# Drivers of Fiscal Outlays in the Public Recapitalization of Banks

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**Abstract**

In recent years unprecedented public intervention has taken place on a global scale to bail out the banking industry as a consequence of the financial crisis. In this paper, we analyze the main empirical factors that predetermine expected fiscal costs from public solvency support. We use data on public recapitalizations in a sample of large banks in 24 advanced countries during the period 2004-2012. Fiscal outlay predictability is addressed after correcting for endogenous bias stemming from the public decision of whether to step into the firm or not, using predictive variables related to CAMELS-rating categories, bank business models, and global exposure, controlling for the macroeconomic environment of the home country. Our findings indicate that both the likelihood of public recapitalization and the direct fiscal costs involved are driven mainly by high leverage and unstable funding. In the euro area, excessive accommodative monetary policy also played a significant role. Mitigating factors include bank lending capacity, cost efficiency and international diversification.

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## 1. Introduction

After the collapse of Lehman Brothers in 2008, a large number of financial institutions were bailed out worldwide in an unprecedented global public intervention aimed to preserve the integrity of the financial system. Although they may be required to safeguard financial stability, public recapitalization programs often constitute an undesirable outcome for key stakeholders. From the perspective of individual banks, public interventions may not only introduce changes in management and the board of directors as well as dilute the participation of shareholders, but may also impose strict limitations on compensation and dividend payments. Hence, it is unlikely that a distressed firm would voluntarily request government support and, as Hoshi and Kashyap (2010) remark, banks do have incentives to turn it down. From the perspective of public authorities, bank bailout policies can impose a massive financial burden for taxpayers in the form of direct funding costs, greater sovereign borrowing costs, and inefficient allocations of the budget. Indeed, the recent crisis has highlighted the vicious link between banking crises and public debt crises. Furthermore, bank rescue packages are not exempt from social or political controversies owing to moral hazard concerns. As a result, the public decision on when and how to recapitalize a firm can reflect a political balance of all these considerations, with no single practice being clearly superior based on theoretical or analytical grounds (Enoch, García and Sundararajan 2001). By contrast, the optimal volume of public capital to be injected into a distressed, but solvent bank is an economic decision that can be objectively founded in the existence of the specific capital needs at the bank level. Consequently, direct recapitalization costs are driven to a large extent by firm-specific factors that underlie this decision. Yet, what are the most important factors that feature or predetermine the expected cost of a public recapitalization at the bank level? Surprisingly, and in spite of the importance of this question, little is formally known, probably because public recapitalizations have historically constituted an isolated and infrequent phenomenon. The global recapitalization experience undergone in the aftermath of the recent financial crisis provides us with a unique environment in which to address this topic.

In this paper, we analyze the empirical factors that predict the resilience of a large-scale bank against future public bailouts, a property which we denote by financial resilience, together with the expected amount of public capital support conditional on this event. The volume of public capital injected into a distressed institution is a direct indicator of the fiscal outlays involved in the operation as well as a proxy for financial weakness in the institution in question. The predictive analysis of this variable allows us to identify the main factors that either increase or reduce the likelihood of public recapitalization and, simultaneously, predetermine the expected cost of a public intervention. Among others, this topic is particularly important for regulatory and supervisory purposes as financial authorities can adopt prudential measures intended to strengthen financial resilience in the system, and/or penalize corporate

decisions that increase the expected costs of public intervention as a consequence of a systemic crisis. While most of the existing academic literature has focused on identifying the factors that determine the likelihood of bankruptcy and the associated negative externality, it has crucially ignored the resolve of public authorities to bail out a banking institution. In this regard, the main contribution of this paper is to provide clear insight into the main bank-specific variables that predict the fiscal costs involved in bank solvency support policies.

A financially-resilient bank is more likely to survive when faced with an adverse macro-financial environment without public support because it has either enough capital to absorb negative shocks or because it successfully manages to raise capital in financial markets on its own (or with partial public support). In recent years, supervisory authorities have periodically assessed the capital adequacy of individual banks under particularly adverse macroeconomic scenarios. Although stress tests are helpful to identify pockets of financial vulnerability and the potential capital shortfall involved, this analysis is not informative regarding the expected cost of public support. First, the estimates of total capital needs are not necessarily equivalent to the volume of public recapitalization that would eventually be required as they hinge on critical assumptions and are subject to model uncertainty. Also they do not address burden sharing agreements between the public and the private sector. Second, stress tests do not identify which specific characteristics make some banks more resilient than others nor do they explain the drivers of these differences. In spite of these limitations, the fact that capital shortfall estimates vary considerably on a bank-to-bank basis under the same simulated scenarios strongly suggests that financial resilience must be firmly rooted in bank-specific structural factors and business practices. This hypothesis is largely supported by the ex-post empirical observation that, in a given country, banks have exhibited a markedly different resilience to the same systemic shocks, and so have the financial costs involved in the resultant public bailouts. Clearly, both features are largely attributable to bank-specific factors that characterize the financial health of the institution rather than to institutional or legal conditions. The central idea exploited in this paper is that these factors can be identified from the massive global public recapitalization programs implemented in the wake of the global financial crisis by using appropriate econometric techniques.

We address this question by considering a sample of banking institutions operating in 24 advanced countries over the period 2004 through 2012. We restrict our attention to large-capitalization firms for three main reasons. As discussed previously, banks have not been equally affected by the global financial crisis, nor have they contributed equally to spread systemic risk. The main players have mostly been large, complex, interconnected financial institutions and banks that had moved away from traditional retail activities or funding sources. In addition, whereas distressed small-sized firms face a number of alternative options beyond public recapitalizations (e.g., merger or liquidation), large-scale banks are unlikely to be left alone without public support because of their systemic importance. Finally, in contrast

to small banks, large-scale banks have typically involved large fiscal outlays, which have led to public outcry. Using data on public interventions that have affected regulatory capital directly (i.e., through ordinary equity, preferred equity, or convertible preference shares), we measure fiscal outlays in relative terms as the ratio of total public capital received to risk-weighted assets. The one-year-ahead predictability of this variable is addressed in terms of time-varying factors at the bank level that are related to financial soundness indicators within the CAMELS rating framework, bank business models, funding strategy, and international diversification.

We use the Heckman (1979) two-step econometric technique to control for the sample selection bias originating in the public decision of whether to intervene or not in a distressed bank, so our results are robust to these considerations. This methodology involves two stages. The first step models the likelihood of public recapitalization, whereas the second one determines the drivers of the implied fiscal outlays by correcting selection bias given the estimates from the first stage. Consistent with the literature on bank-failure prediction, most of the firm-specific characteristics analyzed are leading indicators of the likelihood of a public recapitalization. Our findings suggest that, among these variables, and conditional on the event of a public intervention, low leverage, international diversification, funding stability, lending capacity and cost efficiency seem to have played a major role in mitigating the direct costs involved in bank public recapitalization policies. After controlling for these factors, we find weak or no statistical evidence to support the predictive ability of other variables such as asset quality or trading activities. Similarly, the panel-data approach allows us to control for unobservable heterogeneity, so the main conclusions of our analysis are not affected by country-specific factors stemming, for instance, from legal systems, accounting standards or institutional differences. Furthermore, the main results are robust to a battery of specifications including alternative control variables, accounting standards and macroeconomic indicators.

The analysis of the global recapitalization experience allows us to bring new empirical evidence and extract meaningful conclusions that are particularly relevant for regulatory purposes. Quality management proxied by cost efficiency is widely considered as the most important factor to long-run survival in the studies of bank performance and bank failure; see, among others, Pantalone and Platt (1987), Berger and Humphrey (1992), Barr and Siemens (1994) and Wheelock and Wilson (2000). Our study reveals that, additionally, cost efficiency is a critical variable in predicting the direct fiscal costs involved in public bailouts. Similarly, international diversification, a variable often ignored in the literature of bank-failure prediction, may have been an effective mechanism in reducing bank vulnerabilities as it may provide a stable source of income and profitability during the crisis. While local geographical diversification does not necessarily improve the risk-return trade-off (Acharya, Hasan, and Saunders 2002), international banks with a larger share of assets allocated to foreign subsidiaries may be able to achieve higher risk-adjusted returns; see García-Herrero and Vázquez (2007). However, it is not

entirely obvious that country diversification can produce net benefits. The downside of this business strategy is that internationally-diversified banks can increase cross-border risk exposures and suffer from ring-fencings of profitable subsidiaries. Vázquez and Federico (2012) report evidence suggesting that while domestically-oriented banks are relatively more vulnerable to liquidity risk, large cross-border banks are susceptible to solvency risk. This paper contributes to this debate by showing that international diversification contributed to reduce the likelihood of a public intervention and, in the case of recapitalized firms, mitigated the financial costs involved in the rescue. Our results suggest that, regulators seeking to improve financial resilience at the bank level should promote international diversification. Finally, our analysis shows that Euro-area banks operating in countries with excessively lax monetary policy were subject to higher public recapitalization costs. This result, together with the important role of net interest income in public recaps, supports the view in Adrian and Shin (2010), who point out that excessively low interest rates can set off a bank's risk appetite, triggering over-lending. This, in turn, can be the origin of bank failure requiring subsequent recapitalization.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 discusses the main features of the data involved in our analysis. Section 4 discusses the methodological approach. Section 5 presents the main results from our analysis. Finally, Section 6 summarizes and concludes. Two separate appendices lay out, respectively, the main characteristics of the recapitalization involved (timing, volume, and the particular vehicle used in the operation) and technical details of the estimation methodology used in this paper.

## 2. Literature review

Whereas the recent financial crisis has motivated an increasing interest on systemic risk measurement and risk contagion in the banking industry (see López-Espinosa et al2012, for a recent overview), the analysis focused on the quantification of the public costs involved in the recapitalization programs has received less attention. Hoshi and Kashyap (2010) discuss this topic from a historical perspective, analyzing the similarities between the programs applied in Japan in the 1990s and the Troubled Assets Relief Program (TARP) applied in the US in 2008. Laeven and Valencia (2010, 2012) measure the economic and fiscal costs associated to the recent economic crises from an aggregate macro-economic perspective, comparing the average costs of the 2007-2009 systemic crisis to the historical costs observed in the previous financial crises in the period 1970-2006. According to these authors, output losses and relative increases in public debt have followed steady paths in advanced economies over time. However, direct fiscal outlays committed to the financial sector have been much larger in these economies during the recent crisis. In particular, the median direct fiscal costs associated with financial sector restructuring for the 2007-2009 crisis amounted to 5.9 percent of GDP, while the historical median of this variable was just 3.7 percent. Noting that public sector recapitalizations of financial institutions

have accounted for about 70 percent of fiscal outlays, the average cost of public recapitalization programs in advanced economies represents over 4 percent of GDP.

