bond purchase programme of the ECB. CBPP is found to be an important determinant of the propensity to issue collateralised debt, and had no effect on uncollateralised debt issuance. In this respect it appears that the CBPP contributed to avoid the collapse of debt issuance in covered bonds during the financial crisis.

As for the regressors associated with bank characteristics, estimation results in table 3 show that the ratio of loans to total assets is found to have a negative and significant effect on

[10]Only three instances of issuance of collateralised debt by banks with a rating worse than '*Prime*' were recorded during the pre-crisis period. This means that the impact of the rating on collateralised debt issuance for the pre-crisis period is not identifiable.

the propensity to issue collateralised debt in the pre-crisis period, and it also has a negative impact on uncollateralised debt but only in the crisis period. This result may most likely reflect the higher tendency of less 'traditional' banks, e.g. those more involved in investment banking activities, to raise funds in financial markets. The results also suggest that a higher proportion of deposits on the balance sheet significantly reduces the dependence of the bank on uncollateralised debt issuance both at the pre-crisis and during the crisis periods, with the coefficient being larger in the pre-crisis years (-0.38 vs. -0.22). This clearly points to the substitutability between deposits and securitised funding.

For indicators associated with the macroeconomic environment, it is not easy to summarize the results. It is tentative to suggest that an environment of economic growth and rising inflation increases the propensity to issue although this evidence is only statistically significant for collateralised debt.

5.2 Part-two estimation results

Table 3 also analyses the determinants of the amount of issuance of both collateralised and uncollateralised debt, i.e. part-two of our two-part model. Regarding the regressors associated with financial reputation, during the financial crisis period, those banks with a prime rating, which were shown to have a higher propensity to issue in the previous section, appear to issue smaller amounts of debt when they do so. However this result is not statistically significant. The signs of the coefficients associated with 'market value' and 'volatility', in contrast with the part-one results, are now shown in the table with the expected sign. That is, the magnitude of issuance is larger when market valuation increases and when the volatility of the stock price is low. The 'tier 1 ratio' and 'ROE' turn out to be immaterial in guiding decisions on the amount of issuance both for collateralised and uncollateralised debt and prior and during the financial crisis. Overall, and given the lower value and lack of significance of the majority of these coefficients, we are incline to conclude that financial reputation does not appear to have an impact on decisions associated with the 'amount' of the issuance place on a given quarter.

As for regressors associated with market interventions, 'TACB' only appears to have a positive and significant effect on the volumes issued of uncollateralised debt prior to the financial crisis. Searching for the rationale of a positive coefficient for this variable is, however, not fully intuitive. Results for the dummy on the provision of unlimited liquidity in auctions by the ECB (FRFA) show a positive and significant relationship on collateralised issued volumes for the financial crisis period where this dummy is defined. In this respect it should be recalled that financial institutions need to pledge valid collateral in exchange for liquidity at the ECB, and covered bonds and mortgage bank securities represent a large share in the collateral pool used by banks. This could have rendered holdings of collateralised debt (issued by other banks) more attractive, triggering a rebalancing of assets in banks' balance sheet towards collateralised debt and thus ultimately boosting demand for collateralised debt. Furthermore, covered bonds issued by banks may be retained in their balance sheet and, given their safe and high rating class status, still be pledged as eligible collateral with the ECB. The covered bond purchase programme of the ECB does not appear to have had a significant impact on the magnitude of the volumes issued in both collateralised and uncollateralised debt.

As for the impact of the regressors associated with bank characteristics, on volumes, a key result relates to the changes associated with increases in deposits, as it provides information on liability management patterns of banks. Over the pre-crisis period, higher deposits are associated with smaller issued volumes of collateralised debt, pointing at the substitutability of collateralised debt for deposits. This result is, however, not visible for uncollateralised debt, thus pointing prima facie to a lesser degree of substitutability between uncollateralised debt and deposits. This pattern of substitutability between collateralised debt and deposits appears to change significantly during the crisis period (second sub-sample). The negative coefficient in the regression turns positive suggesting a higher degree of 'rigidity' for managing and substituting among funding sources, which is a natural result during a crisis period, characterised by higher adverse selection, liquidity constraints, increased difficulties to tap markets and higher competition for deposits.

For indicators associated with the macroeconomic environment, once more, and somehow surprisingly, little evidence pointing to a positive link between a favourable economic environment and larger volumes of issuance is found. An interesting result is the strong empirical pattern linking consumer price inflation and collateralised debt in the pre-crisis period. One may interpret this high significance as capturing an endogeneity bias in the context of a credit-driven real state bubble in some European countries, imparting both strong nominal developments and excessive secured debt issuance, as in the case of the 'cedulas' (covered bonds) in Spain.

5.3 Self-issuance and preferred shares

In the estimation results presented in table 3, debt-issuance included both self-issued bonds and bonds placed by external brokers acting on behalf of the bank. Self-issued bonds are bonds issued by the issuer bank acting as sole bookrunner. These bonds are thus to be placed within the customer base of the bank. It might be argued that banks expect to place these 'self-issued' bonds with domestic investors through their branching networks, and that these set of investors might differ from those encounter when issuing a bond through the mediation of bookrunners, that search for investors in international capital markets. These self-issued bonds may also remain in the balance sheet of the bank for quite some time, as often banks hold self-issued bonds to handle refinancing surges, or alternatively to have the ability to offer borrowers efficient prepayment of their mortgage loans. Furthermore, self-issued bonds may also serve as collateral to raise liquidity from the central bank. It is thus sensible to ask whether the estimation results presented in table 3, hold for both self-issued and non-self-issued bonds.

