Bailout uncertainty in a microfounded general equilibrium model of the financial system ☆

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A R T I C L E   I N F O

A B S T R A C T

This paper develops a micro-founded general equilibrium model of the financial system composed of ultimate borrowers, ultimate lenders and financial intermediaries. The model is used to investigate the impact of uncertainty about the likelihood of governmental bailouts on leverage, interest rates, the volume of defaults and the real economy. The distinction between risk and uncertainty is implemented by applying the multiple priors framework to beliefs about the probability of bailout.

Results of the analysis include: (i) An unanticipated increase in bailout uncertainty raises interest rates, the volume of defaults in both the real and financial sectors and may lead to a total drying up of credit markets. (ii) Lower exante bailout uncertainty is conducive to higher leverage, which in turn raises moral hazard and makes the economy more vulnerable to expost increases in bailout uncertainty. (iii) Bailout uncertainty affects the likelihood of bubbles, the amplitude of booms and busts as well as the banking and the credit spreads. (iv) Higher bailout uncertainty is associated with higher returns' variability in diversified portfolios and higher systemic risks, (v) Pre-crisis expansionary monetary policy reinforces those effects by inducing higher aggregate leverage levels. (vi) The larger the change in bailout uncertainty and the change in aversion to this uncertainty, the stronger the pre-crisis buildup and the deeper the ensuing crisis.

A central policy implication of the analysis is that the vaguest is bailout policy prior to a crisis, the lower is the magnitude of investments destroyed or missed due to errors in evaluating bailout and other intervention policies. On the other hand, the clearer is bailout policy upon the eruption of a crisis, the smaller the contraction of credit and the destruction of investment activity.

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1. Introduction

Financial sector bailouts in the US and more recently in Europe have revived the well known dilemma between restoration of confidence in the face of a panic and the costs of moral hazard. On one hand, when a panic engulfs financial markets, bailouts appear indispensable in order to restore confidence and prevent further collapses in the financial system. On the other hand, by subsidizing opportunistic behavior at the expense of taxpayers, bailouts encourage excessive risk taking on the part of financial institutions, borrowers and lenders, and plant the seeds of the next bubble.

Different experts in both policymaking circles, as well as in academia, often find themselves at odds regarding the ways to handle this problem. Therefore, in spite of currently ongoing reforms in regulation, this dilemma is likely to be a central issue during the upcoming decade. Whether, and how exactly will bailout policies be deployed in the future is largely an open issue. Due to the lack

of consensus about the precise ways to deal with the (exante and expost) tradeoffs induced by bailouts, bailout uncertainty is extremely likely to be non negligible in the foreseeable future. The 2008 bailout zigzags in the US (Bear-Stern versus Lehman) and the exante uncertainties about the reaction of EMU governments to sovereign debt problems in Greece, Cyprus Portugal and Spain attest to that.

The main objectives of this paper are: (i) To identify the mechanisms through which beliefs about bailout policy affect short term credit within the financial system, interest rates, credit to the real sector and real investment. (ii) To trace out the impact of an expost (after long term investment decisions have been made) change in bailout perceptions on interest rates and the volume of defaults throughout the entire financial system. (iii) To analyze the impact of expansionary monetary policy on leverage and risk appetite. The paper's framework makes it possible to trace out both the exante and the expost consequences of beliefs about the generosity of bailout policies. Exante, a more generous bailout policy increases moral hazard in all segments of the financial system and induces an overall expansion of credit.[1] But expost the maintenance of a generous bailout policy becomes necessary just to avoid a crisis even if government no longer desires to maintain high bailout levels.

The paper's main findings follow. An unexpected expost increase in bailout uncertainty raises interest rates and the volume of defaults in both the real and the financial sectors. In extreme cases it may lead to a total drying up of credit markets. Low exante bailout uncertainty and expansionary monetary policy induce high levels of leverage and of real investments encouraging the formation of bubbles. This raises, in turn, moral hazard and the economy's vulnerability to changes in bailout uncertainty and other shocks. At the micro level an expost increase in bailout uncertainty operates by lowering expected returns and by increasing the variability of those returns in diversified portfolios, which leads to higher systemic risks. The larger the difference in bailout uncertainty or in the aversion to this uncertainty (prior to a crisis triggering event in comparison to after its realization) the stronger the pre-crisis credit bubble buildup and the deeper the ensuing crisis.