Our study is also related to the vast literature devoted to (banking) failure prediction, a topic with a relatively long history in corporate finance, and upon which several studies on public recapitalizations have been conducted. Since the earlier studies of Beaver (1966) and Altman (1968), it is widely agreed that corporate failure can be predicted by means of observable variables related to the dimensions of liquidity, profitability, solvency, leverage, and activity of the firm. In the spirit of the Altman's score approach, Federal bank supervisory agencies developed a numeric rating system in the 1970s for monitoring commercial banks. This system is based on financial soundness indicators in key areas of potential vulnerability including Capital adequacy, Asset quality, Management soundness, Earnings and profitability, Liquidity indicators, and Sensitivity to market risk (CAMELS). Since then, the use of CAMELS factors has become widespread in the academic literature.[1] Using a logistic probability model, Martin (1977) concluded that different proxies for capital adequacy, liquidity, asset quality and earnings were the most significant determinants of bank failure in the US system. Subsequent studies have shown that banks with lower capitalization, higher ratios of loans to assets, poor quality of loan portfolios, and lower earnings are consistently associated with a higher risk of failure; see, among others, Sinkey (1975, 1978), Berger and Davies (1994), Wheelock and Wilson (2000), and Cihak and Poghosyan (2009). Clearly, public recapitalization is a failure-related event and, therefore, several recent studies have implemented a CAMELS-type approach to characterize the factors that determine the likelihood of a public recapitalization; see Mariathasan and Merrouche (2011), Brei and Gadanecz (2012) and Vázquez and Federico (2012). Consistent with previous research, these studies emphasize the key role of high capital, safe asset management, good governance and liquidity as factors that reduce the likelihood of a public recapitalization.

Whereas our paper can be framed naturally into this context and we build on predictive variables inspired by this literature, there are important differences that distinguish our study. First, the main aim of this paper is to determine the drivers that underlie the volume of public capital injected into a firm, and not just the probability of occurrence of such an event. This consideration causes major differences in the methodological approach required. While the modern literature on bank-failure prediction shows a clear preference for discrete-response regression models or neural networks, the endogenous variable in our analysis is characterized by the decision of public authorities whether to recapitalize or not, which introduces a problem of sample selection bias originated in unobservable factors. We use a panel-data approach building on Heckman's (1979) correction to generate consistent estimates of the main

[1] A sixth indicator, measuring Sensitivity to market risk, was added in 1997 and the acronym was changed to CAMELS. In the empirical analysis conducted in this paper, we shall use firm-related indicators that can be categorized into these six classes; see Section 3 for details.

parameters involved in the predictive equation that relates bailout costs to bank-specific factors. The results from this analysis allow us to discuss both the factors that underlie the probability of a public recapitalization and the expected costs, thereby offering a more complete picture. Second, in addition to variables that can be seen as traditional CAMELS factors, we consider other predictors the importance of which has been highlighted recently in the aftermath of the financial crisis. The so-called Liikanen report (see Liikanen et al. 2012) pointed at excessive risk-taking, often in trading highly-complex instruments or real estate-related lending, excessive leverage, and excessive reliance on short-term funding as major weaknesses of the European banking system. In our study, we analyze variables that are directly related to these considerations. For instance, while the traditional CAMELS framework focuses on regulatory capital leverage as a measure of capital absorption capacity, in our analysis we include leverage and distinguish between stable funding and short-term wholesale funding. While this distinction may not be crucial for predicting the likelihood of a failure, our analysis shows that these financial indicators may have compounded effects when it comes to measuring the size of the expected recapitalization costs. Similarly, we include variables related to off-balance sheet derivative activities and fair-valued securities that have not been analyzed in the previous literature. Importantly, we include novel variables related to international diversification in total earnings, lending capacity in the interbank market and monetary policy stance. We find evidence that these variables, ignored in previous studies, decrease both the probability of being recapitalized and the actual fiscal outlays entailed in these episodes.

Finally, several papers have recently analyzed the effects of public recapitalizations on different dimensions of the banking activity, a topic to which, nevertheless, our study is not directly related. Brei and Gadanecz (2012) analyze the effect of public capital on the risk of bank loan books, finding that rescued banks did not reduce their relative risk more than non-rescued banks. Similarly, Brei et al. (2012) show that public recapitalizations do not necessarily translate into higher credit supply. In contrast, Black and Hazelwood (2012) find evidence that risk-taking behavior is non-linear in bank size. Whereas large US banks that received TARP assistance show a higher average risk of loan originations relative to non-TARP banks through 2009, small TARP bank loans exhibit lower risk relative to non-TARP banks.

## 3. Data

The sample analyzed in this paper comprises (but it is not limited to) the European banks that were included in the list compiled by the European Banking Authority (EBA) with the aim of conducting stress tests in 2011 via their respective national supervisors. This list is characteristically formed by large-scale banks that represent a sizeable share of the local financial industry and are deemed as representative enough or particularly relevant for the stability of the local or European financial system. The 2011 EBA list included 90 banks headquartered in 24 countries. In our study we expanded this list to include banks belonging to 4 advanced economies that host global banks, namely, Australia, Canada, Japan, and the US.

Since the European list is not exhaustive, we included banks that account for up to two thirds of total assets in the local banking industry for the sake of homogenization. Owing to data availability constraints on the bank-specific variables used in our analysis and recent resolution proceedings of troubled banks in Europe (from receivership, merger or liquidation), the final sample analyzed in this paper comprises 84 banks in 24 countries; see Appendix A for details. The aggregate gross fiscal outlay from solvency programs in this sample reached a total value of USD 515 billion in 2012, with an average value of 0.62 percent of GDP per bank, and 3.25 percent of GDP per country.

### 3.1 Endogenous variables

The data of public recapitalizations (timing, capital, and particular instrument involved) were collected from different sources, including the European Commission, Bloomberg, SNL and the websites of the individual banks; see Appendix B for details. We only consider public interventions that have affected regulatory capital directly through ordinary shares, preference shares or convertible preference shares. Public interventions using other financial instruments have not been analyzed given that we want to focus on financial instruments which afford similar rights to shareholders. Using this information, we define two endogenous variables which are related to the likelihood of a public recapitalization and the capital injected in the operation, respectively. In particular, we define $Recap_{it}$, a signaling variable taking value equal to one if bank i was recapitalized in year t and zero otherwise, and $RecapAmount_{it}$, the ratio of total public capital received by bank *i* at year *t* to its risk-weighted assets (RWA) at year *t-1*. Most of the rescued banks received public assistance once in any single year, but certain banks received capital several times in the same year. In both cases, $Recap_{it}$, takes value one in the corresponding year, and $RecapAmount_{it}$ measures the total capital received over the year.

The main variable of interest, $RecapAmount_{it}$ , is defined in relative rather than absolute terms, deflated by RWAs, a proxy for risk and size. In fact, the state aid, as defined by the European Commission, uses RWA as a metric of public support.[2] Furthermore, normalizing the endogenous variable by a risk- and size-related factor is a standard econometric technique, similar in spirit to the log-transform, which mitigates the potential problems of heteroskedasticity in the regression analysis..

### 3.1 Predictive and control variables

Consistent with the previous literature and real supervisory practices, we adopt a CAMELS-type approach in our analysis and use both traditional measures of distress as well as other potential indicators of financial strength to which the likelihood and/or fiscal outlays of public recapitalizations are likely to

[2] See for example the European Commission decision concerning the recapitalization of Alpha Bank: *"The amount of bridge recapitalisation represents around 4.3% of Alpha Bank's RWA as of 31 March 2012. With the preference shares injected in May 2009, the amount of aid received by Alpha Bank in forms other than guarantees and liquidity assistance stands at around 6.3% of the bank's RWA."*

be related according to the recent literature on the global financial crisis. More specifically, we consider (lagged) values of several predictive variables at the bank level which are available from Bankscope with annual frequency. In addition, we also consider a number of macroeconomic variables to control for the economic environment and fiscal space. These variables are available from the IMF WEO database. We provide a detailed explanation of all these variables, grouped into non-mutually exclusive categories, and a discussion of the expected influence on the likelihood and expected costs of future public recapitalization.

*A) Capital Adequacy*

We measure a bank's ability to absorb shocks by its high-quality capital relative to the aggregate size of its balance sheet. This takes account of the underpricing of risk that was prevalent in the run-up to the crisis and yielded high regulatory capital in terms of RWAs despite the increasing build-up of leverage. Given the differences between financial accounting and solvency rules, we include only high quality capital defined as total common equity deflated by total assets $TCETA_{it-1}$. This takes into account the fact that some financial instruments, i.e. subordinated debt or preference shares, are defined as debt in financial statements although they are computed as Tier I capital for regulatory purposes.

*B) Asset Quality*

To measure the quality of the loan portfolio and the provision coverage of non-performing loans, we consider the variable $RILGL_{it-1}$, defined as the *Reserves for Impaired Loans to Gross Loans ratio*. The effect of this variable is ambiguous. On the one hand, greater values of this variable indicate larger buffers in terms of provisions that can be used as a cushion against *expected* losses in the credit portfolio. On the other hand, it may signal rising credit risk, impairing the capacity of the bank to absorb unexpected losses in the loan book.

*C) Management Soundness*

Management quality is difficult to measure directly because it can manifest itself in different forms. Considerable literature has been developed on measuring productive efficiency in banking, however, which conceivably reflects management quality. Following this literature (e.g., Maudos and Fernández de Guevara 2004), we use $CTIR_{it-1}$, defined as the *Cost-to-income ratio of bank* as a proxy of management quality. As such, it is a major determinant of financial strength according to the previous literature on bankruptcy prediction.