Table 4 shows the estimation results when debt issuance (both collateralised and uncollateralised) does not include self-issued bonds. Most of our previously reported results still stand. However, there are two important differences that help to qualify our previous results. First, the impact of the rating on the timing of issuance is no longer significant for collateralised debt issuance during the financial crisis. This suggests, as previously suspected, that it is the quality of the assets itself rather than the financial reputation of the bank that matters when placing collateralised debt among investors. Second, FRFA and CBPP are no longer significant to explain the timing of issuance of (non-self-issued) collateralised bonds. One might speculate that the FRFA policy may have boosted the attractiveness of issuing covered bonds to be retained in the balance sheet of the bank to help release financing pressures. Alternatively, the new attractiveness of covered bonds fostered by the policies of the ECB, made the task of searching for investors easier for banks and placed them in a good position to act as sole bookrunners of the issuance.

Additionally, in our previous results, uncollateralised debt issuance included preferred shares, which are a hybrid between debt and equity. Estimation results shown in Table 5 suggest that the exclusion of preferred shares does not change our previous assessment very much. If any, the results presented show that the expansion of the balance sheet of the central bank, 'TACB', did not only have a positive and significant effect on the timing of debt issuance of uncollateralised debt prior to the financial crisis but also during the financial crisis period.

6 Conclusions

Debt issuance has become a major source of bank funding in recent times. Understanding what drives issuance decisions has thus become increasingly important to understand the transmission of monetary policy shocks, and to monitor financial stability and identify macroprudential policy responses. Modelling debt issuance decisions presents, however, a number of technical challenges. One of the econometric challenges encountered when modelling debt issuance is that the distribution underlying these data is not symmetric and Gaussian, but rather is better represented by truncated distributional assumptions. In this paper we address this problem by extending the two-part modelling framework of Cragg (1971, eq. 7 and 9) to accommodate random effects.

Our proposed truncated two-part model is then used to study the determinants of European banks' access to funding through debt, and in particular the role that financial reputation and market interventions play in this context. In doing so, we consider a broad range of indicators of financial reputation, market intervention as well as several control variables. As theoretical contributions suggest that these determinants may have changed after the recent financial crisis, we split the sample accordingly in our empirical analysis (pre-crisis vs. crisis years). We also follow theoretical models and study collateralised and uncollateralised debt issuance decisions separately.

Our results show that ratings are an important indicator of financial reputation which drives the timing of uncollateralised debt issuance decisions. Ratings are not, however, strongly related to the size of the debt issuance placed with investors. Other financial reputation indicators, such as leverage or the return on equity, which have been frequently considered in the theoretical literature, are found to be of second-order statistical relevance in determining the timing and the amount of debt issuance.

During the recent financial crisis, lack of trust in the banking sector lead to tensions in money and corporate debt markets. In this context, our results also show that official market interventions, in the form of non-standard monetary policies and government guarantees on bonds issued by banks, became an important driver of banks' access to liquidity during the financial turmoil. The Covered Bond Purchase Programme of the ECB is found to have had a positive impact on the timing of collateralised debt issuance by banks.

As expected, we also find evidence of substitutability between deposits and securitised funding both for collateralised and uncollateralised debt. Our empirical results also suggest that the pattern of substitutability may have changed after the financial crisis, when a higher degree of rigidity for managing and substituting among funding sources is recorded.

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Technical Appendix

A Derivation of the likelihood of the two-part model

In what follows, and for notational simplicity we will avoid the use of the subindex *it* and will equally avoid references to the conditionality of the distribution to the random effects ν_i and μ_i. We will thus re-state the bivariate truncated normal distribution of interest as:

$$\left[\begin{array}{c} h \\ y \end{array}\right] \sim TNID\left(\left[\begin{array}{c} \bar{h} \\ \bar{y} \end{array}\right], \mathbf{\Sigma} = \left[\begin{array}{cc} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{array}\right], \left[\begin{array}{c} -\infty \\ c \end{array}\right]\right)$$

where the density function of this bivariate random vector is defined as:[11]

$$f(y,h) = D^{-1}\left(2\pi\sigma\sqrt{1-\rho^2}\right)^{-1}.$$
$$.\exp\left\{-\frac{1}{2(1-\rho^2)}\left[\frac{(y-\bar{y})^2}{\sigma^2} - 2\frac{\rho}{\sigma}(y-\bar{y})\left(h-\bar{h}\right) + \left(h-\bar{h}\right)^2\right]\right\} \qquad \text{(A-1)}$$

and where D is a normalising constant equal to:

$$D = \Phi\left(\frac{\bar{y}-c}{\sigma}\right)$$

In the derivation of the likelihood use will be made of the following two integration results:

$$\int_{-\infty}^{a} \phi(x)\,\Phi\left(\frac{b-\rho x}{\sqrt{1-\rho^2}}\right) dx = \mathbf{\Phi}_2(a,b;\rho) \qquad \text{(A-2)}$$

$$\int x\phi(x)\,\Phi(a+bx)\,dx = \frac{b}{k}\phi\left(\frac{a}{k}\right)\Phi\left(xk+\frac{ab}{k}\right) - \phi(x)\,\Phi(a+bx) \qquad \text{(A-3)}$$

where $k = \sqrt{1+b^2}$. These results are relatively standard in the literature, and can be found in Owen (1980, 10,010.2 and 10,011.1).

