A barrier option framework for rescue package designs and bank default risks

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ABSTRACT

Rescue packages adopted to stabilize the banking system are generally divided into three categories: government purchases of distressed assets, government guaranteed debt issuance programs, and direct equity capital injections. Countries afflicted by the recent financial crisis launched general programs in one or two, and even in three different categories. In this paper, we examine that the design of a government rescue package for a distressed bank depends on the expected reduction of the default risk in the bank's equity returns. We find that the bank's default risk is negatively related to distressed loan purchases, and to capital injections, but positively related to guaranteed debt issuance. We also find that the rescue package including all three categories is not guaranteed to increase stability for the rescued bank. Specifically, the combination of distressed loan purchases and capital injections is superior to the package of the three categories in addition to the solo instrument. This suggests that an effective design of a government rescue package for the financial services industry largely depends on its targets.

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1. Introduction

The global 2007/2008 financial crisis has been widely regarded as the worst financial crisis since the Great Depression. Many governments were reluctant to see bank failures end in a straightforward liquidation since bank termination incurs bankruptcy costs. The major countries afflicted by the global financial crisis launched general programs in distressed asset purchases (Canada), direct capital injections (Italy), asset purchases and guaranteed debt issuance (Australia), asset purchases and capital injections (Japan and Switzerland), issuance and capital injections (Austria and Sweden), and combinations of all three categories (Belgium, Demark, Spain, France, Netherlands, United Kingdom, and United States) as pointed out by Brei et al. (2011). Recent theoretical papers comparing the effectiveness of various rescue packages include Philippon and Schnabl (2009), Breitenfellner and Wagner (2010), Bhattacharya and Nyborg (2011), and Hasman et al. (2011). However, there is heated debate particularly focusing on the microeconomic perspective of bank behavior. The ongoing argument in the literature concerning comparing the effectiveness of different rescue measures warrants an assessment of the extent to which the design of rescue packages affects bank default risks.

Our objective is to make a number of significant contributions to the literature as a result of the following expansion in methodology and scope. First, in regard to the method, we focus on the endogeneity of the bank interest margin decision, i.e., the spread between the loan rate and the deposit rate, by introducing a new framework not previously used in this context. We propose a framework for bank equity valuation based on path-dependent, barrier option models outlined in Brockman and Turtle (2003). This model is specifically designed to address the problem of early bank closure induced by a system-wide financial crisis and the resulting exigency of government assistance. We further illustrate one particular application of the barrier option model to the problem of bankruptcy prediction under various designs of rescue packages. Accordingly, the effectiveness and efficiency of various rescue packages can be demonstrated. In regard to the scope, we perform the numerical analyses on assessing the impacts on bank interest margin and default risk from alternative rescue packages. We formally show how different means of government intervention, specifically including purchases of distressed assets by the government, government guaranteed debt issuance program, direct equity injections, or combinations, can influence decision making of a rescued bank in distress.[1] Our purpose is to illustrate the designs of various rescue packages, which allows better understanding the impact of packages on bank lending strategies and default risks. This focus may not be in the best interest of taxpayers in the short run, but it will be able to identify and reward good management performance.

The results of this paper show how credit risk, barrier, and various rescue packages jointly determine the optimal bank interest margin and then the default risk in the bank's equity returns. Controlling the

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[1] The general reason behind government intervention and fiscal policy is subject to on-going debate and beyond the scope of this paper. In this paper, we follow Breitenfellner and Wagner (2010) and focus on the design of short term government intervention, which aims at stabilizing the banking system. A longer term perspective of government intervention, for example, deposit insurance, is ignored for simplicity.

levels of solo instrument, we find that (i) the optimal bank interest margin is positively related to the low amount of distressed loan purchases, and to the low amount of guaranteed debt issuance and is negatively related to the high amount of loan purchases, and to the high amount of debt issuance, (ii) an increase in the direct equity injections increases the optimal bank interest margin, and (iii) the default risk in the bank's equity returns is negatively related to the loan purchases, to the direct equity injections, and positively to the debt issuance. Furthermore, (iv) by controlling for a level of loan purchases or equity injections, we show that the most effective rescue package for reducing the bank's default risk is the combination of loan purchases and equity injections, and (v) by controlling the level of debt issuance, the most effective rescue package is the combination of the three categories.

This is also highlighted by Breitenfellner and Wagner (2010) who argue that sole instrument of government intervention does not seem to be an appropriate measure to rescue a troubled bank. If a rescue is unavoidable, the prudent action should be the utilization of equity capital injections rather than guaranteed debt issuance alone in order to avoid principal agent conflicts. Philippon and Schnabl (2009) and Hasman et al. (2011) suggest that recapitalizations can be more effective than other forms of rescue in many circumstances. Unlike the previous literature, we argue that the design of a government rescue package largely depends on the stabilization of banking system and conclude that besides buying distressed assets, government should also be conducted via direct equity injections by controlling for the level of either one. Our argument is consistent with the empirical findings of Bebchuk (2008) and Hoshi and Kashyap (2010).