*D) Earnings and Profitability*

Previous studies have shown that banking profitability is inversely related to failure. In this spirit, we define the variable $NII_{it-1}$, characterized as the *Net Interest Income to total assets ratio*, a direct measure of the profitability of the traditional retail banking activity. Clearly, banks which are able to generate consistent sources of income are more likely to be able to overcome adverse shocks. Furthermore, this variable is also related to the business models that characterize the sources of revenue. While traditional banks rely almost exclusively on retail activities, large banks engaged in brokerage and fee-income generating activities over the last decade.

*E) Funding Structure*

In this category, we distinguish between two sources of funding. The variable $Deposits_{it-1}$ denotes the *Customer deposits to total assets ratio*, while $StWsF_{it-1}$ is the *Short-term wholesale funding to total assets ratio*. Deposits capture the relative share of stable funding based on traditional borrowing practices. The latter is a measure of non-stable funding that can amplify liquidity risk as market participants are more credit sensitive than retail depositors and hence more inclined to roll off maturing debt in times of financial distress; see López-Espinosa et al (2012). Short-term wholesale funding has proved to play a fundamental role in spreading financial distress during the recent financial crisis.

*F) Business Model*

A bank's business model describes its strategy to enhance expected earnings and manage risks. We define four variables that capture several dimensions of this category in the banking industry, namely, lending capacity in the interbank market, the volume of trading activities, the importance of non-traditional sources of income, and the activity in the derivatives markets.

First, $LTB_{it-1}$ represents the *Loans and financial advances to other banks to total assets ratio*. This variable captures the availability of short-term funds and, hence, is a measure of liquidity or lending capacity (Ayadi, Arbak and Groen, 2011). Central Banks exhibit the greatest LTB ratios of the financial system, so a higher ratio would be related to a smaller likelihood of distress and smaller capital needs.

Second, the variable $FVS_{it-1}$ stands for *Securities at fair value, trading and available-for-sale category, to customer deposits ratio*. This variable is related to market exposure and captures comovement with financial markets from mark- to-market valuation of securities, since even temporary fluctuations in the market value of assets have to be promptly recognized in the bank's balance sheet.

Since the global financial crisis was triggered by a liquidity run in money markets, we expect a positive relationship with both the likelihood of recapitalization and the expected costs involved in a public recapitalization.

Third, the variable $TNIOI_{it-1}$ stands for *Total non-interest operating income to total assets ratio*. This variable captures the magnitude of non-traditional sources of income including fees and commissions, trading income, and valuation adjustments. Whereas fees and commissions may have displayed a lower elasticity to credit growth than interest income thus helping weather the decline in net interest income from tight margins and deleveraging observed during the crisis, trading income and valuation adjustments may have had an offsetting effect in a downward market. The overall effect on the expected cost of public support is thus ambiguous.

Finally, $DERIV_{it-1}$ is the sum of the positive and negative *Derivative exposures to total assets ratio*. This variable captures one of the key and most risky financial exposures of banks with heavy investment and trading activities; see Ayadi et al. (2012).

*G) Other bank-related factors: Size and cross-border exposures*

In this category, we include the variable $SIZE_{it-1,}$ defined as the logarithm of the *total assets.* This variable attempts to control for unobservable factors that are usually related to the total capitalization of the firm. Previous literature has shown that larger firms are more unlikely to default. On the other hand, conditional on the event of a public recapitalization, the volume of capital required is likely to be positively correlated to size, since large-capitalization firms will require larger investments.

To capture the degree of international diversification, we use $DOM_{it-1}$, defined as *Size of domestic revenues divided by total, domestic and cross-border, revenues*. Data on domestic activity was extracted from Bloomberg. However when this data was not available, it was collected manually from the annual reports. In addition, we consider the variable $DOM_{it-1}*NII_{it-1}$, capturing the interaction between NII and the level of domestic activity. It may be argued that public authorities may be more prone to supporting banks with larger domestic operations and a retail focus given the key role they play in supporting local financial intermediation.

*H) Macroeconomic variables*

To control for the macroeconomic environment where the banking group operates, we use the GDP growth rate of the home jurisdiction. To capture the fiscal space of the sovereignty, we use the fiscal balance of the general government defined as net fiscal revenue to nominal GDP.

In addition, we include the monetary policy stance of the home country to capture the availability of market liquidity and a bank's appetite for risk. This macroeconomic indicator has gained increasing prominence as a trigger for the global financial crisis. We define monetary policy stance as the accumulated difference between the Taylor implied monetary policy rule and the actual interest rate.

**3.3 Descriptive analysis**

Table 1 presents basic descriptive statistics (mean, median, minimum, maximum and standard deviation) of all the variables described in the previous subsections. According to the average estimates, the representative bank in our sample is a large-capitalization firm that relies mainly on short-term funding raised in wholesale markets, it uses a relatively large proportion of derivatives in its portfolio, maintains low levels of liquidity, and exhibits a high sensitivity to market conditions through fair value exposures. Overall, this picture agrees with the bank profile characterized in the Liikanen report.

**[Insert Table 1 around here]**

The unconditional probability of a direct recapitalization, measured as the mean value of the dummy variable $Recap_{it}$, is slightly greater than 9 percent. This feature is consistent with the characteristic low probability of default in the banking industry, reported in the previous literature. In fact, the median of the indicator variable is zero, showing the predominance of this value in the sample. As we shall discuss in greater detail later on, this feature can have a major influence in the standard regression analysis and completely characterizes the methodological approach implemented in our study. The capital injected into a distressed firm represents, on average, 3.6 percent of the RWA of the bank, but it shows a considerable degree of variation, ranging from nearly 1 percent to almost 19 percent.

**[Insert Tables 2a and 2b around here]**

Tables 2a and 2b show the descriptive statistics of the bank-specific variables for the subsample of banks that did and did not receive public recapitalization in the sample, i.e. 48 and 36 banks, respectively. The overall picture suggests that recapitalized banks tend to exhibit a lower capital ratio,

higher short-term wholesale funding, a higher cost-to-income ratio and lower lending capacity on average. Interestingly, the average level of domestic activity of recapitalized banks is substantially higher than those which were not recapitalized, which suggests that this variable may have played a major role in prompting public capital support.

**[Insert Table 3 around here]**

Table 3 shows the sample pairwise correlations between the bank-level variables involved in our analysis. The table shows that larger banks tend to have less deposits over total assets, a higher exposure to derivatives and fair value securities and a higher degree of leverage. In turn, more leveraged banks tend to have lower deposits, lower short-term wholesale funding and lower net interest income over total assets. They also have a higher exposure to fair value securities and derivatives. Finally, the interaction between international diversification and net interest income has a negative correlation with deposits over total assets, with exposure to derivatives and with leverage.

## 4. Methodological approach

Because our data includes time series observations for a sample of individual banks, our main methodological approach builds on panel-data techniques. This methodology presents several advantages, of which the most important is that it enables us to control unobservable individual heterogeneity. The main variable of interest in our analysis, namely the volume of public recapitalization relative to risk-weighted assets is a positive variable that takes zero value when public authorities do not step in. As discussed previously, since public recapitalizations are a rare event, the number of zero observations is relatively large in our sample. This consideration is important because ordinary least-squares may not provide a consistent estimation of the main parameters involved in this context. More sophisticated methodologies have to be considered instead.

There are two econometric approaches which can successfully deal with this problem. On the one hand, we may assume that the dependent variable has been sampled from a censored distribution so that only observations beyond a certain threshold value can be observed, this value being zero. The class of Tobit models and, more specifically, the Tobit model type-I, would be adequate in this case; see Amemiya (1985) for an overview. On the other hand, we may assume that zero value observations are originated from the characteristics of the data generating process. This approach seems more suitable to deal with public recapitalizations because zero-valued observations ultimately reflect the decision of financial authorities not to provide financial assistance to a firm. As pointed out by Maddala (1992), individual decisions that cause zero-valued observations should be modelled under this philosophy. In

this context, least-squares regression-based methodologies cannot ensure consistent estimates because of the existence of a sample selection bias. The correct way to proceed is to consider a model of sample selection known as the Tobit model type-II (Amemiya, 1985). The main features of this modeling approach are briefly described below, but the reader is referred to Appendix C for technical details.

Under this approach, we recognize two different data generating processes causing zero and strictly positive observations, which requires two equations to be characterized: A *selection* equation, and a *main* equation. The Heckman (1979) methodology is usually employed to estimate this model as it delivers consistent estimates of the parameters in the main equation via a two-step technique. In the first step, the selection equation, describing the features that determine whether the relevant variable takes positive or zero values, is estimated through a discrete-decision model, such as the probit model. The main aim is to generate estimates of a latent process, namely, the conditional expectation of the error term. In the second step, the main equation is estimated via least-squares in a regression augmented with the previous estimates of the latent variable aiming to ensure prediction errors with zero conditional expectation. The Heckman methodology has been extended to the panel data case by several authors; see, among others, Wooldridge (1995), Kyriazidou (1997) and Vella and Verbeek (1999). In this paper, we consider an extension of the Heckman methodology based on the techniques developed by Verbeek and Nijman (1996) and Vella and Verbeek (1999); see also Balboa and Martí (2007). The central idea in this approach consists of eliminating the selection bias by incorporating two additional regressors into the main equation, which will be referred to as $s_1$ and $s_2$, hereafter; see the technical Appendix C for exact details.

Thus the two equations in this context are as follows. First, the selection equation, is a probit model, measures the probability that financial authorities consider necessary to intervene in a firm in a given year. The endogenous variable is the dummy variable $Recap_{it}$ and the structure of this equation is as follows:

$$Recap_{it} = X'_{it-1}\beta + Controls'_{jt-1}\lambda + \nu_i + \upsilon_{it} \qquad (1)$$

where $X_{it-1}$ denotes a vector containing lagged values of all the bank-specific characteristics described in Section 3; $Controls_{jt-1}$ is a set of control variables related to the macroeconomic and financial conditions in country j and $\upsilon_{it}$ is a random error term obeying standard regularity conditions. The estimation of this equation is identical in spirit to the standard analysis in bank-failure prediction literature, with the occurrence of public recapitalization signaling a failure-type event. The analysis of the estimated coefficients allows us to discuss the factors that could be used to predict the likelihood of a public recapitalization.