Derivation of the marginal density of h. This is formally defined by:

$$f(h) = \int_{c}^{\infty} f(y,h)\,dy$$

By completing the square in y in equation (A-1) and adopting the change of variable

$$u = \left(1-\rho^2\right)^{-\frac{1}{2}}\left[\frac{y-\bar{y}}{\sigma} - \rho\left(h-\bar{h}\right)\right]$$

it follows that:

$$\int_{c}^{\infty} f(y,h)\,dy = D^{-1}\phi\left(h-\bar{h}\right)\frac{1}{\sqrt{2\pi}}\int_{(1-\rho^2)^{-\frac{1}{2}}\left[\frac{c-\bar{y}}{\sigma}-\rho\left(h-\bar{h}\right)\right]}^{\infty} \exp\left(-\frac{1}{2}u^2\right) du$$

[11] See Horrace (2005) for some general results on the truncated multivariate normal distribution.

which further simplifies to:

$$f\left(h\right)=D^{-1}\phi\left(h-\bar{h}\right)\Phi\left(\left(1-\rho^{2}\right)^{-\frac{1}{2}}\left[\rho\left(h-\bar{h}\right)-\frac{c-\bar{y}}{\sigma}\right]\right) \tag{A-4}$$

Derivation of $f\left(I\left(h\right)=0\right)$. This follows from noting that:

$$f\left(I\left(h\right)=0\right)=\int_{-\infty}^{0}f\left(h\right)dh$$

Using the expression for the marginal distribution in (A-4) gives:

$$\int_{-\infty}^{0}f\left(h\right)dh=D^{-1}\int_{-\infty}^{0}\phi\left(h-\bar{h}\right)\Phi\left(\frac{\frac{\bar{y}-c}{\sigma}+\rho\left(h-\bar{h}\right)}{\sqrt{1-\rho^{2}}}\right)dh$$

$$=D^{-1}\int_{-\infty}^{-\bar{h}}\phi\left(s\right)\Phi\left(\frac{\frac{\bar{y}-c}{\sigma}+\rho\left(s\right)}{\sqrt{1-\rho^{2}}}\right)ds$$

$$=D^{-1}\mathbf{\Phi}_{2}\left(-\bar{h},\frac{\bar{y}-c}{\sigma};-\rho\right)$$

where the second equality follows from changing the order of integration and applying a change of variable $s=h-\bar{h}$, and the last equality follows from the result in (A-2).

Derivation of $f\left(y\left|I\left(h\right)=1\right.\right)f\left(I\left(h\right)=1\right)$. This is simply defined by the formula:

$$f\left(y\left|I\left(h\right)=1\right.\right)f\left(I\left(h\right)=1\right)=\int_{0}^{\infty}f\left(y,h\right)dh$$

Completing the square in h in (A-1) and making use of the change of variable:

$$w=\left(1-\rho^{2}\right)^{-\frac{1}{2}}\left[h-\bar{h}-\frac{\rho}{\sigma}\left(y-\bar{y}\right)\right]$$

after some tedious algebra results into:

$$\int_{0}^{\infty}f\left(y,h\right)dh=D^{-1}\frac{1}{\sigma}\phi\left(\frac{y-\bar{y}}{\sigma}\right)\frac{1}{\sqrt{2\pi}}\int_{-\left(1-\rho^{2}\right)^{-\frac{1}{2}}\left[\bar{h}+\frac{\rho}{\sigma}\left(y-\bar{y}\right)\right]}^{\infty}\exp\left(-\frac{1}{2}w^{2}\right)dw$$

$$=D^{-1}\frac{1}{\sigma}\phi\left(\frac{y-\bar{y}}{\sigma}\right)\Phi\left(\left(1-\rho^{2}\right)^{-\frac{1}{2}}\left(\bar{h}+\frac{\rho}{\sigma}\left(y-\bar{y}\right)\right)\right) \tag{A-5}$$

Conditional density and expected value of y given h is positive. Derivation of the conditional distribution $f(y\,|I(h)=1)$ now follows by simply dividing (A-5) by $f(I(h)=1)$. Derivation of $f(I(h)=1)$ can be easily worked out in the same fashion that we derived $f(I(h)=0)$, but adopting instead the interval $[0,\infty]$ as the range of integration. After some tedious algebra we come to the result:

$$f(y\,|I(h)=1) = \mathcal{K}^{-1}\sigma^{-1}\phi\left(\frac{y-\bar{y}}{\sigma}\right)\Phi\left\{\left(1-\rho^2\right)^{-\frac{1}{2}}\left(\bar{h}+\frac{\rho}{\sigma}(y-\bar{y})\right)\right\}$$

and where $\mathcal{K}$ is a normalising constant defined by:

$$\mathcal{K} = \mathbf{\Phi}_2\left(\bar{h},\frac{\bar{y}-c}{\sigma};\rho\right)$$

