Federal Reserve Bank of Chicago

# Repos, Fire Sales, and Bankruptcy Policy

*Gaetano Antinolfi, Francesca Carapella, Charles Kahn, Antoine Martin, David Mills, and Ed Nosal*

WP 2012-15

# Repos, Fire Sales, and Bankruptcy Policy*

Gaetano Antinolfi  Francesca Carapella  Charles Kahn
Antoine Martin  David Mills  Ed Nosal

May 2012
This version: November 2012

**Abstract**

The events from the 2007-2009 financial crisis have raised concerns that the failure of large financial institutions can lead to destabilizing fire sales of assets. The risk of fire sales is related to exemptions from bankruptcy's automatic stay provision enjoyed by a number of financial contracts, such as repo. An automatic stay prohibits collection actions by creditors against a bankrupt debtor or his property. It prevents a creditor from liquidating collateral of a defaulting debtor since collateral is a lien on the debtor's property. In this paper, we construct a model of repo transactions, and consider the effects of changing the bankruptcy rule regarding the automatic stay on the activity in repo and real investment markets. We find that exempting repos from the automatic stay is beneficial for creditors who that hold the borrowers' collateral. Although the exemption may increase the size of the repo market by enhancing the liquidity of collateral, it can also lead to subsequent damaging fire sales that are associated with reductions in real investment activity. Hence, policy makers face a trade-off between the benefits of investment activity and the benefits of liquid markets for collateral.

## 1 Introduction

An institution that suffers large losses may be forced to sell assets at distressed or *fire-sale* prices. If other institutions revalue their assets at these temporarily low market values, then they too may be forced to sell assets and suffer losses. As a result, the initial sale can set off a cascade of fire sales that inflicts losses on many institutions, (French *et al.*, (2010)). A number of commentators have identified fires sales as depleting the balance sheets of financial institutions and aggravating the fragility of the financial system in the recent financial crisis, (Shleifer and Vishny, 2011). Therefore, via defaults and fire sales, one troubled

*Antinolfi, Board of Governors and Washington University in St. Louis; Carapella, Board of Governors; Martin, New York Fed; Mills, Board of Governors; Kahn, University of Illinois at Urbana-Champaign; Nosal, Chicago Fed

institution can damage another and, as a result, reduce the financial system's capacity efficiently allocate resources. Many commentators have identified stress in the repurchase agreement (repo) market as an important contributor to the recent financial crisis.

This paper develops a model of a repo market. A repo is a borrowing arrangement where the first leg of the transaction has one party—the borrower— "selling" a security to another party—the lender—for cash, and the second leg, which occurs at some predetermined future date, has the borrower repurchasing the security from the lender for cash at a predetermined price. The security that the lender holds in between the two legs is typically referred to as collateral. We examine the implications of different bankruptcy policy rules on the activity in a number of markets: the repo market, any market where the collateral of defaulted borrowers can be resold, and the market for real investment. Under current bankruptcy rules, the repo lender can liquidate the collateral if the borrower defaults before the end of the contract. In effect, the repo contract is exempt from a standard bankruptcy procedure, known as an automatic stay, which prevents creditors from initiating collection actions against a bankrupt debtor or his property. Collateral is considered to be a lien on the debtor's property, so an automatic stay prevents the creditor from liquidating collateral when the debtor files for bankruptcy. An exemption from an automatic stay, which is afforded to a number of financial contracts, has raised concerns that the default of a large financial institution could trigger destabilizing fire sales of assets. Such fears are based on the failure, or near failure of Bear Stearns and Lehman brothers in 2008.[1]

In our model, the possibility of borrower default motivates lenders to request collateral from buyers as a form of insurance, (see also Mills and Reed (2012)). However, the insurance function of the collateral is imperfect. If there is an automatic stay in place, then the inability to immediately liquidate collateral of defaulted borrower imposes a cost on holders of collateral. The cost can be associated with the inability to convert relatively illiquid collateral into a liquid asset, or with the risk that the collateral could lose value. We model the cost as the inability to convert an illiquid asset into a liquid one.

If, instead, bankruptcy rules allow the lender to liquidate the borrower's collateral, then the collateral can be sold in a secondary market. Depending on the liquidity of that market, sales of collateral can have important effects on other market participants. We focus on the effect that lenders' sales of collateral have on real investments when investors are using assets similar to the collateral to secure resources for the investment. Imbedded in our model is an externality that implies that lenders do not take into account the effect they have on investors when making their initial repo decisions and their liquidation decisions in the event of borrower default. Absent this externality, lenders would internalize all the effects of their sales of assets on the economy and make efficient investment decisions in the repo market. The externality is modeled by a

[1] It is worth noting that these fears were, for the most part, not realized in part because Bear Stearns was purchased by JP Morgan Chase, and the US broker dealer unit of Lehman did not declare bankruptcy.

trading friction. The trading friction is an important ingredient in our model; it is also an important ingredient in practice since repos and other financial instruments that make use of collateral are traded in over-the-counter markets. These sorts of markets are not competitive and, hence, are subject to trading frictions.

The externality creates a trade off for policy makers who contemplate using bankruptcy rules as their policy instrument. On the one hand, exempting repo transactions from the automatic stay is desirable because the ability to liquidate the borrower's collateral increases its value to the lender. In this sense, an exemption from the automatic stay makes the repo market more *liquid*. On the other hand, increased activity in the repo market can result in more pronounced fire sales and reduction in investment activity in case of borrower default. The relative size of these two effects depend on the parameter values of the model and, thus, so does the optimal bankruptcy rule.

Under the US Bankruptcy Code, most contracts are subject to an automatic stay when a debtor files for bankruptcy. This stay delays the ability of a creditor to realize value through a sale of the collateral.[2] Over the decades since the current framework was established, an ever-increasing set of qualified financial contracts ("QFC's"), including repos, has been exempted from the stay.[3] (In the case of banks taken over by the FDIC or systemically important financial institutions under Dodd-Frank, there may be a stay for a limited time even for QFC's.)

Our paper focuses on the trade-off between the liquidity of the repo market and the potential for fire sales related to the exemption from the stay. This trade-off is discussed in the legal literature; see Roe (2011). Duffie and Skeel (2012) outline a number of costs and benefits associated with safe harbors from the automatic stay in bankruptcy, including a variety of ways in which the stay can decrease the value of the collateral contract, and on the other side, the potential for costs in a fire sale. (They note that in particular money market mutual funds holding repos may be forced by regulation to sell the collateral in the case of the bankruptcy of a counterparty).

Bolton and Oehmke (2011) argue against privileged positions for derivatives in bankruptcy, because it inefficiently undermines the position of other creditors. The paper that is most closely related to our is Acharya, Anshuman, and Viswanathan (2012) which also examines the costs of bankruptcy-induced fire sales. Our paper does not address some of the benefits of the exemption from the stay associated with close-out netting. An analysis of these benefits is provided in McAndrews and Roberds (2003).

The paper is organized as follows. The basic model, without default, is

[2] Generally speaking, the purpose of an automatic stay is to prevent the destruction of value that can occur when creditors make a "mad dash" to seize the assets the bankrupt firm. To the extent that the assets used as collateral are financial assets rather than real assets, the destructiveness of this "grab race" is less of a consideration, and so in this paper we focus instead on the effects of a rush to *sell* these assets in a less-than-perfectly liquid market.

[3] For an account of the changes in the application of bankruptcy law to repos, see Garbade (2006).

presented in the next section. The basic model is generalized to allow for defaults in section 3. Section 4 examines the nature of a government policy intervention and carefully analyzes the trade-offs that the government faces. Section 5 offers some concluding comments.

# 2 The Basic Model

The economy has 3 dates—1, 2, and 3—and 2 goods—$a$ and $c$. Good $a$ is durable—that is, it can be costlessly stored from one period to the next. Good $c$ is perishable.

There are 4 types of agents: lenders, $L$, borrowers, $B$, investors, $I$, and traders, $T$. The measure of each type of agent is $n^i$, where $i \in \{L, B, I, T\}$.