Second, the main equation is a linear model, measuring the total amount of public capital injected into a distressed bank each year and takes the following form:

$$RecapAmount_{it}^{+} = Z_{it-1}^{'}\gamma + \omega_1 s_{1i} + \omega_2 s_{2it} + \eta_i + \varepsilon_{it} \quad (2)$$

where $RecapAmount_{it}^{+}$ is a strictly positive variable measuring the relative volume of public capital injected; $Z_{it-1}$ is a vector with lagged values of firm-specific characteristics; $s_1$ and $s_2$ are correcting terms estimated from the selection equation (see Appendix C) and $\varepsilon_{it}$ is a random term obeying standard assumptions. The first equation has been estimated using a random effects probit model and the second equation through a linear random effects model. Both equations have also been estimated with standard errors clustered on banks and years.[3]

It is necessary to make two important observations. First, the set of explanatory variables included in the main equation (2) cannot be exactly the same as that included in the selection equation, because a serious problem of multicollinearity may arise in this case. In order to avoid this problem, the selection equation should contain at least two variables that are not included in the main equation, which is known as an exclusion restriction, and motivates the different notation used in the equation (2). Secondly, all the variables on the right-hand side of equations (1) and (2) have been lagged one period. Consistent with the bank-failure literature, this analysis not only allows us to address the predictive ability of bank-specific factors (a more relevant question for monitoring and supervisory purposes than a contemporaneous regression), but also circumvent potential concerns related to the exogeneity of the variables involved. Lags of the main variables are routinely implemented in Instrumental-Variable estimation, since under standard assumptions they are uncorrelated with one-period ahead shocks, but serially correlated with the main indicators considered.

## 5. Empirical results

In this section, we first explain the results of the selection and main equations and then show that they are robust to alternative sets of bank-specific, macro and accounting variables.

### 5.1 Main results

We now discuss the main results obtained in the estimation of the two-step Heckman methodology. Tables 4 reports the parameter estimates for the selection equation (probit) and the main equation (Generalized Least Squares) with robust standard errors computed with multi-way clustering on

[3] Results presented in the paper are those with standard errors clustered on banks and years. All results for selection and main equation remain similar for both methodologies.

bank and year. The table also reports the standard goodness-of-fit measure in the regression. The regressors included in the selection equation are all the bank-specific factors discussed in Section 3 and the macroeconomic variables used to control for time-varying economic conditions. Because the variable DOM is a proxy that builds on an arbitrary consideration, and so is the related variable DOM*NII, we run two sets of regressions, with and without these variables. Given the estimates of the correction terms obtained from the selection equation, the main equation is estimated using the same set of variables with the exception of the variables that, arguably, may have an impact on the probability of default but a less likely effect on the total costs of recapitalization. We excluded the variables DEV and the dummy for the domestic activity.[4]

**[Insert Table 4 around here]**

The first set of results corresponds to the model without international variables, whereas the second set includes them. We first comment upon the main results related to the selection equation. Interestingly, many of the predictive factors involved are largely significant and the estimated coefficients exhibit the expected sign a priori. Leveraged banks, those relying on non-stable funding, and banks more exposed to fair value are more likely to require public assistance. Similarly, a higher lending capability, and better quality management (measured by the inverse of cost-to-income-ratio) significantly reduce the probability of public recapitalization. Additionally, banks with higher net interest income are more likely to receive fiscal outlays in recapitalizations. Adrian and Shin (2010) have pointed out that high interest income implies an increase in forward-looking measures of capital and highlights the risk appetite of banks. This can lead to over-lending which can eventually trigger loan defaults. A higher level of deposits over total assets increases the probability of public recapitalization. Thus, while deposits are a more stable source of funding than other items, they do not seem to lower the probability of recapitalization nor the amount of fiscal outlays disbursed in these episodes. Nevertheless, notice that the economic effect (coefficient size) of short-term funding on recapitalizations is three and six times higher than that of deposits in the selection and main equations, respectively. Taken together, the presented evidence squares well with the overall evidence reported in bankruptcy literature. However, we present additional evidence with respect to the literature, since the impact of management efficiency and the size of the fair-value securities had not been previously analyzed.

Among the set of bank-specific predictors analyzed, only four variables (SIZE, DEP, RILGL and DERV), do not seem to add incremental predictive power over the remaining factors. Previous studies have suggested that size tends to be negatively related to bank-failure. Since our sample is mainly formed by large banks, however, it is possible that size does not exhibit enough variation in our sample to predict

[4] We conducted an analysis on different specifications building on different exclusion restrictions to address the robustness of the results discussed in the text, noting that the main conclusion was not particularly sensitive.

the sheer differences in the likelihood of a public intervention. This result would suggest that the perception of the estimated coefficient on DERV is negative, indicating a smaller likelihood of recapitalization, which is not significant.

The specification including the international dimension yields relevant results. First, the model fit is substantially better, as the $R^2$ increases from 0.65 to 0.67 in the baseline model. Second, and more importantly, the interaction between the net interest income and the proportion of domestic lending by banks emerges as an important predictor of the likelihood of a public recapitalization. This implies that banks that run a high interest income *and* which have a domestic orientation are more likely to require public assistance. As a result, the analysis suggests that international diversification has been a key factor to reduce the probability of a public recapitalization. This strategy allows for lower correlations in individual asset returns across different economies, which would have translated into a lower default probabilities.[5]

We now turn our attention to the results from the main equation, analyzing the role played by firm-specific factors to determine direct recapitalization costs. Several variables analyzed, related to CAMEL rating categories, are useful predictors of the recapitalization amounts or fiscal outlays. The more significant variables are related to the funding structure of the bank, liquidity and its management efficiency. A higher degree of solvency –measured by the capital to asset ratio- and a higher lending capacity reduce the expected costs bailout whereas the opposite is the case for short-term wholesale funding and fair value securities. In turn, a lower cost-to-income ratio results in lower recapitalization costs. Finally, the extent of international income diversification is again a significant determinant of the volume of recapitalization at the usual confidence levels. Thus, for instance, when both the home bank and the home economy are in distress, an international bank can sell part of its international assets at a reasonably high price, thus providing an effective buffer in terms of solvency.

### 5.2 Robustness checks

In this subsection, we assess the robustness of the baseline results along heterogeneous dimensions in the set of drivers: The banking business model, the accounting standards and the effect of the single Euro-zone monetary policy in a diverse set of countries. As shown below, not only are the main results preserved in these alternative specifications, but new interesting insights emerge.

*A) Business model*

[5] In a different context, Vermeuler (2011) compares international equity portfolios before and during the financial crisis finding that international stock market diversifications seem to have provided large gains during the crisis, despite the large correlation between stock markets.

Table 5 shows the parameter estimates of the model including a variable proxying for the bank business model. This variable is the ratio of the total non-interest income to total assets. A higher value of this variable implies that the bank obtains more income through non-traditional banking activities. The main equation shows that banks operating with a higher non-interest income are more likely to incur higher fiscal outlays for the public authority in the context of public recapitalizations. All baseline results in both selection and main equations are preserved under this alternative specification. Additionally, the $R^2$ increases to 0.68.

*B) Accounting standards*

In our sample, the US is the only country using locally accepted accounting standards, since the remaining countries follow IFRS. We control for these alternative accounting configurations in the estimations reported in Table 6, which includes a US dummy for all US banks. Results are again very similar to the baseline specifications. Moreover, Table 6 shows that the US dummy significantly predicts a higher level of public recapitalization with respect to non-US banks in the main equation at the 10% level.

*C) EMU and the influence of the interest rate*

In Table 7 we estimate our model controlling for two factors affecting banks: their belonging to the European Monetary Union and the yearly accumulated difference between the Taylor (1993) implied and actual interest rates. This difference is a proxy for how lax/tight monetary policy is. We deem it important to interact bank specific variables with these two dimensions for several reasons. In particular, monetary policy in countries which have adopted the euro is outside the scope of the local monetary authorities. While monetary stability is ensured overall by a rigorous Central Bank, there is less monetary policy discretion. Moreover, a single monetary policy is not likely to fit all countries equally well, given that the business cycle is not perfectly synchronized across them. Indeed, our results in Table 7, while preserving the ones previously obtained, show that banks in the Eurozone countries where monetary policy was excessively lax received larger fiscal outlays. This is a very interesting result which highlights that financial stability should also be a concern of the monetary authority when setting interest rates. Additionally, the $R^2$ increases to 0.69, highlighting the good model fit of this specification.

**[Insert Tables 5, 6 and 7 around here]**

## 6. Concluding remarks and policy recommendations

This paper tries to determine the bank-specific factors that predict fiscal outlays in bank public recapitalization programs. The recent recapitalization process in the aftermath of the financial crisis offers us a unique setting to address this question from a global perspective. To this end, we apply the two-step econometric framework designed by Heckman (1979), which allows us to identify the main drivers of public recapitalizations and their impact on fiscal outlays after controlling for the selection biases. In this way, we are able to back out from the specific avenues of moral hazard associated with too important to fail institutions (TITFs) due to their perceived expectation of future public capital support. Our exercise contains many different results, but here we highlight three especially novel and important ones: International diversification and management efficiency mitigate bank fragility, whereas a larger share of trading activities tends to exacerbate it.

Risks emanating from fiscal uncertainties in the U.S. and the ongoing sovereign debt in the euro area lie at the heart of global financial stability concerns. The legacy of public debt, averaging an all-time high of 110 percent of GDP in 2012 for the advanced economies, is the fiscal fallout from the global financial crisis. Rising public deficits have emerged from the devastating effect of an impaired banking sector on real economic activity. Also the fiscal liability from direct public solvency support to banking institutions has been significant. In the wake of the financial crisis and given the widespread absence of regulatory frameworks for orderly resolution of failing banks, many governments were pushed into massive and coordinated public bailouts in order to preserve financial stability. Sadly, the overall cost of the financial crisis has fallen on taxpayers causing an understandable public outcry. More importantly, the massive scale of public recapitalization measures, while succeeding in preventing the collapse of the financial sector, has magnified spillover effects from banking institutions to sovereigns, created harmful feedback loops, and left governments highly exposed to sudden swings in market confidence. Greater sovereign risk is already having adverse effects on banks and financial markets (CGFS, 2011).