The *expected value of y given h is positive*, can be derived from the previous conditional density, namely:

$$E(y\,|I(h)=1) = \int_c^{\infty} y\, f(y\,|I(h)=1)\, dy$$

This integral, using (A-2) and (A-3) above, can be shown to be equal to:

$$E(y\,|I(h)=1) = \bar{y}+\mathcal{K}^{-1}\sigma\left\{\rho\phi\left(\bar{h}\right)\Phi\left(\frac{\sigma^{-1}(\bar{y}-c)-\rho\bar{h}}{\sqrt{1-\rho^2}}\right)+\phi\left(\frac{\bar{y}-c}{\sigma}\right)\Phi\left(\frac{\bar{h}-\rho\sigma^{-1}(\bar{y}-c)}{\sqrt{1-\rho^2}}\right)\right\}$$

B Solution to the integral in $S(\nu_i)$

In what follows we once more employ the index it, and make the conditional distributions explicit. We further define an indicator function I_{it} which takes the value of 0 if $y_{it}=0$ and takes the value of 1 otherwise, as used in the main text. We further make use of $\mathcal{T}_i$ to denote a set with elements those t such that $I_{it}=1$, and use $\tilde{T}_i$ to denote the number of elements in that set. As it is standard, the conditional density function of the random effects can split as $f(\nu_i,\mu_i) = f(\mu_i\,|\nu_i)\, f(\nu_i)$ with

$$f(\mu_i\,|\nu_i) = \left(2\pi\sigma_{\mu|\nu}\right)^{-\frac{1}{2}}\exp\left\{-\frac{1}{2}\frac{\left(\mu_i-\sigma_{\nu\mu}\sigma_{\nu\nu}^{-1}\nu_i\right)^2}{\sigma_{\mu|\nu}}\right\} \tag{B-6}$$

$$f(\nu_i) = \left(2\pi\sigma_{\nu\nu}\right)^{-\frac{1}{2}}\exp\left\{-\frac{1}{2}\frac{\nu_i^2}{\sigma_{\nu\nu}}\right\}$$

where we have defined:

$$\mathbf{\Omega} = \begin{bmatrix}\sigma_{\nu\nu} & \sigma_{\nu\mu}\\ \sigma_{\mu\nu} & \sigma_{\mu\mu}\end{bmatrix}, \qquad \sigma_{\mu|\nu} = \sigma_{\mu\mu}-\sigma_{\nu\mu}^2\sigma_{\nu\nu}^{-1}$$

Using these, allows us to write:

$$S(\nu_i) = \int_{\mu_i} \prod_{t=1}^{T} \left[\frac{1}{\sigma} \phi \left(\frac{y_{it} - \bar{y}_{it}}{\sigma} \right) f(\mu_i | \nu_i) \right]^{I_{it}} d\mu_i$$

$$= \int_{\mu_i} \prod_{t \in \mathcal{T}_i} \frac{1}{\sigma} \phi \left(\frac{y_{it} - \bar{y}_{it}}{\sigma} \right) f(\mu_i | \nu_i) \, d\mu_i$$

$$= P(\nu_i) \int_{\mu_i} \exp \left\{ -\frac{1}{2} \sum_{t \in \mathcal{T}_i} (q\mu_i - Q(\nu_i, t))^2 \right\} d\mu_i \tag{B-7}$$

with:

$$P(\nu_i) = \prod_{t \in \mathcal{T}_i} \frac{1}{\sigma \sqrt{\sigma_{\mu|\nu}}} \frac{1}{\sqrt{2\pi}} \phi \left(\frac{y_{it} - \bar{y}_{it} + \sigma_{\nu\mu}\sigma_{\nu\nu}^{-1}\nu_i}{\sqrt{\sigma^2 + \sigma_{\mu|\nu}}} \right)$$

$$q = \frac{\sqrt{\sigma^2 + \sigma_{\mu|\nu}}}{\sigma \sqrt{\sigma_{\mu|\nu}}}$$

$$Q(\nu_i, t) = \frac{1}{q} \left(\frac{y_{it} - \bar{y}_{it}}{\sigma^2} + \frac{\nu_i}{\sigma_{\mu|\nu}} \right)$$

and where the equality in (B-7) can be worked out using fairly standard algebra. It remains to complete the square in μ_i in equation (B-7). This gives:

$$S(\nu_i) = P(\nu_i) R(\nu_i) \int_{\mu_i} \exp \left\{ -\frac{1}{2} \left(\tilde{T}_i^{\frac{1}{2}} q\mu_i - \tilde{T}_i^{-\frac{1}{2}} \sum_{t \in \mathcal{T}_i} Q(\nu_i, t) \right)^2 \right\} d\mu_i \tag{B-8}$$

with:

$$R(\nu_i) = \exp \left\{ -\frac{1}{2} \sum_{t \in \mathcal{T}_i} Q(\nu_i, t)^2 \right\} \exp \left\{ \frac{1}{2} \tilde{T}_i^{-1} \left[\sum_{t \in \mathcal{T}_i} Q(\nu_i, t) \right]^2 \right\}$$