Lenders and borrowers are born at the beginning of date 1. Borrowers live at dates 1 and 2, and lenders live at dates 1, 2 and 3. Investors and traders are born at the beginning of date 3 and live only at date 3.

Borrowers like to consume good $a$ at date 2. They possess a costless technology that instantaneously converts good $c$ into good $a$ one-for-one in date 1 or date 2. They can also produce good $c$, but only at date 2, at a cost of 1 unit of effort per unit of good. The preferences of a borrower, $U^B$, are given by

$$U^B = a_2 - c_2.$$

(Subscripts indicate when the goods are produced or consumed.)

Lenders want to consume goods $a$ and $c$ at dates 2 and 3; they like good $c$ more than good $a$. Lenders can produce good $c$ only at date 1, where one unit of costly effort produces one unit of good $c$. The preferences of a lender, $U^L$, are given by

$$U^L = u(c_2) + c_3 + \gamma a_2 + \gamma a_3 - c_1,$$

where $u$ is increasing and strictly concave, and $0 < \gamma < 1$.

Traders are endowed with $\bar{c}$ units of good $c$ at date 3. They like to consume goods $a$ and $c$ at date 3, and their preferences, $U^T$, are given by

$$U^T = a_3 + c_3.$$

Investors are endowed with $\bar{a}$ units of good $a$ at date 3. They like to consume goods $a$ and $c$, and their preferences, $U^I$, are

$$U^I = a_3 + c_3.$$

Investors have a costless technology that instantaneously converts good $c$ into good $a$. Unlike the borrower's technology, which is one-to-one, the investor's technology, $f$, is increasing, strictly concave and $f'(\bar{a}) > 1$. The last assumption implies that $f$ is a productive technology in the sense that if the investor could exchange his endowment of good $a$ for $\bar{a}$ units of good $c$, then marginal return is strictly greater than one for all levels of input $c \in (0, \bar{a}]$.

Agents trade in pairs; that is, they are bilaterally matched. Agents are matched at the beginning of date 1 and at the beginning of date 3. The date 1 and date 3 matching processes are independent of one another. Since investors and traders are not alive at date 1, only lenders and borrowers enter the matching process at that time.

Some bilateral matches can generate surplus for the agents in the match. For example, borrowers and lenders can benefit from trading good $c$ at date 1 for good $c$ at date 2. In particular, a matched lender can produce good $c$ at date 1 and give it to the borrower, (who converts it into good $a$). In return, the borrower can produce good $c$ for the lender at date 2. Let this trading arrangement be compactly represented by the "contract" $(c_1, c_2)$. Note that since the good $c$ that is produced at date 1 is converted to good $a$ one-for-one, $a_1 = c_1$; and since good $a$ is durable, $a_2 = a_1$. Implicitly embedded in contract $(c_1, c_2)$ is a promise: the borrower promises to produce good $c$ for the lender at date 2. We will assume that agents can commit to any (feasible) promise they make when matched.

Traders and investors can benefit from exchanging good $a$ for good $c$ at date 3. In particular, a matched investor can exchange some of his endowment of good $a$ for some the the trader's endowment of good $c$. The trading arrangement between investors and traders can be represented by the contract $(a_3, c_3)$, i.e., the investor gives up $a_3$ units of his endowment of good $a$ and receives $c_3$ units of the trader's endowment of good $c$.

The date-1 contract, $(c_1, c_2)$, between a matched lender and borrower is determined by bargaining. The lender's payoff (and surplus) associated with contract $(c_1, c_2)$ is $u(c_2) - c_1$. Since technology and durability of good $a$ implies that $c_1 = a_1 = a_2$, the borrower's surplus is $c_1 - c_2$. Total match surplus generated by contract $(c_1, c_2)$ is

$$S^{BL} = u(c_2) - c_2.$$

A borrower accepts contract $(c_1, c_2)$ only if $c_1 \geq c_2$ and a lender accepts only if $u(c_2) \geq c_1$. For simplicity, we assume that the lender has all of the bargaining power and makes a take-it-or-leave-it offer to the borrower. This bargaining protocol implies that the lender will choose $c_2 = c_1$ and, hence, receives the entire match surplus.[4] The lender offers contract $(c^*, c^*)$ to the borrower, where $u'(c^*) = 1$, since this offer maximizes match surplus. The borrower will accept this offer.

Let $m^{ij}$ represent the probability that agent $i$ is matched with agent $j$ at date 1, and let $m$ represent the measure of productive date 1 matches. We will assume that the matching technology is Leontief in nature and takes the form $m = \min\left\{n^L, n^B\right\}$, $m^{LB} = m/n^L$, $m^{BL} = m/n^B$, and $m^{BB} = m^{LL} = 0$. For this matching technology one can interpret agents as directing their search to a productive partner, where the "short side" of the market determines the number of matches.

[4]Dividing surplus between the bargainers will not significantly affect our results).

Lenders have no incentive to enter the date 3 matching process, independent of being matched or not at date 1, since they have nothing to offer in a date 3 match that could generate a match surplus. Therefore, the expected payoff to a lender—measured before agents are matched at date 1—is $m^{LB}\left[u\left(c^*\right)-c^*\right]$. Since the lender has all of the bargaining power in a date 1 match with a borrower, the expected payoff to a borrower is zero.

Only investors and traders enter the date 3 matching process. In an investor-trader match, the investor's payoff associated with contract $(a_3, c_3)$ is $f\left(c_3\right)+\bar{a}-a_3$. The surplus that the investor receives is $f\left(c_3\right)+\left(\bar{a}-a_3\right)-\bar{a}=f\left(c_3\right)-a_3$. The trader's payoff associated with contract $(a_3, c_3)$ is $a_3+\bar{c}-c_3$, and the surplus he receives is $a_3+\bar{c}-c_3-\bar{c}=a_3-c_3$. Hence the total match surplus is

$$S^{IT}=f\left(c_3\right)-c_3.$$

The investor will accept contract $(a_3, c_3)$ only if $f\left(c_3\right)>a_3$, and the trader will accept the offer $(a_3, c_3)$ only if $a_3 \geq c_3$. We assume that the investor has all of the bargaining power. The investor will offer contract $(a_3, c_3)$ to the trader, where $a_3=c_3=\min\{\bar{a}, \bar{c}\}$, which implies that the match surplus is $f(\min\{\bar{a}, \bar{c}\})-\min\{\bar{a}, \bar{c}\}$. For convenience, define $\bar{\imath} \equiv \min\{\bar{a}, \bar{c}\}$, i.e., $\bar{\imath}$ represents the amount of good $c$ that an investor receives from a trader, and the amount of good $a$ that he gives the trader.

Let $M^{ij}$ represent the probability that agent $i$ is matched with agent $j$ at date 3, and $M$ represent the measure of date-3 productive matches. For a Leontief matching function, $M=\min\left\{n^I, n^T\right\}$, $M^{IT}=M/n^I$, $M^{TI}=M/n^T$, and $M^{II}=M^{TT}=0$. Since the investor has all of the bargaining power, his payoff is $M^{IT}\left(f\left(\bar{\imath}\right)-\bar{\imath}\right)+\bar{a}$, and the expected payoff to the trader is $\bar{c}$.