Looking forward, public solvency support to TITF institutions may have also created deleterious consequences for private incentives. To address the TITF problem, systemic institutions will be subject to an enhanced regulatory regime and more intense and efficient supervision. The methodology to identify a TITF institution developed by the Basel Committee of Banking Supervision (BCBS), is based on an indicator-based measurement approach to reflect the different aspects of banking operations that generate negative externalities and make a bank critical for the stability of the financial system'.[6] Other model-based approaches laid out in the academic literature use quantitative methods to estimate the contribution of individual banks to the distress of the financial system. In all cases, systemic risk measures attempt to evaluate the ripple effects from a bank's failure throughout the financial system but, crucially, ignore the incentives of public authorities to bail out banking institutions. Also, they focus on measuring the externalities that a systemic institution may generate in the system rather than on assessing its probability

[6] The selected indicators reflect the size of banks, their interconnectedness, the lack of readable available substitutes for the services they provide, their global activity, and their complexity (BCBS, 2011).

of default. This oversight critically breaks the circuit between the designation of a bank as a TIFT and its expected fiscal costs from a possible bailout.

This paper tries to fill this gap by directly measuring the probability of government recapitalization and the fiscal cost generated by public solvency programs as a function of bank-specific determinants. The analysis is based on a set of 84 global banks domiciled in 24 jurisdictions over the period from 2004 through 2012. The aggregate gross fiscal outlay from solvency programs in our sample conducted by end-2012 reached USD 515 billion, with an average of 0.62 percent of GDP per bank, and 3.25 percent of GDP per country. The set of relevant indicators predicting government support measures include bank-specific variables that reflect asset quality, business model, funding strategy, management quality, and cross-border activities, controlling for the macroeconomic environment of the parent bank.

Our results suggest that banks' funding sources, management quality, lending capacity and international diversification emerge as the main leading indicators with which to predict future fiscal liabilities. In agreement with our first finding, funding stability has been one of the backbones of the new regulatory bank regulation in the Basel III Committee. With regard to higher management quality, it has been associated with a bank's higher capacity to absorb unexpected losses. Our analysis shows that it also reduces expected fiscal costs. The global crisis has highlighted the vulnerability of banks acting as net recipients of liquidity in the interbank market and being subject to rollover risk of maturing liabilities. By contrast, the last indicator has proved more controversial. Brought to the fore by the disorderly resolution of Lehman Brothers in 2008, cross-jurisdictional activity has been identified as the main driver of systemic risk. Not surprisingly, it has become a key indicator used by the Financial Stability Board (FSB) to identify global systemic financial institutions (G-SIFIs). Interestingly, our results point at the stabilizing effect of international diversification in decreasing the probability of a bank's public bailout. This effect is non-linear in a bank's business model. Specifically, a bank with significant domestic operations is more likely to be rescued and generates a larger fiscal outlay conditional on public support. This result points at the motivation of local authorities to bail out banks which are perceived to play a significant role in providing financial intermediation services to the home economy, rather than to contain global externalities from the disorderly failure of an internationally active bank.

The policy implications from our analysis are immediate. First, it underlines the imperative to enhance cross-border cooperation agreements so that home and host authorities of global financial institutions cooperate and coordinate national resolution regimes. Second, it reveals the need to integrate the microprudential regulatory approach to financial stability, aimed at minimizing the probability of failure of an individual institution, with the macroprudential agenda, seeking to contain the adverse spillovers from the failure of a systemic institution on public finances. Identifying the determinants of fiscal costs may also help underpin the agenda for financial sector reform, enhance incentives in banking institutions,

and create a level playing field in the banking sector, haunted by the global massive bailout program conducted in 2008-2012.

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**Table 1. Summary Statistics. All Banks.**

| Variable | Mean | Median | Min | Max | Std. Dev |
|---|---|---|---|---|---|
| *Recap* | 0.0920 | 0 | 0 | 1 | 0.2893 |
| *Size* | 12.4629 | 12.4523 | 8.6321 | 15.0686 | 1.4217 |
| *TCETA* | 0.0259 | 0.0210 | -0.0615 | 0.1613 | 0.0217 |
| *Deposits* | 0.4386 | 0.4402 | 0.0368 | 0.9106 | 0.1767 |
| *StWsF* | 0.1780 | 0.1744 | 0 | 0.5288 | 0.1780 |
| *FVS* | 0.5593 | 0.3823 | 0 | 4.5616 | 0.5793 |
| *LTB* | 0.0877 | 0.0692 | 0.0001 | 0.4424 | 0.0733 |
| *RILGL* | 0.0259 | 0.0210 | 0.0004 | 0.1613 | 0.0217 |
| *DERIV* | 0.1066 | 0.0629 | 0 | 1 | 0.1417 |
| *CTIR* | 0.6188 | 0.5942 | 0.2281 | 3.4619 | 0.2275 |
| *NII* | 0.0170 | 0.0162 | 0.0019 | 0.0631 | 0.0097 |
| *TNIOI* | 0.0108 | 0.0095 | -0.0063 | 0.0519 | 0.0083 |
| *DOM* | 0.7247 | 0.7576 | 0.0191 | 1 | 0.2502 |
| *DOM*NII* | 0.0126 | 0.0111 | 0.0002 | 0.0554 | 0.0089 |
| *Recapamount* | 0.0363 | 0.0246 | 0.0045 | 0.1312 | 0.0319 |

This table shows some summary statistics of the bank-specific pooled variables used in our exercise for all banks. $Recap_{it-1}$ is a binary variable: 1 if the bank received public recapitalization, zero otherwise. $Size_{it-1}$ is the natural logarithm of total assets. $TCETA_{it-1}$ is the total common equity over total asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. It is a proxy for the quality and coverage of gross loans. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $TNIOI_{it-1}$ is the total non-interest operating income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between NII and the level of domestic activity. $Recapamount_{it}$ is the amount of public recapitalization received by a bank at year *t* deflated by risk-weighted assets at year *t-1*.

**Table 2a. Summary Statistics: Publicly Recapitalized Banks.**

| Variable | Mean | Median | Min | Max | Std. Dev |
|---|---|---|---|---|---|
| *Size* | 12.3328 | 12.2563 | 9.9654 | 15.0686 | 1.2156 |
| *TCETA* | 0.0240 | 0.0304 | -0.0403 | 0.0649 | 0.0264 |
| *Deposits* | 0.4428 | 0.4837 | 0.0369 | 0.7363 | 0.1862 |
| *StWsF* | 0.2389 | 0.2356 | 0.0501 | 0.5288 | 0.1157 |
| *FVS* | 0.5497 | 0.2749 | 0.0196 | 4.1975 | 0.7229 |
| *LTB* | 0.0623 | 0.0458 | 0.0001 | 0.1936 | 0.0507 |
| *RILGL* | 0.0328 | 0.0206 | 0.0011 | 0.1271 | 0.0299 |
| *DERIV* | 0.1324 | 0.0535 | 0.0031 | 0.8177 | 0.1324 |
| *CTIR* | 0.7802 | 0.6305 | 0.4374 | 3.4619 | 0.5880 |
| *NII* | 0.0194 | 0.0212 | 0.0025 | 0.0378 | 0.0100 |
| *TNIOI* | 0.0096 | 0.0061 | 0 | 0.0467 | 0.0113 |
| *DOM* | 0.7488 | 0.7442 | 0.0584 | 1 | 0.2135 |
| *DOM*NII* | 0.0145 | 0.0132 | 0.0005 | 0.0364 | 0.0086 |
| *Recapamount* | 0.0363 | 0.0246 | 0.0045 | 0.1312 | 0.0319 |

This table shows some summary statistics of the bank-specific pooled variables used in our exercise for all publicly recapitalized banks. $Size_{it-1}$ is the natural logarithm of total assets. $TCETA_{it-1}$ is the total common equity over total asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. It is a proxy for the quality and coverage of gross loans. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $TNIOI_{it-1}$ is the total non-interest operating income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between NII and the level of domestic activity. $Recapamount_{it}$ is the amount of public recapitalization received by a bank at year *t* deflated by risk-weighted assets at year *t-1*.

**Table 2b. Summary Statistics: Non-Publicly Recapitalized Banks.**

| Variable | Mean | Median | Min | Max | Std. Dev |
|---|---|---|---|---|---|
| *Size* | 12.4758 | 12.4755 | 8.6321 | 14.9356 | 1.4410 |
| *TCETA* | 0.0414 | 0.0391 | -0.0435 | 0.1215 | 0.0206 |
| *Deposits* | 0.4382 | 0.4379 | 0.0596 | 0.9106 | 0.1760 |
| *StWsF* | 0.1719 | 0.1716 | 0 | 0.4811 | 0.0874 |
| *FVS* | 0.5603 | 0.3848 | 0 | 4.5616 | 0.5641 |
| *LTB* | 0.0902 | 0.0709 | 0.0001 | 0.4424 | 0.0747 |
| *RILGL* | 0.0252 | 0.0211 | 0.0004 | 0.1613 | 0.0206 |
| *DERIV* | 0.1078 | 0.0638 | 0 | 1 | 0.1427 |
| *CTIR* | 0.6028 | 0.5926 | 0.2281 | 1.6793 | 0.1433 |
| *NII* | 0.0168 | 0.0160 | 0.0019 | 0.0631 | 0.0097 |
| *TNIOI* | 0.0110 | 0.0097 | -0.0044 | 0.0519 | 0.0080 |
| *DOM* | 0.7224 | 0.7630 | 0.0191 | 1 | 0.2536 |
| *DOM*NII* | 0.0124 | 0.0108 | 0.0002 | 0.0554 | 0.0090 |

This table shows some summary statistics of the bank-specific pooled variables used in our exercise for all publicly recapitalized banks. $Size_{it-1}$ is the natural logarithm of total assets. $TCETA_{it-1}$ is the total common equity over total asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. It is a proxy for the quality and coverage of gross loans. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $TNIOI_{it-1}$ is the total non-interest operating income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between NII and the level of domestic activity.