Now, by simply adopting a change of variable $s_i = \tilde{T}_i^{\frac{1}{2}} q\mu_i - \tilde{T}_i^{-\frac{1}{2}} \sum_{t \in \mathcal{T}_i} Q(\nu_i, t)$, and noting that the indexes of integration are unaffected by this change (that is, they remain $-\infty$ and ∞), the integral in (B-8) can be easily solved to give the result:

$$S(\nu_i) = P(\nu_i) R(\nu_i) \tilde{T}_i^{-\frac{1}{2}} q^{-1} \sqrt{2\pi} \tag{B-9}$$

Table 1: List of Banks in the Sample.

index	Bank	Country	Total assets
1	Erste Group Bank	Austria	215536
2	Raiffeisen Bank Intl.	Austria	147932
3	Oest.Volksbanken Pc.	Austria	87709
4	Oberbank	Austria	17071
5	Bk.Fur Tirol Und Vbg.	Austria	9227
6	Dexia	Belgium	647027
7	Kbc Group	Belgium	381920
8	Bank Of Cyprus	Cyprus	43197
9	Marfin Popular Bank	Cyprus	43287
10	Hellenic Bank	Cyprus	8866
11	Danske Bank	Denmark	475952
12	Jyske Bank	Denmark	33441
13	Sydbank	Denmark	21670
14	Spar Nord Bank	Denmark	9644
15	Pohjola Pankki	Finland	40977
16	Aktia	Finland	11180
17	Alandsbanken	Finland	3615
18	Bnp Paribas	France	2289322
19	Credit Agricole	France	1758771
20	Societe Generale	France	1247000
21	Deutsche Bank	Germany	2305337
22	Commerzbank	Germany	1011535
23	National Bk.Of Greece	Greece	123055
24	Efg Eurobank Ergasias	Greece	86867
25	Alpha Bank	Greece	73709
26	Bank Of Piraeus	Greece	57263
27	Agri.Bank Of Greece	Greece	33256
28	Tt Hellenic Postbank	Greece	17896
29	Attica Bank	Greece	5236
30	Bank Of Ireland	Ireland	199891
31	Allied Irish Banks	Ireland	182685
32	Unicredit	Italy	1052838
33	Intesa Sanpaolo	Italy	677378
34	Banca Monte Dei Paschi	Italy	254743
35	Banco Popolare	Italy	138908
36	Ubi Banca	Italy	131683
37	Mediobanca	Italy	76323
38	Banca Ppo. Emilia Romagna	Italy	59948
39	Banca Popolare Di Milano	Italy	55639
40	Banca Carige	Italy	42040
41	Credito Emiliano	Italy	30501
42	Credito Valtellines	Italy	28315
43	Banca Ppo. Di Sondrio	Italy	28014
44	Banco Di Sardegna Rsp	Italy	14039
45	Banca Popolare Etruria	Italy	11498
46	Bnc.Di Desio E Delb.	Italy	8653
47	Van Lanschot	Netherlands	21760
48	Sns Reaal	Netherlands	130723
49	Ing Groep	Netherlands	1369848
50	Banco Comr.Portugues	Portugal	99321
51	Banco Espirito Santo	Portugal	84636
52	Banco Bpi	Portugal	48948
53	Banif-Sgps	Portugal	16919
54	Banco Santander	Spain	1250476
55	Bbv.Argentaria	Spain	584438
56	Bankia	Spain	303190
57	Banco Popular Espanol	Spain	131686
58	Banco De Sabadell	Spain	96176
59	Bankinter	Spain	61991
60	Caixabank	Spain	273387
61	Banco De Valencia	Spain	24416
62	Nordea Bank	Sweden	669176
63	Seb	Sweden	256039
64	Svenska Handbkn.	Sweden	268612
65	Swedbank	Sweden	204562
66	Royal Bank Of Scotland	United Kingdom	2583668
67	Barclays	United Kingdom	2120610
68	HSBC Holding	United Kingdom	2024362
69	Lloyds Banking Group	United Kingdom	1249906
70	Standard Chartered	United Kingdom	392063

NOTE: Total assets value refers to largest value in Mln of euros recorded over the period 2003Q1-2012Q1.

Table 2: Descriptive Statistics of Data.

Series	Min	1st Quantile	Median	3rd Quantile	Maximum	Mean	standard deviation
Coll. debt issuance	0.00	0.00	0.00	0.27	9.31	0.34	0.83
Uncoll. debt issuance	0.00	0.00	0.32	1.14	10.39	0.82	1.22
tier 1 ratio	3.9	7.4	8.4	10.1	19.1	9.0	2.2
ROE	-193.5	5.3	10.9	16.7	39.6	9.1	17.0
market value	0.02	3.5	5.6	9.1	36.0	6.9	5.1
volatility	0.00	0.17	0.26	0.40	4.09	0.33	0.25
TACB	22.0	50.0	60.0	85.0	150.0	68.0	25.0
GovGuar	0.00	0.00	0.00	0.00	1.00	0.06	0.23
loans	3.0	60.0	68.0	76.0	93.0	66.0	15.0
deposits	4.6	33.3	43.6	53.2	90.2	43.8	15.5
GDP	-9.78	-0.21	1.55	2.81	8.12	0.86	3.00
CPI	-6.1	1.5	2.2	2.9	5.6	2.2	1.3
r	0.16	1.09	2.13	3.82	6.31	2.48	1.47
yield	1.8	3.6	4.2	4.5	24.7	4.3	1.5

Table 3: Estimation results of two-part model.