It is well known since Knight (1921) that risk and uncertainty are distinct concepts. Modern formulations of this distinction in the context of pecuniary returns conceptualize risk as some measure of spread for a *known distribution* of the stochastic return. Uncertainty, on the other hand, is a situation in which individuals are *unsure about the probability distribution* of returns and entertain the possibility that several alternative probability distributions have positive measure. An increase in uncertainty is then viewed as a an enlargement of the set of plausible probability distributions. Ellsberg (1961) and others have demonstrated by means of experiments that individuals are averse to ambiguity in the sense that, other things the same, they prefer a lottery with a known probability distribution to a lottery in which several distributions are believed to be possible.

Gilboa and Schmeidler (1989) conceptualize an investor's uncertainty by postulating that she possesses a subjective set of probability measures (multiple priors) over outcomes.[2] Their framework implies that for each possible action the investor assumes that the worst (by the expected utility criterion) possible distribution will realize and chooses her action so as to attain maximum expected utility over this set of worst outcomes. This paper utilizes the Gilboa and Schmeidler (1989) notion of uncertainty and the associated maxmin behavioral criterion to analyze the impact of an increase in uncertainty about governmental bailout

policy on financial markets, the aggregate level of credit and, through them, on the real economy.

Prior to Lehman's collapse the financial market beliefs about the probability of bailout have been relatively optimistic due to Bear-Stern's bailout in March 2008 as well as to the implicit US government guarantees of Fannie Mae and Freddie Mac's liabilities (Meltzer, 2009). In terms of Gilboa and Schmeidler's (1989) framework this means that the family of binomial bailout distributions with positive mass was concentrated in the relatively high range of bailout probabilities. After Lehman's collapse in mid September 2008 this range expanded downward toward bailout probabilities that previously were given zero mass.[3]

The behavior of credit default swap (CDS) spreads during the two weeks following Lehman's collapse provides a dramatic illustration of the sensitivity of bailout perceptions to public signals. In the aftermath of this collapse credit markets experienced substantial waves of deleveraging, totally drying up in some cases, and both the level and variability of CDS spreads went through the roof. To demonstrate it, Fig. 1 shows the behavior of Citibank's CDS spread index during the period just preceding Lehman's default and the final approval of the TARP bailout package at the beginning of October 2008.[4] The figure demonstrates the high sensitivity of the CDS spread to ongoing public signals about the likelihood of bailouts. In particular, the spread strongly reacts to events like the rejection of the proposed TARP bailout package by Congress in September 2008 and its final approval in early October. This supports the view that financial markets participants are quite sensitive to news about the likelihood of bailouts.

Following Lehman's collapse and the ensuing public debate among policymakers about the wisdom of governmental bailouts two things happened. Public uncertainty (also known as ambiguity in the decision theory literature) about the likelihood of bailouts increased and so did the public's aversion to this uncertainty (or ambiguity aversion in the terminology of decision theory). Importantly, beliefs are not the only determinant of an individual's subjective set of priors, but also her preferences concerning ambiguity. That is, this set need not be the set of priors that is literally deemed possible by the individual. In particular, suppose two individuals share the same subjective information, i.e., they both believe the same set of bailout probabilities are possible. Then modern decision theory implies that the set of multiple priors of the *less* ambiguity averse individual is a *subset* of the set of multiple priors of the *more* ambiguity averse individual.[5]

Expansion of the set of multiple bailout priors in the aftermath of Lehman's collapse may, thus, reflect more ambiguous beliefs or a higher degree of ambiguity aversion or both. Obviously both factors reinforce each other. Our sense is that, in the aftermath of the financial trauma caused by Lehman's default the increase in ambiguity aversion might have been more important and more persistent. The reason for this is, that after a traumatic event individuals remain fearful (aversion to uncertainty) long after danger is over.[6] Be that as it may, the upshot is that following this episode the set of multiple priors about the probability of bailouts expanded. As a consequence the lower bound on the set of binomial

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[1] Borio and Drehmann (2009) convincingly argue that such a credit buildup raises the likelihood of a financial crisis.

[2] The recent literature on robustness is also based upon the notion of multiple priors (Hansen and Sargent, 2008)

[3] Note that, although such expansion of beliefs involves assignment of positive mass to bailout probabilities that had zero mass prior to Lehman's collapse, the latter is not quite a "black swan" event (Taleb, 2007). Taleb's black Swan is an event whose perceived probability had zero mass (or this event has not even been considered in the state space due to unawareness) prior to its initial realization. By contrast the perceived probability of no bailout prior to Lehman's collapse was not zero. However, after this event some bailout distributions that previously were assigned zero mass entered the set of (plausible) bailout distributions with positive mass.

[4] Source: Cochrane and Zingales (2009).

[5] See, for example Ghirardato and Marinacci (2002, Theorem 17 (*ii*)) and Klibanoff et al. (2005, p. 1872).

[6] A further elaboration of this reasoning is given two paragraphs below.