**Table 3. Correlations of bank-specific variables**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1. TCETA* | 1.00 | | | | | | | | | | | |
| *2. SIZE* | -0.44*** | 1.00 | | | | | | | | | | |
| *3. DEP* | 0.57*** | -0.48*** | 1.00 | | | | | | | | | |
| *4. SWF* | -0.48*** | 0.16*** | -0.57*** | 1.00 | | | | | | | | |
| *5. FVS* | -0.40*** | 0.25* | -0.60*** | 0.26 | 1.00 | | | | | | | |
| *6. LTB* | -0.18*** | -0.06 | -0.19*** | 0.20*** | 0.34*** | 1.00 | | | | | | |
| *7. RILGL* | 0.10** | -0.33*** | 0.27*** | -0.08* | -0.17*** | -0.09** | 1.00 | | | | | |
| *8. DERV* | -0.36*** | 0.53*** | -0.47*** | 0.12*** | 0.24*** | -0.06 | -0.17*** | 1.00 | | | | |
| *9. CTIR* | -0.28*** | 0.07 | -0.21*** | 0.16*** | 0.14*** | 0.13*** | 0.11*** | 0.20*** | 1.00 | | | |
| *10. DOM*NII* | 0.60*** | -0.50*** | 0.67*** | -0.37*** | -0.46*** | -0.26*** | 0.36*** | -0.44*** | -0.17*** | 1.00 | | |
| *11. NII* | 0.59*** | -0.41*** | 0.68*** | -0.34*** | -0.51*** | -0.30*** | 0.43*** | -0.40*** | -0.22*** | 0.88*** | 1.00 | |
| *12. TNOI* | 0.39*** | -0.06 | 0.45*** | -0.34*** | -0.24*** | 0.04 | 0.02 | -0.20*** | -0.18*** | 0.42*** | 0.44*** | 1.00 |

***p<0.01, **p<0.05, *p<0.1.

**Table 4**
**Estimations for all Public Recapitalizations of Banks (Baseline)**

| Predictive Variables | Dependent variable | | Dependent Variable | |
|---|---|---|---|---|
| | First stage- Probability of recapitalizations ($Recap_{it}$) | Second stage- Volume of recapitalizations ($RecapAmount_{it}$) | First stage- Probability of recapitalizations ($Recap_{it}$) | Second stage- Volume of recapitalizations ($RecapAmount_{it}$) |
| $Size_{it-1}$ | 0.06 | -0.01 | -0.04 | -0.01 |
| $TCETA_{it-1}$ | -27.56*** | -1.60*** | -25.73*** | -1.65*** |
| $Deposits_{it-1}$ | 1.87 | 0.02 | 1.97** | 0.05** |
| $StWsF_{it-1}$ | 4.39*** | 0.12** | 4.79*** | 0.19** |
| $FVS_{it-1}$ | 0.28** | -0.01 | 0.25** | 0.01 |
| $LTB_{it-1}$ | -6.83*** | -0.36*** | -6.64*** | -0.38*** |
| $RILGL_{it-1}$ | -8.37 | -0.35 | -6.91 | -0.32 |
| $CTIR_{it-1}$ | 1.35*** | 0.04** | 1.31*** | 0.05*** |
| $DERIV_{it-1}$ | -0.75 | - | -0.80 | 0.01 |
| $GROWTH_{jt-1}$ | -2.86 | -0.04 | -2.97 | -0.03 |
| $DOM_{it-1}*NII_{it-1}$ | - | - | 45.51*** | 1.94** |
| $NII_{it-1}$ | 41.75* | 1.34* | - | - |
| $DOM_{it-1}$ | - | - | -0.47 | - |
| $FISCAL\ BALANCE_{jt-1}$ | 0.64 | - | -0.72 | - |
| *Constant* | -2.20* | -0.03 | -1.03 | -0.09 |
| $S1_i$ | | 0.01* | | 0.01** |
| $S2_{it}$ | | 0.03*** | | 0.04 |
| $N$ | 511 | 46 | 511 | 46 |
| $R^2$ | | 0.65 | | 0.67 |

*** p<0.01, ** p<0.05, * p<0.10.

Two-step Heckman methodology. The first stage is a probit model with standard errors clustered on banks and years and the second stage is a linear model with standard errors clustered on banks and years. The terms $S1_{it}$ and $S2_{it}$ are introduced in the second stage in order to correct the sample selection bias problem. In the first stage the endogenous variable is $Recap_{it}$, which is a binary variable: 1 if the bank received public recapitalization, zero otherwise. $Size_{it-1}$ is the natural logarithm of the total assets. $TCETA_{it-1}$ is the total common equity to asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between the net interest income and the level of domestic activity. $GROWTH_{jt-1}$ is the GDP growth of the country *j*. $FISCAL\ BALANCE_{jt-1}$ is the fiscal deficit of a country *j* divided by GDP. $Recapamount_{it}$ is the endogenous variable in the second step, and is the amount of public recapitalization received by a bank deflated by risk-weighted assets.

**Table 5**
**Estimations for all Public Recapitalizations of Banks (Business Model)**

| **Predictive Variables** | **Dependent variable** | |
|---|---|---|
| | First stage: Probability of recapitalizations ($Recap_{it}$) | Second stage: Volume of recapitalizations ($RecapAmount_{it}$) |
| $Size_{it-1}$ | -0.08 | -0.01 |
| $TCETA_{it-1}$ | -27.43*** | -1.65*** |
| $Deposits_{it-1}$ | 1.68** | 0.07 |
| $StWsF_{it-1}$ | 5.10*** | 0.18** |
| $FVS_{it-1}$ | 0.22** | -0.01 |
| $LTB_{it-1}$ | -7.31*** | -0.38*** |
| $RILGL_{it-1}$ | -6.42 | -0.28 |
| $CTIR_{it-1}$ | 1.37*** | 0.05** |
| $TNIOI_{it-1}$ | 19.97 | 1.08*** |
| $DOM_{it-1}*NII_{it-1}$ | 38.59* | 1.63** |
| $DERIV_{it-1}$ | -0.72 | 0.02 |
| $GROWTH_{jt-1}$ | -3.42 | -0.07 |
| $FISCAL\ BALANCE_{jt-1}$ | -0.73 | - |
| $DOM_{it-1}$ | -0.38 | - |
| *Constant* | -1.66 | -0.50 |
| $S1_i$ | | 0.01*** |
| $S2_{it}$ | | 0.04*** |
| *N* | 511 | 46 |
| $R^2$ | | 0.68 |

*** p<0.01, ** p<0.05, * p<0.10

Two-step Heckman methodology. The first stage is a probit model with standard errors clustered on banks and years and the second stage is a linear model with standard errors clustered on banks and years. The terms $S1_{it}$ and $S2_{it}$ are introduced in the second stage in order to correct the sample selection bias problem. In the first stage the endogenous variable is $Recap_{it}$, which is a binary variable: 1 if the bank received public recapitalization, zero otherwise. $Size_{it-1}$ is the natural logarithm of the total assets. $TCETA_{it-1}$ is the total common equity to asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $TNIOI_{it-1}$ is the total non-interest operating income to total asset ratio. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between the net interest income and the level of domestic activity. $GROWTH_{jt-1}$ is the GDP growth of the country *j*. $FISCAL\ BALANCE_{jt-1}$ is the fiscal deficit of a country *j* divided by GDP. $Recapamount_{it}$ is the endogenous variable in the second step, and is the amount of public recapitalization received by a bank deflated by risk-weighted assets.

**Table 6**
**Estimations for all Public Recapitalizations of Banks (with US dummy)**

| Predictive Variables | Dependent variable | |
|---|---|---|
| | First stage: Probability of recapitalizations ($Recap_{it}$) | Second stage: Volume of recapitalizations ($RecapAmount_{it}$) |
| $Size_{it-1}$ | -0.15*** | -0.01 |
| $TCETA_{it-1}$ | -26.15*** | -1.57*** |
| $Deposits_{it-1}$ | 1.57** | 0.03** |
| $StWsF_{it-1}$ | 4.90*** | 0.17** |
| $FVS_{it-1}$ | 0.17** | 0.01 |
| $LTB_{it-1}$ | -6.81*** | -0.36*** |
| $RILGL_{it-1}$ | -5.58 | -0.26 |
| $CTIR_{it-1}$ | 1.09*** | 0.04** |
| $DOM_{it-1}*NII_{it-1}$ | 32.51 | 1.28** |
| $US_{it-1}$ | 0.69 | 0.02* |
| $DERIV_{it-1}$ | -0.42 | 0.02 |
| $GROWTH_{jt-1}$ | -3.15 | 0.01 |
| $FISCAL\ BALANCE_{jt-1}$ | 0.87 | - |
| $DOM_{it-1}$ | 0.51 | - |
| *Constant* | -0.40 | -0.02 |
| $S1_i$ | | 0.01*** |
| $S2_{it}$ | | 0.03*** |
| $N$ | 506 | 32 |
| $R^2$ | | 0.67 |

*** p<0.01, ** p<0.05, * p<0.10

Two-step Heckman methodology with the US dummy. The first stage is a probit model with standard errors clustered on banks and years and the second stage is a linear model with standard errors clustered on banks and years. The terms $S1_{it}$ and $S2_{it}$ are introduced in the second stage in order to correct the sample selection bias problem. In the first stage the endogenous variable is $Recap_{it}$, which is a binary variable: 1 if the bank received public recapitalization, zero otherwise. $Size_{it-1}$ is the natural logarithm of the total assets. $TCETA_{it-1}$ is the total common equity to asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between the net interest income and the level of domestic activity. $GROWTH_{jt-1}$ is the GDP growth of the country *j*. $FISCAL\ BALANCE_{jt-1}$ is the fiscal deficit of a country *j* divided by GDP. $Recapamount_{it}$ is the endogenous variable in the second step, and is the amount of public recapitalization received by a bank deflated by risk-weighted assets.