Let $p_a$ represent the value to an investor of having an additional unit of good $a$, measured in terms of good $c$, at the beginning of date 3 before matching takes place. Then, when $\bar{\imath}=\bar{a}$,

$$p_a=M^{IT} f^{\prime}\left(\bar{a}\right)+\left(1-M^{IT}\right),$$

i.e., the investor is indifferent between receiving $p_a$ units of good $c$ for sure, and receiving an additional unit of good $a$.[5]

Consider the problem of a planner whose objective is to maximize total social surplus, $S$, where

$$\begin{aligned} S &= m\left(u\left(c_2\right)-c_1\right)+m\left(a_2-c_2\right)+M\left[\left(\bar{c}-c_3\right)+a_3-\bar{c}\right]+ \\ & \quad M\left[\left(\bar{a}-a_3\right)+f\left(c_3\right)-\bar{a}\right] \\ &= m\left(u\left(c_2\right)-c_2\right)+M\left(f\left(c_3\right)-c_3\right), \end{aligned}$$

[5] When $\bar{\imath}=\bar{c}$, then the price of good $a$ is 1 since if the investor is given an additional unit good $a$ he will simply consume it. The *average* price of good $a$, however, is

$$M^{IT}\left[\frac{\bar{c}}{\bar{a}} \frac{f\left(\bar{c}\right)}{\bar{c}}+\frac{\bar{a}-\bar{c}}{\bar{c}}\right]+\left(1-M^{IT}\right)>1.$$

We would argue that in this case, the average price is the relevant statistic when thinking about gains from trade.

since $c_1 = a_2$. Assuming that the planner must respect agent participation constraints, total social surplus will be maximized at $c_2 = c^*$ and $c_3 = \bar{\imath}$, the take-it-or-leave-it offers made by the lender and investor, respectively.[6] The planner can implement this surplus as long as $u(c_2) \geq a_2 \geq c_2$ and $f(c_3) \geq a_3 \geq c_3$, i.e., agent participation constraints are satisfied. Although the planner can redistribute surplus from the lender to the borrower (by increasing $a_2$ from $c^*$) and from the investor to the trader (by increasing $a_3$ from $\bar{a}$), he cannot increase total surplus compared to the equilibrium outcome.

The equilibrium in the basic model is Pareto efficient. The basic model lacks frictions that are needed to generate contracts that resemble repo contracts or something that looks like a "fire sale." In addition, since agents do not default on the their contracts, the basic model can say nothing about bankruptcy or bankruptcy policy. In the next section we introduce a borrower default friction and examine how this affects optimal contracts, and the relationship between bankruptcy policy and fire sales.

# 3 A Model with Borrower Default

We extend the basic model by introducing the possibility of exogenous default by borrowers. Default is modeled by having the possibility that borrowers die between dates 1 and 2. With probability $\delta$ a random fraction $\Delta$ of borrowers die, and with probability $1-\delta$ no one dies.[7] We will refer to the former outcome as the default state, and the latter as the no-default state. From an ex ante date 1 perspective, the probability that a borrower dies is $\delta\Delta$. We use two parameters to describe default so that we can model a rare event, a 'small' $\delta$, such as a major financial meltdown, a 'big' $\Delta$.

The Section 2 contract between the lender and borrower can be interpreted as an unsecured (by collateral) loan since it is only the borrower's promise that supports the date 2 payment. In practice, it is not at all unusual for unsecured creditors to receive nothing in the event that the borrower defaults. We model this outcome by assuming that when a matched borrower—holding $c_1$ units of good $a$ and promising to produce $c_2$ units of good $c$ at date 2—dies in between dates 1 and 2, the good $a$ he is holding "disintegrates," and, as a result, the lender receives nothing. Although there is little the lender can do about a borrower's broken promise to supply good $c$ at date 2—the borrower is dead after all—the lender can secure his claim against the borrower by contractually preventing the borrower from holding good $a$ between dates 1 and 2. Specifically, the contract can specify that the lender produces good $c$ at date 1 and gives it to a borrower; the borrower then converts good $c$ into good $a$, *and gives*

[6] The planner also takes as given the matching techologies and the bargaining protocol of the agents.

[7] We can assume that with probability $1-\delta$, a finite number, i.e., a set of measure zero, of borrowers die. This way there can be defaults even in "good" times, but these defaults are essentially unimportant for the economy. This would correspond to situations (in the real world) where there are "fails" or defaults and these have no significant implications for asset prices or economic activity.

*good a back to the lender to hold as collateral.* At date 2, the collateral—good $a$—is transferred back to the borrower if he produces good $c$ for the lender; if the borrower does not produce at date 2—because he has died—the collateral becomes the property of the lender. This sort of contract partially insures the lender against a borrower default: If the borrower dies, then the lender has the collateral which is valuable to him at both dates 2 and 3.

Whether one interprets the above contract as a collateralized loan or a repo contract depends on *when* the lender is able to use the collateral. In practice, bankruptcy law specifies when collateral can be used by the lender. Under the US Bankruptcy Code, virtually all collateral is subject to an automatic stay when a debtor files for bankruptcy. This means that a secured (by collateral) creditor is unable to access and use the collateral for a certain period of time after a debtor defaults. However, some financial assets, such as derivatives and repo contracts, are exempt from the automatic stay, which implies that a secured creditor can immediately access and use the collateral as he sees fit. In terms of the model, if the bankruptcy policy dictates an automatic stay in the event of a debtor default, then the contract described above is a *collateralized loan.* In this situation, in the event of a debtor default, the earliest that collateral can by used by the lender is at date 3 after the matching process has been completed. If, instead, the bankruptcy policy exempts the collateral from an automatic stay, then the above contract is *repo*, and the lender can use the collateral as he sees fit starting at date 2, when it becomes known that the debtor has (died and) defaulted on his contractual payment of $c_2$. In the next section, we analyze the implications of a bankruptcy policy that exempts the collateralized contracts from an automatic stay. In the subsequent section, we examine the implications of a bankruptcy policy that imposes an automatic stay on collateral.

## Repo contracts

A repo contract is represented compactly by $(\tilde{c}_1, \tilde{c}_2)$, where the "initial loan" size is $\tilde{c}_1$, the amount of collateral is $a_1 = \tilde{c}_1$, and the "loan repayment" is $\tilde{c}_2$. If the borrower does not default, then the lender receives $\tilde{c}_2$ units of good $c$ from the borrower, and the lender transfers the collateral, $\tilde{c}_1$ units of good $a$ to the borrower at date 2. If the borrower defaults, then, at date 2 the lender owns the collateral, $a$, which can be used by him starting at date 2.

Suppose a matched borrower dies. The lender can consume the collateral at either dates 2 or 3, and his payoff is $\gamma\tilde{c}_1$. Alternatively, the lender can enter the date 3 matching process with his collateral. If he is matched with a trader, then there are gains from trade because the lender's relative valuation of good $a$ to good $c$ is $\gamma$ and the trader's is 1. Hence, the lender's payoff can exceed $\gamma\tilde{c}_1$ if he is matched with a trader.[8]

Denote the terms of trade in a lender-trader match by the contract $(\tilde{a}_3, \tilde{c}_3)$, where the lender gives $\tilde{a}_3$ units of good $a$ to the trader in exchange for $\tilde{c}_3$

[8] If the lender is matched with an investor, there are no gains from trade—since both agents have good $a$—and his payoff will be $\gamma\tilde{c}_1$.

units of good $c$. The payoff to the lender associated with contract $(\tilde{a}_3, \tilde{c}_3)$ is $\gamma(\tilde{a}_2 - \tilde{a}_3) + \tilde{c}_3$, where $\tilde{a}_2$ represents the amount of good $a$ that the lender brings into the match, and the payoff to the trader is $\tilde{a}_3 + \bar{c} - \tilde{c}_3$. Total *surplus* in a lender-trader match is $(1-\gamma)\tilde{a}_3$.

Assume the lender has all of the bargaining power. The trader will accept the lender's offer only if $\tilde{a}_3 \geq \tilde{c}_3$, and the take-it-or-leave-it assumption implies that $\tilde{a}_3 = \tilde{c}_3$. The payoff to a matched lender holding collateral equal to $\tilde{a}_2$ is

$$\begin{aligned}\gamma(\tilde{a}_2 - \tilde{a}_3) + \tilde{c}_3 &= \begin{cases} \tilde{a}_2 & \text{if } \tilde{a}_2 \leq \bar{c} \\ \gamma(\tilde{a}_2 - \bar{c}) + \bar{c} & \text{if } \tilde{a}_2 > \bar{c} \end{cases} \\ &= \min\{\tilde{a}_2, \bar{c} + \gamma(\tilde{a}_2 - \bar{c})\}\end{aligned}$$

(a concave function of $\tilde{a}_2$) and the payoff to the trader is $\bar{c}$. Since the lender's expected payoff associated with entering the date 3 matching process is strictly greater than $\gamma\tilde{a}_2 = \gamma\tilde{c}_1$, he will always enter the date 3 matching process holding collateral $\tilde{a}_2$ when his borrower defaults.