	COLLATERALISED DEBT ISSUANCE				UNCOLLATERALISED DEBT ISSUANCE			
	2003Q1-2007Q2		2007Q3-2012Q1		2003Q1-2007Q2		2007Q3-2012Q1	
	part-one	part-two	part-one	part-two	part-one	part-two	part-one	part-two
fin. reputation								
tier 1 ratio	-0.06	-0.54	0.06	-0.07	-0.28	0.22	0.11	-0.03
	(0.16)	(0.49)	(0.11)	(0.19)	(0.18)	(0.19)	(0.11)	(0.28)
ROE	0.02	-0.13	0.17	-0.27	0.44*	-0.31	0.05	-0.46
	(0.15)	(0.31)	(0.13)	(0.21)	(0.18)	(0.21)	(0.11)	(0.28)
market value	-0.14	0.69	-0.40**	0.50*	0.01	0.32	-0.27**	0.33
	(0.17)	(0.48)	(0.15)	(0.23)	(0.06)	(0.23)	(0.10)	(0.26)
volatility	-0.17	-0.42	0.08	-0.11	-0.06	0.12	0.27*	-0.16
	(0.11)	(0.24)	(0.09)	(0.14)	(0.11)	(0.14)	(0.11)	(0.21)
Non-Invest. Rating			-0.30	-0.37			0.21	0.89
			(0.54)	(0.98)			(0.32)	(0.54)
Prime Rating			0.73*	-0.63	0.65	0.29	1.51**	-0.38
			(0.32)	(0.49)	(0.53)	(0.98)	(0.33)	(0.57)
mk. interventions								
TACB	-1.40**	0.27	-0.20	-0.03	-0.44*	0.35	-0.17	-0.04
	(0.25)	(0.43)	(0.13)	(0.20)	(0.18)	(0.27)	(0.14)	(0.00)
FRFA			0.78	2.16**			0.22	0.87
			(0.41)	(0.54)			(0.38)	(0.59)
CBPP			0.62**	-0.11			0.09	0.34
			(0.18)	(0.31)			(0.21)	(0.27)
GovGuar								3.28**
								(0.47)
other								
loans	-0.66**	0.74	-0.15	0.98**	-0.30	0.99**	-0.42**	1.62**
	(0.18)	(0.41)	(0.18)	(0.33)	(0.24)	(0.33)	(0.13)	(0.42)
deposits	-0.21	-1.50**	-0.26	-0.05	-0.38*	0.36*	-0.22*	-0.20
	(0.21)	(0.51)	(0.14)	(0.24)	(0.17)	(0.24)	(0.09)	(0.25)
GDP	0.25*	-0.36	0.18*	-0.28	0.20	0.12	0.12	-0.15
	(0.12)	(0.28)	(0.09)	(0.15)	(0.14)	(0.49)	(0.10)	(0.18)
CPI	0.18	0.51*	0.07	0.30*	0.07	0.03	-0.09	-0.07
	(0.12)	(0.24)	(0.10)	(0.15)	(0.16)	(0.15)	(0.08)	(0.12)
r	0.67**	-0.07	0.35*	0.93**	0.07	0.41*	-0.02	0.82**
	(0.19)	(0.38)	(0.15)	(0.23)	(0.18)	(0.15)	(0.14)	(0.31)
yield	-0.22	0.42	0.14	-0.09	0.08	-0.22	-0.18	-0.05
	(0.16)	(0.31)	(0.14)	(0.27)	(0.14)	(0.23)	(0.11)	(0.00)
σ_ν	2.46		1.06		1.12		2.27	
$\rho_{\nu\mu}$	0.00		0.00		-0.00		0.00	
σ_μ	1.58		1.51		1.42		2.36	
σ	1.19		0.96		1.23		1.54	
ρ	-0.05		0.16		0.25		-0.31	
Obs	606		979		527		968	
l.c.obs	225		413		435		717	

NOTE: Standard deviations of estimated coefficients are reported in between brackets. Significance levels higher than 1% and 5% are denoted respectively with ** and *. Obs is used to denote available observations and l.c.obs to denote number of observations where the dependent binary variable takes the value of zero. The model was also estimated with an intercept term and seasonal dummies, for brevity these are not reported in the table.

Table 4: Estimation results of two-part model (excluding self-issuance).