The remainder of this paper is organized as follows: Section 2 reviews related literature, Section 3 outlines the theoretical foundation of our approach, Section 4 derives the equilibrium solution and the comparative static results, and Section 5 presents a numerical analysis followed by our conclusion in the final section.

2. Literature review

Our theory of bank rescue package designs is related to four strands of the literature. The first major contributors to the recent literature on bank rescue packages include Landier and Ueda (2008), Breitenfellner and Wagner (2010), and Brei et al. (2011). Landier and Ueda (2008) discuss the relative merits of some alternative bailout mechanisms and conclude that an efficient mechanism for bailing out banks from defaulting is to provide an ex post guarantee to their creditors. That is to pay them the difference between the face values of their claims and what their debtor bank can repay in adverse future state. Breitenfellner and Wagner (2010) illustrate how the design of government bailout programs can influence decision making among banks and suggest that rather than solely providing guarantees, government support should be aimed at appropriate capital ratios within the banking system. Brei et al. (2011) examine whether the rescue packages adopted during the global financial crisis helped sustain the supply of bank lending and suggested that recapitalizations may not translate into greater credit supply until bank balance sheets are sufficiently strengthened. In addition to examining bank rescue packages, our focus on the bank interest margin management was influenced by various rescue package designs and consequently shifts our analysis in a different direction.

The second strand is the literature on bank interest margins. Ho and Saunders (1981), Saunders and Schumacher (2000), Maudos and de Guevara (2004), Williams (2007), and Hawtrey and Liang (2008) have provided models of bank interest margins based on the bid-ask spread model of Stoll (1978). Unlike previous formulations, Zarruk and Madura (1992), Wong (1997, 2011), and Tsai (2012, 2013) have provided models of bank interest margins based on the firm-theoretical model of Sealey (1980). The primary difference between our model and these papers is that we consider the effects of various rescue packages, adopted during the global financial crisis, on the optimal bank interest

margins based on the path-dependent barrier option model of Brockman and Turtle (2003), and Lin and Hung (2013). The principal advantage of this barrier approach is the obvious handling of bank failures which played a prominent role in the discussion of spread risk-taking behavior.

In the third strand, our paper related to the literature on bank rescue measure, Gorton and Huang (2004), argues that the government can bail out banks in distress because it can provide liquidity more effectively than private investors. Diamond and Rajan (2005) show that bank bailouts can backfire by increasing the demand for liquidity and causing insolvency. Philippon and Schnabl (2009) analyze the optimal design of government interventions to eliminate both free-riding and opportunistic participation and focus on the form of efficient recapitalization under debt overhang. Glasserman and Wang (2009) develop a contingent claims framework to estimate market values of securities issued during bank recapitalizations such as preferred stock and warrants. Hasman et al. (2011) argue that the presence of binding capital regulation, adequate capitalization is a necessary condition for lending; moreover, recapitalizations can be more effective than other forms of rescue in many circumstances. Bhattacharya and Nyborg (2011) indicate that banks needing bailout require overcoming debt overhang, in order to sustain their incentives for new lending, as well as dealing with adverse selection with respect to the quality of bank's balance sheets. Our paper focuses on effects of various rescue packages on the default risk in the bank's equity returns through interest margin decisions in a barrier option analysis.

The fourth strand of the literature to which our work is most directly related is that on conformity, particularly Brei et al. (2011).[2] Other examples include Bebchuk (2008), Philippon and Schnabl (2009), Bhattacharya and Nyborg (2011), and Hasman et al. (2011). The fundamental insight shared by these papers is that conformity is generated by a desire to distinguish oneself from the types whose attributes are not so desirable. This insight is an important aspect of rescue package design as well, since the analyst agrees with the financial authority to avoid being identified as untalented in banking stability management. What distinguishes our work from this literature is our focus on the commingling of the assessment of bank interest margin management with the assessment of various rescue package designs, and, in particular, the emphasis we put on the interaction between bank default probabilities and conformity in the context of rescue packages.

3. The model

In the model, we assume that all economic decisions are made and values are determined in a single-period horizon with two dates, 0 and 1, denoted by $t \in [0,1]$. The model is designed to capture in a minimal fashion the following characteristics of a rescued bank. (i) The government is reluctant to see bank failures end in a straightforward liquidation and the distressed bank is bailed out by purchases of distressed assets by the government, government guaranteed debt issuance program, direct equity injections, or combinations. (ii) The distressed asset purchase program allows the troubled bank to swap the loan repayments for guaranteed returns. (iii) The guaranteed debt issuance program ensures an amount of external financing for the bank. (iv) In the program of the direct equity injections, the government invests in the bank by increasing equity stake, but avoids nationalizing the bank. It is well recognized that the design of a government rescue package for distressed banks largely depends on its targets. Our model

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