The repo contract $(\tilde{c}_1, \tilde{c}_2)$ that the lender offers the borrower in a date 1 match is clearly affected by the possibility that his borrower defaults. Since the lender has all of the bargaining power in the date 1 match, $\tilde{c}_1 = \tilde{c}_2 = \tilde{a}_1 = \tilde{a}_2$. Denote the probability that the lender is matched with a trader in the event that his borrower dies by $M_d^{LT}$, and let $M_d$ denote the measure of matches between traders and either lenders or investors at date 3 in the default state. For the Leontief matching technology lenders and investors direct their search to traders, and, therefore, $M_d = \min\left\{n^I + \Delta m, n^T\right\}$ and

$$M_d^{LT} = \frac{M_d}{\Delta m + n^I}.$$

We can characterize the optimal date 1 repo contract, $(\tilde{c}_1, \tilde{c}_2)$, by considering the following maximization problem, which is to choose the amount of good $c_1$ to produce.

$$\begin{aligned}&\max_{c_1} -c_1 + (1-\delta\Delta)\,u(c_1) + \\ &\delta\Delta\left[M_d^{LT}\min\{c_1, \bar{c} + \gamma(c_1 - \bar{c})\} + \left(1 - M_d^{LT}\right)\gamma c_1\right],\end{aligned} \tag{1}$$

If the borrower does not die the lender consumes $c_1$ units of good $c$ at date 2. If the borrower dies, the lender is able to enter the date-3 matching process since there is an exemption on the automatic stay. He consumes $c_1$ units of good $a$ if he is not matched. If he is matched, then the amount he consumes depends on whether his collateral is less than or greater than the trader's endowment. The term in brackets arises because if a lender's collateral, $c_1$ units of good $a$ is less than the trader's endowment of $\bar{c}$, then he will be able to exchange all of his collateral for good $c$. On the other hand if his collateral is greater than the trader's endowment, the lender will only be able to exchange part of his collateral for good $c$. Note that there is a discrete decrease in the *marginal* benefit associated with having an additional unit of good $c$ at $c = \bar{c}$; the expected marginal benefit falls from $\delta\Delta\left[M^{LT} + \left(1 - M^{LT}\right)\gamma\right]$ to $\delta\Delta\gamma$.

Thus the choice $\tilde{c}_1$ is characterized by the first order conditions for this problem as follows:

(i) If $(1-\delta\Delta)\, u'(\bar{c}) + \delta\Delta\gamma > 1$, then $\tilde{c}_1 > \bar{c}$,
where $(1-\delta\Delta)\, u'(\tilde{c}_1) + \delta\Delta\gamma = 1$;
(ii) If $(1-\delta\Delta)\, u'(\bar{c}) + \delta\Delta\left(M_d^{LT} + \left(1-M_d^{LT}\right)\gamma\right) < 1$, then $\tilde{c}_1 < \bar{c}$,
where $(1-\delta\Delta)\, u'(\tilde{c}_1) + \delta\Delta\left(M_d^{LT} + \left(1-M_d^{LT}\right)\gamma\right) = 1$;
(iii) otherwise, $\tilde{c}_1 = \bar{c}$.

Suppose that the default state is realized and, as a result, $\Delta n^B$ borrowers die in between dates 1 and 2. Then, at date 3, traders, investors and lenders will enter the matching process. Denote the probability that an investor is matched with a trader in the default state as $M_d^{IT}$, where $M_d^{IT} = M_d^{LT}$. The terms of trade between a matched investor and trader is not a function of the matching probability $M_d^{LT}$. Hence, the investor exchanges $\bar{\imath} = \min\{\bar{a}, \bar{c}\}$ units of good $a$ for $\bar{\imath}$ units of good $c$ with the trader. From the investor's date 3 perspective, when $\bar{\imath} = \bar{a}$, the price of good $a$, measured before agents are matched at date 3, $p_a^{\delta}$, is

$$p_a^{\delta} = M_d^{IT} f'(\bar{a}) + \left(1 - M_d^{IT}\right).$$

It is important to emphasize that $p_a^{\delta} \leq p_a$, since $M^{IT} \geq M_d^{IT}$.[9] When $M^{IT} > M_d^{IT}$, $p_a > p_a^{\delta}$, and the lower price in the default state will be referred to as a "fire sale" of asset $a$. The value of asset $a$ decreases to investors because lenders' enter the date-3 matching process to sell their collateral and this reduces the probability that the investors are matched with traders. (In the no-default state, an event that occurs with probability $1-\delta$, the price of asset $a$ is $p_a$.) There are real effects associated with the fire sale since the total amount of real investment falls, compared to the situation where borrowers do not default.

# 4 Government policy

In the basic no-default model, the government cannot increase total social surplus, compared to the equilibrium allocation. When borrowers can default, however, a government may be able to increase total social surplus, compared to the equilibrium allocation, by affecting the flow of lenders that enter the date-3 matching process. In particular, the government policy instrument is the specification of automatic stay provisions or exclusions on collateral. Let $\theta$ represent the fraction of lenders that are allowed to use the collateral of their defaulting

[9] As above, $M^{IT}$ represents the probability that an investor is matched with a trader in the no-default state. In the no-default state, lenders do not enter the date-3 matching process. When $\bar{\imath} = \bar{c}$, the appropriate measure of gains from trade is the average price of good $a$, and

$$M_d^{IT}\left[\frac{\bar{c}}{\bar{a}}\frac{f(\bar{c})}{\bar{c}} + \frac{\bar{a}-\bar{c}}{\bar{c}}\right] + \left(1 - M^{dIT}\right) \leq M^{IT}\left[\frac{\bar{c}}{\bar{a}}\frac{f(\bar{c})}{\bar{c}} + \frac{\bar{a}-\bar{c}}{\bar{c}}\right] + \left(1 - M^{IT}\right).$$

borrower as they see fit starting at the beginning of date 2. An exemption from an automatic stay on collateral for *all* lenders implies that $\theta = 1$, and an automatic stay on all collateral, where lenders are only able to access their collateral in date 3 after the matching process is completed, implies that $\theta = 0$. When $\theta = 1$, the $(\tilde{c}_1, \tilde{c}_2)$ is a repo contract; when $\theta = 0$, it is a collateralized loan contract. Note that $\theta \in (0, 1)$ can be interpreted as a partial exemption from an automatic stay in the sense that some lenders, $\theta\Delta m$ of them, are exempt from an automatic say and others, $(1-\theta)\Delta m$ of them, are not. It is important to emphasize that if a lender's collateral is subject to an automatic stay, then he (and his collateral) cannot participate in the date-3 matching process.

Government policy, through its effect on $\theta$, can affect the payoffs and behavior of the various agents in the economy. The expected payoff to a borrower, $W_B$, is

$$W_B = m^{BL}(1-\delta\Delta)(\tilde{a}_1 - \tilde{c}_2),$$

where $m^{BL}$ is the probability that a borrower is matched with a lender at date 1. The behavior of the borrower can be affected by government policy since policy can affect $\tilde{c}_1$, which, in turn, affects $\tilde{a}_1$ and $\tilde{c}_2$. The payoff to the borrower is unaffected by government policy since the lender has all of the bargaining power, $\tilde{c}_2 = \tilde{a}_1$, which implies that $W_B = 0$.

The payoff to the lender, $W_L$, is given by

$$\begin{aligned} W_L &= m^{LB}\{-\tilde{a}_1 + (1-\delta\Delta)u(\tilde{c}_2) + \delta[\Delta\theta(M_d^{LT}(\tilde{c}_3 + \gamma\tilde{a}_2 - \gamma\tilde{a}_3) + \\ & \quad \left(1 - M_d^{LT}\right)\gamma\tilde{a}_2)] + \Delta(1-\theta)\gamma\tilde{a}_2\}. \end{aligned}$$

Government policy can the the payoff of the lender directly—since $\theta$ appears in $W_L$—and indirectly through $\tilde{c}_1$ and $\tilde{c}_2$—and, as a result, through $\tilde{a}_1$ ,$\tilde{a}_2$, $\tilde{c}_3$, and $\tilde{a}_3$.