	COLLATERALISED DEBT ISSUANCE				UNCOLLATERALISED DEBT ISSUANCE			
	2003Q1-2007Q2		2007Q3-2012Q1		2003Q1-2007Q2		2007Q3-2012Q1	
	part-one	part-two	part-one	part-two	part-one	part-two	part-one	part-two
fin. reputation								
tier 1 ratio	-0.26	-1.13	0.04	0.16	-0.16	-0.01	-0.18	0.03
	(0.33)	(0.59)	(0.11)	(0.21)	(0.18)	(0.21)	(0.11)	(0.92)
ROE	0.05	0.09	0.17	0.10	0.32*	-0.26	0.11	-0.04
	(0.16)	(0.32)	(0.14)	(0.25)	(0.15)	(0.25)	(0.13)	(2.29)
market value	0.24	1.18*	-0.19	0.26	-0.00	0.56**	-0.15	0.17
	(0.30)	(0.55)	(0.14)	(0.27)	(0.11)	(0.27)	(0.14)	(0.64)
volatility	-0.31*	-0.54	-0.01	-0.47*	-0.06	0.13	0.21*	-0.27
	(0.15)	(0.34)	(0.19)	(0.20)	(0.10)	(0.20)	(0.10)	(0.56)
Non-Invest. Rating			-0.41	-2.50			-0.07	-1.31
			(0.77)	(1.72)			(0.45)	(1.09)
Prime Rating			0.22	-0.98	0.57	-0.12	0.76*	-0.45
			(0.31)	(0.56)	(0.43)	(1.72)	(0.36)	(1.88)
mk. interventions								
TACB	-0.54*	0.22	-0.08	0.02	-0.31	0.44*	-0.32	0.51
	(0.27)	(0.41)	(0.12)	(0.33)	(0.16)	(0.35)	(0.18)	(0.49)
FRFA			0.77	1.60*			0.32	0.95
			(0.43)	(0.75)			(0.72)	(1.21)
CBPP			0.23	-0.81			0.06	0.09
			(0.19)	(0.45)			(0.16)	(2.02)
GovGuar								2.59*
								(1.16)
other								
loans	-0.12	1.11*	0.19	1.47**	0.07	1.57**	-0.11	1.97**
	(0.33)	(0.48)	(0.26)	(0.31)	(0.38)	(0.31)	(0.50)	(0.56)
deposits	-0.67*	-1.64**	-0.41**	-0.23	-0.32	0.14	-0.34*	-0.54
	(0.33)	(0.63)	(0.14)	(0.26)	(0.18)	(0.26)	(0.17)	(0.50)
GDP	-0.07	-0.28	0.29*	-0.33	0.17	0.26	0.02	0.07
	(0.16)	(0.33)	(0.12)	(0.18)	(0.13)	(0.56)	(0.10)	(0.23)
CPI	0.39*	0.66*	-0.01	0.15	0.05	-0.00	-0.10	-0.30
	(0.16)	(0.33)	(0.12)	(0.20)	(0.15)	(0.18)	(0.12)	(0.15)
r	0.49*	-0.27	0.16	0.64*	0.03	0.14	-0.02	0.85
	(0.21)	(0.43)	(0.17)	(0.26)	(0.17)	(0.20)	(0.40)	(0.69)
yield	-0.05	0.46	-0.02	0.28	0.07	-0.03	-0.29	0.76
	(0.19)	(0.41)	(0.16)	(0.35)	(0.13)	(0.26)	(0.27)	(0.47)
σ_ν	1.11		0.85		1.02		0.89	
$\rho_{\nu\mu}$	-0.00		0.00		0.00		-0.00	
σ_μ	1.02		1.38		0.89		2.38	
σ	1.46		0.82		1.20		1.43	
ρ	0.44		0.24		0.24		0.05	
Obs	606		984		528		973	
l.c.obs	205		321		415		614	