**Table 7**
**Estimations for all Public Recapitalizations of Banks (with Euro dummy + MPDIF)**

| Independent Variables | Dependent variable | |
|---|---|---|
| | First stage- Probability of recapitalizations ($Recap_{it}$) | Second stage- Volume of recapitalizations ($Recapamount_{it}$) |
| $Size_{it-1}$ | 0.01 | 0.01 |
| $TCETA_{it-1}$ | -31.09*** | -1.22** |
| $Deposits_{it-1}$ | 0.75 | -0.09** |
| $StWsF_{it-1}$ | 4.46*** | 0.01 |
| $FVS_{it-1}$ | 0.32*** | -0.01 |
| $LTB_{it-1}$ | -6.64*** | -0.25*** |
| $RILGL_{it-1}$ | -8.01*** | -0.23 |
| $CTIR_{it-1}$ | 1.80*** | 0.02 |
| $TNIOI_{it-1}$ | 36.62*** | 1.88*** |
| $DOM_{it-1}*NII_{it-1}$ | 48.69*** | 1.44*** |
| $EURO_{it-1}$ | -0.72* | 0.01 |
| $MPDIF_{it-1}$ | 0.42 | -0.06 |
| $EURO*MPDIF_{it-1}$ | 7.26*** | 0.26*** |
| $DERIV_{it-1}$ | -0.89 | 0.04 |
| $GROWTH_{jt-1}$ | -1.51 | 0.11 |
| $FISCAL\ BALANCE_{jt-1}$ | 2.36 | - |
| $DOM_{it-1}$ | -0.20 | - |
| *Constant* | -3.12** | -0.03 |
| $S1_i$ | | 0.01 |
| $S2_{it}$ | | 0.01 |
| $N$ | 511 | 46 |
| $R^2$ | | 0.69 |

*** p<0.01, ** p<0.05, * p<0.10

Two-step Heckman methodology with the EURO dummy for EMU countries. The first stage is a probit model with standard errors clustered on banks and years and the second stage is a linear model with standard errors clustered on banks and years. The terms $S1_{it}$ and $S2_{it}$ are introduced in the second stage in order to correct the sample selection bias problem. In the first stage the endogenous variable is $Recap_{it}$, which is a binary variable: 1 if the bank received public recapitalization, zero otherwise. $Size_{it-1}$ is the natural logarithm of the total assets. $TCETA_{it-1}$ is the total common equity to asset ratio. $Deposits_{it-1}$ is the customer deposits to total assets ratio. $StWsF_{it-1}$ is the short-term wholesale funding to total assets ratio. $FVS_{it-1}$ is the securities at fair value to customer deposits ratio. $LTB_{it-1}$ is the loans and financial advances to other banks to total assets ratio. $RILGL_{it-1}$ is the reserves for impaired loans to gross loans ratio. $DERIV_{it-1}$ is the positive and negative derivate exposures to total assets ratio. $CTIR_{it-1}$ is the cost-to-income ratio of bank. $TNIOI_{it-1}$ is the total non-interest operating income to total asset ratio. $NII_{it-1}$ is the Net Interest Income to total assets ratio. $DOM_{it-1}$ is the level of domestic activity, proxied by the size of domestic revenues divided by total, domestic and cross-border, revenues. $DOM_{it-1}*NII_{it-1}$ is the interaction between the net interest income and the level of domestic activity. $GROWTH_{jt-1}$ is the GDP growth of country *j*. $FISCAL\ BALANCE_{jt-1}$ is the fiscal deficit of a country *j* divided by GDP. $MPDIF_{it-1}$ is the difference between the accumulated Taylor-implied and actual monetary policy rates. $EURO*\ MPDIF_{it-1}$ is the interaction between the EMU dummy and *MPDIF*. $Recapamount_{it}$ is the endogenous variable in the second step, and is the amount of public recapitalization received by a bank deflated by risk-weighted assets.

## Appendix A: Final List of Banking Groups

| Country | Bank | Assets 2011 (mn USD) |
|---|---|---|
| Australia | Australia and New Zealand banking group | 581,463 |
| Australia | Commonwealth bank of australia | 717,245 |
| Australia | National Australia Bank Ltd | 737,243 |
| Australia | Westpac Banking corp | 655,544 |
| Austria | Erste Bank Group (EBG) | 271,712 |
| Austria | Oesterreichische Volksbank AG | 53,221 |
| Austria | Raiffeisen Bank International (RBI) | 190,173 |
| Belgium | DEXIA | 534,039 |
| Belgium | KBC BANK | 311,911 |
| Canada | Bank of Montreal | 502,737 |
| Canada | Bank of Nova Scotia | 596,990 |
| Canada | Canadian Imperial Bank of Commerce | 385,415 |
| Canada | Royal Bank of Canada | 797,261 |
| Canada | Toronto-Dominion Bank | 735,947 |
| Cyprus | BANK OF CYPRUS PUBLIC CO LTD | 48,486 |
| Cyprus | Cyprus Popular Bank Public Co | 43,682 |
| Denmark | DANSKE BANK | 596,004 |
| Finland | OP-Pohjola Group | 119,404 |
| France | BNP PARIBAS | 2,542,739 |
| France | BPCE | 1,472,888 |
| France | CREDIT AGRICOLE | 2,230,053 |
| France | SOCIETE GENERALE | 1,528,493 |
| Germany | Bayerische Landesbank | 399,979 |
| Germany | COMMERZBANK AG | 856,208 |
| Germany | DekaBank Deutsche Girozentrale, Frankfurt | 173,034 |
| Germany | DEUTSCHE BANK AG | 2,799,978 |
| Germany | DZ BANK AG Dt. Zentral-Genossenschaftsbank | 525,199 |
| Germany | HSH Nordbank AG, Hamburg | 175,839 |
| Germany | Hypo Real Estate Holding AG, München | 306,102 |
| Germany | Landesbank Baden-Württemberg | 482,674 |
| Germany | Landesbank Berlin AG | 169,718 |
| Germany | Norddeutsche Landesbank -GZ | 294,514 |
| Germany | WestLB AG, Düsseldorf | 217,247 |
| Greece | AGRICULTURAL BANK OF GREECE S.A. (ATEbank) 1/ | 39,627 |
| Greece | ALPHA BANK | 76,527 |
| Greece | EFG EUROBANK ERGASIAS S.A. | 99,394 |
| Greece | NATIONAL BANK OF GREECE | 138,271 |
| Greece | PIRAEUS BANK GROUP | 63,853 |
| Greece | TT HELLENIC POSTBANK S.A. 1/ | 20,733 |
| Hungary | OTP BANK NYRT. | 42,382 |
| Ireland | ALLIED IRISH BANKS PLC | 176,803 |
| Ireland | BANK OF IRELAND | 200,388 |
| Ireland | IRISH LIFE AND PERMANENT | 93,204 |
| Italy | BANCA MONTE DEI PASCHI DI SIENA S.p.A | 311,427 |
| Italy | BANCO POPOLARE - S.C. | 173,537 |
| Italy | INTESA SANPAOLO S.p.A | 827,042 |
| Italy | UNICREDIT S.p.A | 1,199,080 |
| Italy | UNIONE DI BANCHE ITALIANE SCPA (UBI BANCA) | 167,944 |

| | | |
|---|---|---|
| Japan | Japan Post Bank | 2,325,675 |
| Japan | Mizuho Financial Group | 1,890,274 |
| Luxembourg | BANQUE ET CAISSE D'EPARGNE DE L'ETAT | 51,419 |
| Malta | BANK OF VALLETTA (BOV) | 8,943 |
| Netherlands | ABN AMRO BANK NV | 523,589 |
| Netherlands | ING BANK NV | 1,655,102 |
| Netherlands | RABOBANK NEDERLAND | 946,649 |
| Poland | POWSZECHNA KASA OSZCZEDNOSCI BANK POLSKI S | 55,817 |
| Portugal | Banco BPI, SA | 55,578 |
| Portugal | BANCO COMERCIAL PORTUGUÊS, SA (BCP OR MILLE | 120,950 |
| Portugal | Banco Espirito Santo | 103,813 |
| Portugal | CAIXA GERAL DE DEPÓSITOS, SA | 156,201 |
| Slovenia | NLB dd-Nova LJUBLJANSKA BANKA D.D. (NLB d.d.) | 21,277 |
| Slovenia | NOVA KREDITNA BANKA MARIBOR D.D. (NKBM d.d.) | 7,525 |
| Spain | BANCO BILBAO VIZCAYA ARGENTARIA S.A. (BBVA) | 773,306 |
| Spain | BANCO DE SABADELL, S.A. | 129,949 |
| Spain | BANCO POPULAR ESPAÑOL, S.A. | 169,395 |
| Spain | BANCO SANTANDER S.A. | 1,619,260 |
| Spain | BANKIA | 391,831 |
| Spain | CAJA DE AHORROS Y PENSIONES DE BARCELONA | 365,385 |
| Sweden | Nordea Bank AB (publ) | 926,645 |
| Sweden | Skandinaviska Enskilda Banken AB (publ) (SEB) | 343,025 |
| Sweden | Svenska Handelsbanken AB (publ) | 356,340 |
| Sweden | Swedbank AB (publ) | 269,620 |
| United Kindom | BARCLAYS plc | 2,417,327 |
| United Kindom | HSBC HOLDINGS plc | 2,555,579 |
| United Kindom | LLOYDS BANKING GROUP plc | 1,500,535 |
| United Kindom | ROYAL BANK OF SCOTLAND GROUP plc | 2,329,726 |
| United States | Bank of America | 2,129,046 |
| United States | Bank of New York Mellon | 325,266 |
| United States | Citigroup | 1,873,878 |
| United States | JP Morgan Chase | 2,265,792 |
| United States | Regions Financial | 127,050 |
| United States | State Street Corp | 216,827 |
| United States | Suntrust Bank | 176,859 |
| United States | Wells Fargo | 1,313,867 |

Note: 1/ Total assets as of 2008.