The expected payoff to a trader, $W_T$, is

$$\begin{aligned} W_T &= (1-\delta)\left[M^{TI}(\hat{a}_3 - \hat{c}_3 + \bar{c}) + \left(1 - M^{TI}\right)\bar{c}\right] + \\ & \quad \delta\left[M_d^{TI}(\hat{a}_3 - \hat{c}_3 + \bar{c}) + M_d^{TL}(\tilde{a}_3 - \tilde{c}_3 + \bar{c}) + \left(1 - M_d^{TI} - M_d^{TL}\right)\bar{c}\right] \\ &= \left[(1-\delta)M^{TI} + \delta M_d^{TI}\right](\hat{a}_3 - \hat{c}_3) + \delta M_d^{TL}(\tilde{a}_3 - \tilde{c}_3) + \bar{c}, \end{aligned}$$

where the 'hat' over the $a_3$ and $c_3$ represents (optimal) offers made by the investor to the trader,

$$M_d^{TL} = \frac{M_d}{n^T}\frac{\Delta\theta m}{\Delta\theta m + n^I}$$

and

$$M_d^{TI} = \frac{M_d}{n^T}\frac{n^I}{\Delta\theta m + n^I}.$$

Since investors and lenders have all of the bargaining power in their matches with traders, $\hat{a}_3 = \hat{c}_3$ and $\tilde{a}_3 = \tilde{c}_3$, which implies that $W_T = \bar{c}$. Hence, the payoff to the trader is unaffected by government policy $\theta$. In fact, $\hat{c}_3 = \min\{\bar{c}, \bar{a}\} = \bar{a}$, which is the trade allocation in a trader-investor match in a world without default. Note, however, that $\tilde{c}_3$ and $\tilde{a}_3$ can be affected by government policy.

Finally, the payoff to the investor, $W_I$, is

$$\begin{aligned} W_I &= (1-\delta)\left[M^{IT}\left(f\left(\hat{c}_3\right)-\hat{a}_3+\bar{a}\right)+\left(1-M^{IT}\right)\bar{a}\right]+ \\ &\quad \delta\left[M_d^{IT}\left(f\left(\hat{c}_3\right)-\hat{a}_3+\bar{a}\right)+\left(1-M_d^{IT}\right)\bar{a}\right] \\ &= \left[(1-\delta)M^{IT}+\delta M_d^{IT}\right]\left(f\left(\hat{c}_3\right)-\hat{a}_3\right)+\bar{a}. \end{aligned}$$

Although the behavior of the investor is unaffected by government policy—since $\hat{a}_3 = \hat{c}_3 = \min\{\bar{a}, \bar{c}\} = \bar{a}$—his payoff is affected since the matching probability $M_d^{IT}$ is a function of $\theta$.

In order to evaluate various government policies, we must understand how the behavior of a lender—which is simply his choice of $\tilde{c}_1$—is influenced by changes in $\theta$. The lender's problem is a straightforward generalization of the problem (1) in section 3, to take account of government policy, $\theta$.

$$\begin{aligned} &\max_{c_1} -c_1+(1-\delta\Delta)\,u\left(c_1\right)+ \\ &\delta\Delta\left\{\theta\left[M_d^{LT}\min\{c_1, \bar{c}+\gamma\left(c_1-\bar{c}\right)\}+\left(1-M_d^{LT}\right)\gamma c_1\right]+(1-\theta)\,\gamma c_1\right\} \quad \text{(G1)} \end{aligned}$$

The first-order condition characterizing $\tilde{c}_1$ is as follows,

$$\text{(i) If } (1-\delta\Delta)\,u'\left(\bar{c}\right)+\delta\Delta\gamma>1, \text{ then } \tilde{c}_1>\bar{c}, \tag{2}$$
$$\text{where } (1-\delta\Delta)\,u'\left(\tilde{c}_1\right)+\delta\Delta\gamma=1;$$
$$\text{(ii) If } (1-\delta\Delta)\,u'\left(\bar{c}\right)+\delta\Delta\left(\gamma+(1-\gamma)\theta M_d^{LT}\right)<1, \text{ then } \tilde{c}_1>\bar{c}, \tag{3}$$
$$\text{where } (1-\delta\Delta)\,u'\left(\tilde{c}_1\right)+\delta\Delta\left(\gamma+(1-\gamma)\,\theta M_d^{LT}\right)=1;$$
$$\text{(iii) Otherwise, } \tilde{c}_1=\bar{c}.$$

Proposition 1 demonstrates how loan size, $\tilde{c}_1$, for the contract $(\tilde{c}_1, \tilde{c}_2)$ is affected by a change in the government policy variable $\theta$.

**Proposition 1** *$\tilde{c}_1$ is weakly increasing in $\theta$.*

**Proof.** If $\tilde{c}_1 < \bar{c}$, then from (3), we have

$$\frac{\partial \tilde{c}_1}{\partial \theta}=-\frac{\delta\Delta\,(1-\gamma)\,\partial\left(\theta M_d^{LT}\right)/\partial\theta}{(1-\delta\Delta)\,u''\left(c_1\right)}. \tag{4}$$

Since

$$\theta M_d^{LT}=\begin{cases} \theta & \text{if } \ \Delta\theta m+n^I<n^T \\ \frac{\theta n^T}{\Delta\theta m+n^I} & \text{if } \ \Delta\theta m+n^I>n^T \end{cases},$$

and

$$\frac{\partial\left(\theta M_d^{LT}\right)}{\partial\theta}=\begin{cases} 1 & \text{if } \ \Delta\theta m+n^I<n^T \\ \frac{n^I n^T}{\left(\Delta\theta m+n^I\right)^2} & \text{if } \ \Delta\theta m+n^I>n^T \end{cases}, \tag{5}$$

we get that $\partial\tilde{c}_1/\partial\theta > 0$. If $\tilde{c}_1 \geq \bar{c}$, then from (2), $\partial\tilde{c}_1/\partial\theta = 0$. ■

The intuition behind this proposition is straightforward. Having access to the date-3 matching process is valuable for the lender. Suppose that $\tilde{c}_1 < \bar{c}$.

One can interpret an increase in $\theta$ as providing the lender with better insurance against borrower default in the sense that an increase in $\theta$ increases the probably that lender will be able to exchange good $a$—which he values "a little"—for good $c$—which he values "a lot"—if the borrower defaults. Since the cost associated with borrower default declines as $\theta$ increases, the lender has an incentive to increase his date 1 loan, $\tilde{c}_1$, and the collateral $\tilde{a}_1 = \tilde{c}_1$ that he holds. Suppose now that $\tilde{c}_1 \geq \bar{c}$. In this situation, the lender has no incentive to increase his date-1 loan size $\tilde{c}_1$ when $\theta$ increases since, independent the lender being is matched or not at date 3, the value of an additional unit collateral, conditional on the borrower defaulting, is unchanged and equal to $\gamma < 1$.

The government seeks to maximize total social surplus, $S$, which is given by

$$S = n^B W_B + n^L W_L + n^I (W_I - \bar{a}) + n^T (W_T - \bar{c}).$$

The assumed bargaining conventions imply that the expression for total social surplus can be simplified to

$$S = n^L W_L + n^I (W_I - \bar{a}),$$

which means we only need to focus on the behavior of and payoffs to lenders and investors.

We now characterize how government policy affects total social surplus. Since $\hat{c}_3 = \bar{\imath} \equiv \min\{\bar{a}, \bar{c}\}$, the surplus to investors is

$$W_I - \bar{a} = \left[(1-\delta) M^{IT} + \delta M_d^{IT}\right] (f(\bar{\imath}) - \bar{\imath}), \tag{6}$$

and government policy $\theta$ affects the investor's surplus only through the matching probability, $M_d^{IT}$.