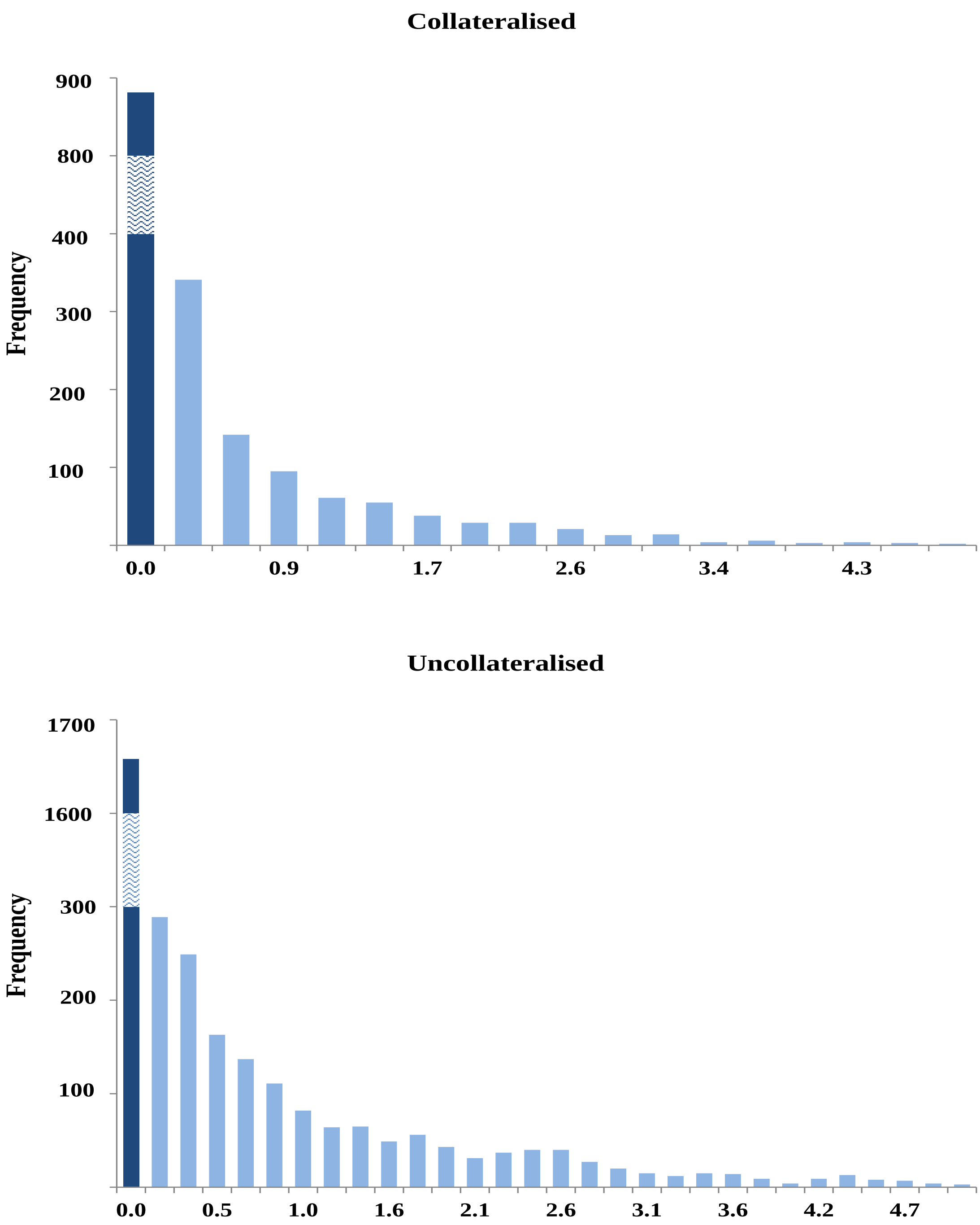
NOTE: Standard deviations of estimated coefficients are reported in between brackets. Significance levels higher than 1% and 5% are denoted respectively with ** and *. Obs is used to denote available observations and l.c.obs to denote number of observations where the dependent binary variable takes the value of zero. The model was also estimated with an intercept term and seasonal dummies, for brevity these are not reported in the table.

Table 5: Estimation results of two-part model (excluding preferred shares).

	UNCOLLATERALISED DEBT ISSUANCE			
	2003Q1-2007Q2		2007Q3-2012Q1	
	part-one	part-two	part-one	part-two
fin. reputation				
tier 1 ratio	-0.32	0.24	-0.08	0.02
	(0.19)	(0.08)	(0.12)	(0.21)
ROE	0.46**	-0.32	0.05	-0.33
	(0.17)	(0.19)	(0.12)	(0.26)
market value	0.01	0.35	-0.21*	0.33
	(0.00)	(0.22)	(0.10)	(0.22)
volatility	-0.05	0.12	0.30**	-0.09
	(0.11)	(0.14)	(0.11)	(0.19)
Non-Invest. Rating			0.63	0.41
			(0.32)	(0.78)
Prime Rating	0.69	0.21	1.11**	-0.43
	(0.53)	(0.99)	(0.28)	(0.56)
mk. interventions				
TACB	-0.44*	0.39*	-0.43**	-0.04
	(0.18)	(0.00)	(0.16)	(0.26)
FRFA			0.81	0.69
			(0.49)	(0.79)
CBPP			0.32	0.32
			(0.22)	(0.34)
GovGuar				2.98**
				(0.45)
other				
loans	-0.30	1.02**	-0.35**	1.42**
	(0.24)	(0.21)	(0.13)	(0.37)
deposits	-0.40*	0.35*	-0.15	-0.17
	(0.18)	(0.00)	(0.10)	(0.23)
GDP	0.15	0.13	0.09	-0.16
	(0.14)	(0.00)	(0.10)	(0.16)
CPI	0.06	0.03	-0.05	-0.03
	(0.16)	(0.14)	(0.08)	(0.13)
r	0.07	0.43**	0.16	0.63*
	(0.18)	(0.09)	(0.20)	(0.31)
yield	0.09	-0.23	-0.12	-0.02
	(0.14)	(0.22)	(0.12)	(0.31)
σ_ν	1.12		1.67	
$\rho_{\nu\mu}$	-0.00		-0.00	
σ_μ	1.48		2.13	
σ	1.25		1.40	
ρ	0.22		0.00	
Obs	527		968	
l.c.obs	434		714	

NOTE: Standard deviations of estimated coefficients are reported in between brackets. Significance levels higher than 1% and 5% are denoted respectively with ** and *. Obs is used to denote available observations and l.c.obs to denote number of observations where the dependent binary variable takes the value of zero. The model was also estimated with an intercept term and seasonal dummies, for brevity these are not reported in the table.

Figure 1: Distribution of the debt to total assets ratio.



NOTE: Frequency refers to the number of observations.