## Appendix B. Direct Fiscal Outlays from Public Recapitalization in 2008-2012

| Country | Bank | Year | Gross amount | In percent of GDP | |
|---|---|---|---|---|---|
| | | | (billion USD) | (by bank) | (by country) |
| Austria | Erste Group Bank AG | 2009 | 1.7 | 0.45 | 1.49 |
| | Raiffeisen International AG | 2009 | 2.3 | 0.61 | |
| | Volksbanken AG | 2012 | 0.3 | 0.08 | |
| | Volksbanken AG | 2009 | 1.3 | 0.35 | |
| Belgium | Dexia SA | 2008 | 2.8 | 0.56 | 2.11 |
| | KBC Bank NV | 2009 | 2.8 | 0.59 | |
| | KBC Bank NV | 2008 | 4.9 | 0.96 | |
| Cyprus | Cyprus Popular Bank Public Co | 2012 | 2.3 | 8.68 | 8.68 |
| France | Banque Populaire | 2008 | 2.7 | 0.09 | 0.93 |
| | Banque Populaire | 2009 | 3.8 | 0.15 | |
| | BNP Paribas SA | 2008 | 13.5 | 0.47 | |
| | Crédit Agricole SA | 2008 | 3.9 | 0.14 | |
| | Société General | 2008 | 2.2 | 0.08 | |
| Germany | Bayerische Landesbank | 2009 | 3.8 | 0.12 | 1.96 |
| | Bayerische Landesbank | 2008 | 5.1 | 0.14 | |
| | Commerzbank AG | 2008 | 10.5 | 0.29 | |
| | Commerzbank AG | 2009 | 13.7 | 0.41 | |
| | HSH Nordbank AG | 2009 | 4.0 | 0.12 | |
| | Hypo Real Estate Holding AG | 2010 | 2.5 | 0.07 | |
| | Hypo Real Estate Holding AG | 2011 | 3.0 | 0.08 | |
| | Hypo Real Estate Holding AG | 2009 | 8.8 | 0.27 | |
| | Landesbank Baden | 2009 | 7.2 | 0.22 | |
| | Norddeutsche Landesbank -GZ | 2012 | 4.0 | 0.11 | |
| | WestLB AG | 2009 | 4.5 | 0.14 | |
| Greece | ALPHA BANK | 2009 | 1.3 | 0.40 | 9.54 |
| | ALPHA BANK | 2012 | 2.4 | 0.78 | |
| | ATEbank SA | 2011 | 0.7 | 0.22 | |
| | ATEbank SA | 2009 | 0.9 | 0.27 | |
| | EFG EUROBANK ERGASIAS S.A. | 2009 | 1.3 | 0.40 | |
| | EFG EUROBANK ERGASIAS S.A. | 2012 | 5.0 | 1.63 | |
| | NATIONAL BANK OF GREECE | 2009 | 0.5 | 0.15 | |
| | NATIONAL BANK OF GREECE | 2011 | 1.3 | 0.42 | |
| | NATIONAL BANK OF GREECE | 2012 | 9.3 | 3.04 | |
| | Piraeus Bank SA | 2009 | 0.5 | 0.15 | |
| | Piraeus Bank SA | 2011 | 0.5 | 0.16 | |
| | Piraeus Bank SA | 2012 | 5.9 | 1.93 | |
| Ireland | Allied Irish Banks, Plc | 2009 | 4.5 | 2.03 | 8.28 |
| | Allied Irish Banks, Plc | 2010 | 4.9 | 2.35 | |
| | Bank of Ireland | 2010 | 1.4 | 0.66 | |
| | Bank of Ireland | 2011 | 2.5 | 1.12 | |
| | Bank of Ireland | 2009 | 4.8 | 2.13 | |
| Italy | BANCA MONTE DEI PASCHI DI SI | 2012 | 2.5 | 0.11 | 0.11 |

| | | | | | |
|---|---|---|---|---|---|
| Netherlands | ABN AM RO | 2010 | 8.1 | 1.04 | 2.58 |
| | ING Belgium SA/NV | 2008 | 12.5 | 1.43 | |
| | SNS REAAL NV | 2008 | 1.0 | 0.11 | |
| Portugal | CAIXA GERAL DE DEPÓSITOS, S. | 2012 | 2.0 | 0.83 | 0.83 |
| Slovenia | NLB dd-Nova LJUBLJANSKA BANK | 2011 | 0.2 | 0.38 | 1.48 |
| | NLB dd-Nova LJUBLJANSKA BANK | 2012 | 0.5 | 0.92 | |
| | NOVA KREDITNA BANKA MARIBO | 2012 | 0.1 | 0.18 | |
| Spain | Bankia, SA | 2010 | 5.4 | 0.4 | 1.88 |
| | Bankia, SA | 2012 | 23.5 | 1.5 | |
| United Kingdom | Lloyds Banking Group Plc | 2009 | 5.6 | 0.26 | 4.56 |
| | Lloyds Banking Group Plc | 2008 | 29.5 | 1.10 | |
| | Royal Bank of Scotland Group Plc | 2008 | 34.7 | 1.30 | |
| | Royal Bank of Scotland Group Plc | 2009 | 41.6 | 1.91 | |
| United States | Bank of America Corporation | 2008 | 15.0 | 0.10 | 1.36 |
| | Bank of America Corporation | 2009 | 30.0 | 0.22 | |
| | Bank of New York Mellon Corporati | 2008 | 3.0 | 0.02 | |
| | BB&T Corporation | 2008 | 3.1 | 0.02 | |
| | Capital One Financial Corporation | 2008 | 3.6 | 0.02 | |
| | Citigroup Inc. | 2008 | 45.0 | 0.31 | |
| | Goldman Sachs | 2008 | 10.0 | 0.07 | |
| | JPMorgan Chase & Co. | 2008 | 25.0 | 0.17 | |
| | Morgan Stanley | 2008 | 10.0 | 0.07 | |
| | PNC Financial Services Group, Inc. | 2008 | 7.6 | 0.05 | |
| | Regions Financial Corporation | 2008 | 3.5 | 0.02 | |
| | State Street Corporation | 2008 | 2.0 | 0.01 | |
| | SunTrust Banks, Inc. | 2008 | 1.4 | 0.01 | |
| | SunTrust Banks, Inc. | 2008 | 3.5 | 0.02 | |
| | U.S. Bancorp | 2008 | 6.6 | 0.05 | |
| | Wells Fargo & Company | 2008 | 25.0 | 0.17 | |
| *Memo items:* | | | | | |
| *TOTAL* | | | *520.9* | | |
| Bank/Country Average | | | | *0.65* | *3.27* |

**Appendix C: Heckman (1979) methodology**

The nature of public recapitalization programs suggests the so-called Tobit type-II model (Amemiya 1985), which is a model of sample selection characterized by the system of equations:

$$d_{it}^{*} = z_{it}^{'}\gamma + \nu_i + \upsilon_{it} \quad \text{(C.1)}$$

$$\mathrm{y}_{it}^{*} = x_{it}^{'}\beta + \eta_i + \varepsilon_{it} \quad \text{(C.2)}$$

$$\mathrm{y}_{it} = \mathrm{y}_{it}^{*} \times d_{it} \quad \text{(C.3)}$$

where $d_{it}$ is a dummy variable taking value equal to one if the latent process $d_{it}^{*}$ is strictly positive and zero otherwise. In our analysis, $d_{it}$ corresponds to the occurrence of a public recapitalization, while the main variable of interest, $y_{it}$, measures the volume of capital injected deflated by RWAs. The variables $d_{it}^{*}$ and $y_{it}^{*}$ are latent processes driven by the set of variables $z_{it}$ and $x_{it}$ and two error components. The terms $\nu_i$ and $\upsilon_{it}$ in (C.1) are orthogonal and normal distributed with zero mean and standard deviations equal to $\sigma_\nu$ and 1, respectively. Similarly, the terms $\eta_i$ and $\varepsilon_{it}$ in (C.2) are orthogonal errors with zero mean and finite covariance matrix. The main set of innovations $\upsilon_{it}$ and $\varepsilon_{it}$ are assumed to be normally distributed with zero mean and finite covariance matrix. Under this assumption, the selection equation (C.1) is a random effects probit model, while the main equation (C.2) is a linear random effects model.

This model is usually estimated using the Heckman (1979) methodology, which gives consistent estimates of the parameters in the main equation via a two-step technique. The methodology applied in the main section is based on the techniques developed by Verbeek and Nijman (1996) and Vella and Verbeek (1999). The central idea consists of eliminating the selection bias by incorporating two additional regressors into the main equation. These terms, denoted as *s1* and *s2* in the main text, represent the expected values of $\eta_i$ and $\varepsilon_{it}$ conditional on the vector of all possible outcomes $d_{it}$, namely, $E(\eta_i \mid d_{it})$ and $E(\varepsilon_{it} \mid d_{it})$. Let $u_{it} = \eta_i + \varepsilon_{it}$. Then, it follows readily that

$$E(\eta_i \mid d_{it}) = \frac{\sigma_{\upsilon\eta}}{\sigma_\nu^2 + T_i\sigma_\upsilon^2} \sum_{t=1}^{T_i} E\left(u_{it} \mid d_{it}\right) \equiv s1 \quad \text{(C.4)}$$

$$E(\varepsilon_{it} \mid d_{it}) = \frac{\sigma_{\upsilon\varepsilon}}{\sigma_\upsilon^2} E(u_{it} \mid d_{it}) - E(\eta_i \mid d_{it}) \equiv s2 \quad \text{(C.5)}$$

with $\sigma_{ab} \equiv Cov(a,b)$, and $T_i$ denoting the number of time-series observations for the *i*-th individual. Both terms are characterized by nuisance parameters that can be estimated consistently from the data and the conditional expectation $E\left(u_{it} \mid d_{it}\right)$, which according to Verbeek and Nijman (1996) can be characterized as:

$$E\left(u_{it} \mid d_{it}\right) = \int_{-\infty}^{\infty} \left[\nu_i + E\left(\upsilon_{it} \mid d_{it}, \nu_i\right)\right] f\left(\nu_i \mid d_{it}\right) d\nu_i \tag{C.6}$$

where $E\left(\upsilon_{it} \mid d_{it}, \nu_i\right)$ is the residual generalized residual from a random effects probit model, and the conditional density $f\left(\nu_i \mid d_{it}\right)$ is given by

$$f\left(\nu_i \mid d_{it}\right) = \frac{\frac{1}{\sigma_\nu}\phi\left(\frac{\nu}{\sigma_\nu}\right)\prod_{s=1}^{T_i} l_{is}\left(d_{is} \mid z_{is}, \nu_i\right)}{\int_{-\infty}^{\infty}\left[\frac{1}{\sigma_\nu}\phi\left(\frac{\nu}{\sigma_\nu}\right)\prod_{s=1}^{T_i} l_{is}\left(d_{is} \mid z_{is}, \nu\right)\right] d\nu} \tag{C.7}$$

Where the term $l_{is}$ has the form of the likelihood contribution in a cross-sectional probit model, and $\phi(a)$ denotes the density function of the standard normal distribution evaluated at *a*. These terms can be readily evaluated given the estimates of the selection equation.