**Proposition 2** *The investor's payoff is weakly decreasing in $\theta$.*

**Proof.** Note that

$$\frac{\partial M_d^{IT}}{\partial \theta} = \begin{cases} 0 & \text{if} \quad n^T > \Delta\theta m + n^I \\ -\frac{\Delta m n^T}{(\Delta\theta m + n^I)^2} & \text{if} \quad n^T \leq \Delta\theta m + n^I \end{cases}$$

and, since $M^{IT} = \min\left\{n^I, n^T\right\}/n^I$, $\partial M^{IT}/\partial\theta = 0$. Therefore, $\partial W_I/\partial\theta = \delta\left(\partial M_d^{IT}/\partial\theta\right)(f(\bar{a}) - \bar{a})$ or

$$\frac{\partial W_I}{\partial \theta} = \begin{cases} 0 & \text{if} \quad n^T > \Delta\theta m + n^I \\ -\delta \frac{\Delta m n^T}{(\Delta\theta m + n^I)^2} (f(\bar{a}) - \bar{a}) & \text{if} \quad n^T \leq \Delta\theta m + n^I \end{cases}. \tag{7}$$

■

This proposition accords with intuition. If the measure of traders is relatively large—in the sense that $n^T > \Delta\theta m + n^I$—then increasing access to the date-3 matching process for lenders has no effect on the investors' surpluses since investors are matched with probability one at date 3. If, however, the number of traders is not relatively large—in the sense that $n^T \leq \Delta\theta m + n^I$—then increasing access to the date-3 matching process to lenders will reduce the probability that investors are matched with traders and, hence, reduces the payoffs to lenders.

Turning to lenders, since, $\tilde{c}_1 = \tilde{c}_2 = \tilde{a}_2 = \tilde{a}_1$ and $\tilde{a}_3 = \min\{\tilde{c}_1, \bar{c}\}$, the surplus function for a lender can be simplified to

$$W_L = m^{LB}\left\{-\tilde{c}_1 + (1-\delta\Delta)\, u(\tilde{c}_1) + \delta\Delta\gamma\tilde{c}_1 + \delta\Delta\theta M_d^{LT}\tilde{a}_3 (1-\gamma)\right\}. \tag{8}$$

To assess how its policy affects total social surplus, the government must understand how $W_L$ is affected by a change in $\theta$.

**Proposition 3** *The lender's payoff is strictly increasing in $\theta$.*

**Proof.** The derivative of (8) with respect to $\theta$ is

$$\begin{aligned}\frac{\partial W_L}{\partial\theta} &= m^{LB}\left\{\frac{\partial\tilde{c}_1}{\partial\theta}\left[-1+\delta\Delta\gamma+(1-\delta\Delta)\,u'(\tilde{c}_1)\right] + m^{LB}\delta\Delta(1-\gamma)\frac{\partial\tilde{a}_3}{\partial\theta}\theta M_d^{LT}\right\} + \\ &\quad m^{LB}\delta\Delta(1-\gamma)\left\{\frac{\partial\left(\theta M_d^{LT}\right)}{\partial\theta}\tilde{a}_3\right\}\end{aligned} \tag{9}$$

The first line of (9) is equal to zero. When $\tilde{c}_1 < \bar{c}$, this is implied by (**??**), recognizing that $\partial\tilde{c}_1/\partial\theta = \partial\tilde{a}_3/\partial\theta$. When $\tilde{c}_1 \geq \bar{c}$, (3) implies that $\partial\tilde{c}_1/\partial\theta = \partial\tilde{a}_3/\partial\theta = 0$. Therefore

$$\begin{aligned}\frac{\partial W_L}{\partial\theta} &= m^{LB}\delta\Delta(1-\gamma)\left\{\frac{\partial\left(\theta M_d^{LT}\right)}{\partial\theta}\tilde{a}_3\right\} \\ &= m^{LB}\delta\Delta(1-\gamma)\begin{cases}\tilde{a}_3 & \text{if } \Delta\theta m + n^I < n^T \\ \frac{n^I n^T}{(\Delta\theta m + n^I)^2}\tilde{a}_3 & \text{if } \Delta\theta m + n^I > n^T\end{cases} \\ &> 0\end{aligned}$$

■

The intuition behind proposition 2 is straightforward. Holding $\tilde{c}_1$ constant, an increase in $\theta$ increases the chance that the lender will be able to participate in the date-3 matching process. This unambiguously increases the surplus of the lender because, in the event of a borrower default, the value of either part or all of the lender's collateral $a$ increases from $\gamma a$ to $a$. As well, if $\tilde{c}_1 < \bar{c}$, then, holding the date-3 matching probability constant, an increase in $\theta$ optimally increases $\tilde{c}_1$ and, by construction, the lender's collateral holdings. Since an increase in $\tilde{c}_1$ is an optimal response to an increase in $\theta$, the lender's surplus must also increase.

Propositions 2 and 3 identify the trade-off that the government faces when choosing its policy. An increase in $\theta$ (weakly) lowers the probability that an investor will be matched with a trader and, hence, (weakly) lowers the level of (productive) investment. But an increase in $\theta$ strictly increases the probability that a lender will be matched with a trader, in the event of a borrower default, and this enhances the "liquidity" of a lender's collateral. (Collateral becomes more "liquid" in the sense that it can be converted into the consumption good with a higher probability.) To assess a government policy that changes the value of $\theta$, one simply has to compare the "investment effect" with the "liquidity effect." Generally speaking, the net effect can go either way as the magnitudes of the two effects depend upon model parameters.

Consider first the situation where $n^T > \Delta m + n^I$. One can interpret this situation as one where the date-3 market is "very liquid"–having the capacity always to match both investors and lenders with probability one. In this situation, the optimal government policy is clear.

**Proposition 4** *When $n^T > \Delta m + n^I$, then the optimal government policy provides an exemption from a bankruptcy stay for all lenders.*

**Proof.** From (7) and (9), when $n^T > \Delta m + n^I$

$$\frac{\partial S}{\partial \theta} = n^L \frac{\partial W_L}{\partial \theta} + n^I \frac{\partial W_I}{\partial \theta} = m\delta\Delta\left(1-\gamma\right)\tilde{a}_3 > 0,$$

for all $\theta$. Hence, the government should choose $\theta$ "as high as possible," i.e., $\theta = 1$. ■

Consider now the interesting case where the date-3 market is illiquid from the investor's perspective in the sense that $n^I > n^T$. For this case, again using (7) and (9), we obtain

$$\frac{\partial S}{\partial \theta} = \frac{1}{\left(\Delta\theta m + n^I\right)^2}\left[\left(1-\gamma\right)\tilde{a}_3\left(\theta\right) - \left(f\left(\bar{\imath}\right) - \bar{\imath}\right)\right]. \qquad (10)$$

When $n^I > n^T$, the optimal government policy is determined by comparing the value of $f\left(\bar{\imath}\right) - \bar{\imath}$—which is proportional to the investment effect—with that of $\left(1-\gamma\right)\tilde{a}_3\left(\theta\right)$—which is proportional to the liquidity effect—for various values of $\theta$. More formally,

**Proposition 5** *Suppose $n^I > n^T$. If*

$$\left(1-\gamma\right)\tilde{a}_3\left(0\right) > \left(f\left(\bar{\imath}\right) - \bar{\imath}\right),$$

*then the optimal government policy provides an exemption from a bankruptcy stay of all lenders, i.e., $\theta = 1$. If*

$$\left(1-\gamma\right)\tilde{a}_3\left(1\right) < \left(f\left(\bar{\imath}\right) - \bar{\imath}\right),$$

*then is the optimal government policy requires a bankruptcy stay for all lenders, i.e., $\theta = 0$.*

**Proof.** Since $\tilde{a}_3 = \min\left\{\tilde{c}_1, \bar{c}\right\}$, Proposition 1 implies that $\partial\tilde{a}_3/\partial\theta \geq 0$. If $\left(1-\gamma\right)\tilde{a}_3\left(0\right) > \left(f\left(\bar{\imath}\right) - \bar{\imath}\right)$, then from (10) $\partial W/\partial\theta > 0$ for all $\theta \in [0,1]$, and setting $\theta = 1$ is optimal. If $(1-\gamma)\,\tilde{a}_3(1) < (f(\bar{\imath}) - \bar{\imath})$, then from (10) $\partial W/\partial\theta < 0$ for all $\theta \in [0,1]$, and setting $\theta = 0$ is optimal. ∎

Note the message of the proposition: Even though the date-3 market is illiquid from the perspective of investors—even if lenders are not permitted to participate—it may be optimal for the government to exempt defaulted lenders from a bankruptcy stay. This will happen when, intuitively speaking, the "liquidity value" of allowing lenders to have access to traders is greater than the "investment value" associated with investor-trader matches. It is true that when $\theta = 1$, lenders will displace economy-wide investment when $n^I > n^T$. However, the value of the liquidity, $(1-\gamma)\,\tilde{a}_3$, generated by lenders exceeds that of the displaced investment.

The next proposition shows that when $n^I > n^T$ nothing is gained by considering policies with interior $\theta \in (0,1)$.

**Proposition 6** *When $n^I > n^T$, either it is optimal to provide an exemption from the bankruptcy stay to all lenders, $\theta = 1$, or it is optimal to impose a bankruptcy stay on all lenders, $\theta = 0$.*

**Proof.** Consider the derivative of surplus in formula 10. If there is a strict interior maximum $\hat{\theta}$, then this expression must be positive for values of $\theta$ just below $\hat{\theta}$ and negative for values of $\theta$ just above $\hat{\theta}$. But since $\tilde{a}_3(\theta)$ is a non decreasing function, this is impossible. ∎

When $n^I > n^T$, the optimal government policy is either imposes a bankruptcy stay on all lenders or an exemption from a bankruptcy stay for all lenders. Although a partial exemption, i.e., $\theta \in (0,1)$, is permitted, it is never optimal, except for the knife edge case where $S'(\theta) = 0$ for all $\theta \in [0,1]$.[10] But even in this knife-edge case, $\theta = 1$ or $\theta = 0$ is an optimal policy. In spite of the relative illiquidity of the date-3 market, i.e., $n^I > n^T$, an exemption from a bankruptcy stay for all lenders is optimal when the liquidity value associated with providing access to the date 3 market for lenders is greater than the displacement of real investment opportunities.

The final case in terms of date-3 market liquidity to consider is the intermediate case where $n^I < n^T$ and $\Delta n^L + n^I > n^T$. In other words, there is enough activity in the date 3 market to provide goods to all investors, but not enough to provide goods to all lenders as well. Let $\theta^*$ be such that $\theta^* \Delta n^L + n^I = n^T$ —in other words the value of $\theta$ which exhausts the supply of traders. Clearly, it would never be optimal for the government to choose a $\theta < \theta^*$. Optimal government policy here somewhat mirrors the case where $n^I > n^T$, except now the lower bound of optimal government policy is $\theta^*$ instead of $\theta = 0$. In particular

**Proposition 7** *When $n^I < n^T$ and $\Delta n^L + n^I > n^T$ an optimal government policy either provides an exemption from a bankruptcy stay for all lenders, $\theta = 1$, or imposes a bankruptcy stay on fraction $1 - \theta^*$ of lenders.*

**Proof.** The proof follows those of Propositions 5 and 6. ∎

[10] Among other things, this knife-edge case requires that $\tilde{c}_1 > \bar{c}$.

In other words with the Leontief matching technology the essential question is whether there is greater social value from a match by an investor or a match to fulfill liquidity needs of the lenders. If the investments are more valuable, then fire sales should be discouraged to the extent that they crowd out this investment. If the liquidity needs are more valuable, then they should be encouraged through complete exemptions from automatic stays.

# 5 Final Remarks

This paper has deals with specific costs and benefits of the exemption from the automatic stay associated with repos in bankruptcy. The benefit we focus on is the improvement in insurance arising from the ability of the lender to dispose of his collateral quickly, and the cost is the disruption of the market for the collateral and investments goods. The desirability of extending the automatic stay to repos depends on the relative importance of these costs and benefits.

The standard argument in favor of automatic stays in the bankruptcy process is the destruction of value associated with an uncoordinated break-up of the bankrupt firm. When the assets being sold are financial instruments rather than real assets, this justification *appears* to be less important. Furthermore, having the option to allow some financial contracts to avoid the automatic stay seems to be desirable as a way of increasing the opportunities for flexibility in a firm's borrowing and thereby reduce borrowing costs. (While other articles, noted in the introduction, have emphasized the costs imposed on less favored lenders, as a first pass, this is a justification for the law to limit the use of this favored treatment itself, not a justification for the prohibition of the favored treatment).

The fire sale cost applies not to the firm itself (in which case initial contracting by the firm with its various counterparties could ultimately resolve the problem) but to other participants in the market for the collateral good. Thus the importance of the cost depends on the effect that the firm's bankruptcy has on the market—roughly speaking, on the liquidity and depth of that market. In this respect, the conclusions of our model correspond to the comments by Duffie and Skeel (2012), which advocate the exemption from the bankruptcy stay only when the market for the collateral is extremely liquid. (In our model, depth can be associated with the excess of traders willing to take the collateral when lenders attempt to dispose of it). We provide a simple comparison of these costs with the benefits from the improved opportunities of borrowing through increase of the liquidity of the loans provided to the firm initially.

The externality that gives rise to a fire sale in our model is a direct result of trade being mediated by over-the-counter markets. These markets generate a search externality, where sellers of collateral can crowd out investors because both of these parties are searching for the same thing: liquidity. If, alternatively, we model exchange as occurring on purely competitive markets, then the externality disappears. In particular, the optimal bankruptcy policy would exempt the automatic stay because the exemption gives all agents an opportunity to seek liquidity, and competitive markets ensure that liquidity ends up with agents that place the highest value on it. Although this result is interesting, it is not particularly helpful or relevant from a policy perspective, precisely because repo markets are not competitive—they are over-the-counter. Given this, we would argue that the externality that is central to our analysis is both appropriate and realistic. It also turns out that it is also extremely tractable to analyze, although other forms of externality, for example through cash-in-the-market pricing (Allen and Gale 2007), will yield similar results.

Finally, there may be ways to reduce the risk of fire sales that do not require a change to the bankruptcy code. For example, repos could be cleared by a central counter party, CCP. A CCP interposes itself between the borrower and the lender, where the CCP holds the collateral and margins of the parties and is legally responsible for making the second leg repo transactions. If the CCP is well managed, it would have access to liquidity in the event of a borrower default, and, as a result, could dispose of the defaulted borrower's collateral in a non-disruptive way. As well, CCP members—i.e., the borrowers and lenders—can directly confront the externality identified in our model by agreeing to a set of rules regarding disposition of collateral that minimize the risk of fire sales. A repo CCP, however, faces the same challenges that any CCP face in the event of multiple simultaneous defaults by members. In terms of the repo CCP, it may default on its promised payments if it does not liquidate a substantial portion of its collateral. But such a liquidation could result in fire-sale prices.

# 6 References


Allen, F. and D. Gale, 2007, *Understanding Financial Crises*, Oxford University Press.

Acharya, Viral V., V. Ravi Anshuman, and S. Viswanathan. 2012. "Bankruptcy Exemption of Repo Markets: Too Much Today for Too Little Tomorrow?" Manuscript.

Bolton, Patrick and Martin Oehmke. 2011. "Should Derivatives be Privileged in Bankruptcy?" NBER working paper 17599.

Duffie, Darell, and David Skeel. 2012. "A Dialogue on the Costs and Benefits of Automatic Stays for Derivatives and Repurchase Agreements." Rock Center for Corporate Governance at Stanford University Working Paper No. 108.

French, K R, M N Baily, J Campbell, J H Cochrane, D W Diamond, D Duffie, A K Kashyap, F S Mishkin, R G Rajan, D S Scharfstein, R J Shiller, H S Shin, M J Slaughter, J C Stein and R M Stulz. 2010. *The Squam Lake Report: Fixing the Financial System.* Princeton University Press.

Garbade, Kenneth D. 2006, "The Evolution of Repo Contracting Conventions in the 1980s," Federal Reserve Bank of New York, Economic Policy Review, May 2006 Volume 12, Number 1, pp. 27.42.

McAndrews, James J., and William Roberds. 2003. "Payment Intermediation and the Origins of Banking," manuscript.

Mills, Jr., David C. and Robert R. Reed. 2012. "Default Risk and Collateral in the Absence of Commitment," manuscript.

Roe, Mark. 2011. "The Derivatives Players' Payment Priorities as Financial Crisis Accelerator." Stanford Law Review 63.

Shleifer, Andrei and Robert Vishny. 2011. "Fire Sales in Finance and Macroeconomics," Journal of Economic Perspectives, Winter, 2011.

## Working Paper Series

A series of research studies on regional economic issues relating to the Seventh Federal Reserve District, and on financial and economic topics.

## Working Paper Series *(continued)*

## Working Paper Series *(continued)*

Robustness and Macroeconomic Policy — **WP-10-04**
*Gadi Barlevy*

Benefits of Relationship Banking: Evidence from Consumer Credit Markets — **WP-10-05**
*Sumit Agarwal, Souphala Chomsisengphet, Chunlin Liu, and Nicholas S. Souleles*

The Effect of Sales Tax Holidays on Household Consumption Patterns — **WP-10-06**
*Nathan Marwell and Leslie McGranahan*

Gathering Insights on the Forest from the Trees: A New Metric for Financial Conditions — **WP-10-07**
*Scott Brave and R. Andrew Butters*

Identification of Models of the Labor Market — **WP-10-08**
*Eric French and Christopher Taber*

Public Pensions and Labor Supply Over the Life Cycle — **WP-10-09**
*Eric French and John Jones*

Explaining Asset Pricing Puzzles Associated with the 1987 Market Crash — **WP-10-10**
*Luca Benzoni, Pierre Collin-Dufresne, and Robert S. Goldstein*

Prenatal Sex Selection and Girls' Well‐Being: Evidence from India — **WP-10-11**
*Luojia Hu and Analía Schlosser*

Mortgage Choices and Housing Speculation — **WP-10-12**
*Gadi Barlevy and Jonas D.M. Fisher*

Did Adhering to the Gold Standard Reduce the Cost of Capital? — **WP-10-13**
*Ron Alquist and Benjamin Chabot*

Introduction to the *Macroeconomic Dynamics*:
Special issues on money, credit, and liquidity — **WP-10-14**
*Ed Nosal, Christopher Waller, and Randall Wright*

Summer Workshop on Money, Banking, Payments and Finance: An Overview — **WP-10-15**
*Ed Nosal and Randall Wright*

Cognitive Abilities and Household Financial Decision Making — **WP-10-16**
*Sumit Agarwal and Bhashkar Mazumder*

Complex Mortgages — **WP-10-17**
*Gene Amromin, Jennifer Huang, Clemens Sialm, and Edward Zhong*

The Role of Housing in Labor Reallocation — **WP-10-18**
*Morris Davis, Jonas Fisher, and Marcelo Veracierto*

Why Do Banks Reward their Customers to Use their Credit Cards? — **WP-10-19**
*Sumit Agarwal, Sujit Chakravorti, and Anna Lunn*

## **Working Paper Series** *(continued)*

| | |
|---|---|
| The impact of the originate-to-distribute model on banks before and during the financial crisis<br>*Richard J. Rosen* | **WP-10-20** |
| Simple Markov-Perfect Industry Dynamics<br>*Jaap H. Abbring, Jeffrey R. Campbell, and Nan Yang* | **WP-10-21** |
| Commodity Money with Frequent Search<br>*Ezra Oberfield and Nicholas Trachter* | **WP-10-22** |
| Corporate Average Fuel Economy Standards and the Market for New Vehicles<br>*Thomas Klier and Joshua Linn* | **WP-11-01** |
| The Role of Securitization in Mortgage Renegotiation<br>*Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff* | **WP-11-02** |
| Market-Based Loss Mitigation Practices for Troubled Mortgages Following the Financial Crisis<br>*Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff* | **WP-11-03** |
| Federal Reserve Policies and Financial Market Conditions During the Crisis<br>*Scott A. Brave and Hesna Genay* | **WP-11-04** |
| The Financial Labor Supply Accelerator<br>*Jeffrey R. Campbell and Zvi Hercowitz* | **WP-11-05** |
| Survival and long-run dynamics with heterogeneous beliefs under recursive preferences<br>*Jaroslav Borovička* | **WP-11-06** |
| A Leverage-based Model of Speculative Bubbles (Revised)<br>*Gadi Barlevy* | **WP-11-07** |
| Estimation of Panel Data Regression Models with Two-Sided Censoring or Truncation<br>*Sule Alan, Bo E. Honoré, Luojia Hu, and Søren Leth–Petersen* | **WP-11-08** |
| Fertility Transitions Along the Extensive and Intensive Margins<br>*Daniel Aaronson, Fabian Lange, and Bhashkar Mazumder* | **WP-11-09** |
| Black-White Differences in Intergenerational Economic Mobility in the US<br>*Bhashkar Mazumder* | **WP-11-10** |
| Can Standard Preferences Explain the Prices of Out-of-the-Money S&P 500 Put Options?<br>*Luca Benzoni, Pierre Collin-Dufresne, and Robert S. Goldstein* | **WP-11-11** |
| Business Networks, Production Chains, and Productivity: A Theory of Input-Output Architecture<br>*Ezra Oberfield* | **WP-11-12** |
| Equilibrium Bank Runs Revisited<br>*Ed Nosal* | **WP-11-13** |

## **Working Paper Series** *(continued)*

Are Covered Bonds a Substitute for Mortgage-Backed Securities? **WP-11-14**
*Santiago Carbó-Valverde, Richard J. Rosen, and Francisco Rodríguez-Fernández*

The Cost of Banking Panics in an Age before "Too Big to Fail" **WP-11-15**
*Benjamin Chabot*

Import Protection, Business Cycles, and Exchange Rates:
Evidence from the Great Recession **WP-11-16**
*Chad P. Bown and Meredith A. Crowley*

Examining Macroeconomic Models through the Lens of Asset Pricing **WP-12-01**
*Jaroslav Borovička and Lars Peter Hansen*

The Chicago Fed DSGE Model **WP-12-02**
*Scott A. Brave, Jeffrey R. Campbell, Jonas D.M. Fisher, and Alejandro Justiniano*

Macroeconomic Effects of Federal Reserve Forward Guidance **WP-12-03**
*Jeffrey R. Campbell, Charles L. Evans, Jonas D.M. Fisher, and Alejandro Justiniano*

Modeling Credit Contagion via the Updating of Fragile Beliefs **WP-12-04**
*Luca Benzoni, Pierre Collin-Dufresne, Robert S. Goldstein, and Jean Helwege*

Signaling Effects of Monetary Policy **WP-12-05**
*Leonardo Melosi*

Empirical Research on Sovereign Debt and Default **WP-12-06**
*Michael Tomz and Mark L. J. Wright*

Credit Risk and Disaster Risk **WP-12-07**
*François Gourio*

From the Horse's Mouth: How do Investor Expectations of Risk and Return
Vary with Economic Conditions? **WP-12-08**
*Gene Amromin and Steven A. Sharpe*

Using Vehicle Taxes To Reduce Carbon Dioxide Emissions Rates of
New Passenger Vehicles: Evidence from France, Germany, and Sweden **WP-12-09**
*Thomas Klier and Joshua Linn*

Spending Responses to State Sales Tax Holidays **WP-12-10**
*Sumit Agarwal and Leslie McGranahan*

Micro Data and Macro Technology **WP-12-11**
*Ezra Oberfield and Devesh Raval*

The Effect of Disability Insurance Receipt on Labor Supply: A Dynamic Analysis **WP-12-12**
*Eric French and Jae Song*

## Working Paper Series *(continued)*