FINANCIAL INTERMEDIARIES AS MARKETS FOR FIRM ASSETS*

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This article proposes a theory of financial intermediation based on intermediaries’ role in the reallocation of assets of distressed firms. The article suggests that intermediaries aggregate information on firms in credit relationships and use this information to facilitate asset reallocation across firms. However, this role of intermediaries hinges on debt contracts that grant lenders the right to foreclose assets of distressed borrowers and, hence, exclude the most productive asset users from the resale market. We characterise conditions under which intermediaries arise and under which their role in the credit market enhances their role as markets for firm assets.

Financial intermediaries appear to have a key role in the restructuring and liquidation of distressed firms. In particular, there is ample evidence that financial intermediaries are active in the reallocation of displaced capital. According to Sheard (1994, p. 203), in Japan ‘A key part of reorganisation under main bank supervision or management is the implementation of a plan of asset sales with proceeds typically used to recover bank loans’. Sheard (1994) surveys several cases in which, by exploiting their position at the core of industrial groups (keiretsu), main banks eased mergers of distressed firms with solvent ones or helped to identify buyers for liquidated assets within the keiretsu. Edwards and Fisher (1994, p. 174) argue that in Germany a function of banks during reorganisations is to ‘use bank contacts to facilitate a merger with another firm as a means of resolving the crisis’. De Cecco and Ferri (1996, pp. 47–8) maintain that, by knowing possible synergies among firms, banks can suggest solutions for an efficient reallocation of assets and corporate control and that in several countries there is widespread anecdotal evidence of this role of banks. For example, they report the results of a study which shows that a group of 26 Italian banks play an active role in the market for corporate assets. Analysing asset reallocation in the aircraft industry, Habib and Johnsen (1999, p. 698) write that specialised financial intermediaries such as ‘aircraft finance firms, are actively engaged in fully integrated redeployment, including valuation, repossession, and resale’.

In this article, we put forward a theory of financial intermediaries as markets for corporate assets. Following the search literature (Kiyotaki and Wright, 1993), we model the market for corporate assets as a decentralised one affected by trade frictions: solvent firms search for the displaced assets of bankrupt firms but matching is imperfect and firms can end up with assets unsuitable for them.\(^1\) Financial intermediaries arise as

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\(^1\) Ramey and Shapiro (2001, p. 961) stress the importance of search costs in asset redeployment and argue: ‘Thin markets and costly search complicate the process of finding buyers whose needs best match the capital’s characteristics. The cost of search includes not only monetary costs, but also the time it takes to find good matches within the industry’. 
centralised markets where information on assets and buyers is readily available, allowing displaced assets to migrate towards their most productive uses. Thus, our analysis shows that intermediaries can intermediate not only between savers and firms at the investment stage but also among firms at the restructuring stage, easing the redeployment of their assets. Nonetheless, the role of intermediaries in the credit market is critical for their role as redeployers. In fact, financial intermediaries ease asset redeployment by aggregating information on firms in the credit market.

In our economy, lenders have an incentive to collect information on assets if they have signed debt contracts to repossess assets when borrowers default. Therefore, debt is critical for the role of intermediaries as information aggregators. However, debt has a cost in asset reallocation. Firms that have borrowed in the credit market and have defaulted may still be the best asset users from an ex ante perspective. Under debt contracts, these firms return assets to lenders after defaulting and do not participate in the resale market. Therefore, on the one hand intermediaries solve trade frictions in the market for corporate assets; on the other hand, the type of contract that allows them to perform this role, debt, may exclude the most productive asset users from this market.

We find that, in a region of the parameter space, our economy exhibits multiple equilibria and agents’ beliefs affect the financial structure. The average quality (productivity) of asset users in the decentralised resale market is a driving force behind the existence of multiple equilibria. In the decentralised market less productive users coexist with highly productive ones. Since the decentralised market is affected by trade frictions, the asset liquidation value reflects the share of highly productive users. In turn, this share depends on the distribution of intermediated debt and dispersed (non-intermediated) equity contracts in the population. As more highly productive firms choose intermediated debt and lose control of their assets upon default, the quality of the decentralised market, i.e. the share of highly productive users, decreases. Under some conditions, if agents believe that many firms use intermediaries and sign intermediated debt contracts at the investment stage, they will expect the decentralised market to be of low quality and will use intermediaries.

In the second part of the article, we extend the model and investigate the role of liquidity in the market for corporate assets, i.e. the ratio between assets available for redeployment and second hand users. We find that the role of intermediaries as matchmakers between savers and firms in the credit market can enhance their role as resale markets. Intuitively, by increasing the number of highly productive matches in the credit market, intermediaries increase the share of highly productive users in the decentralised market. This improvement in the quality of the decentralised market reduces firms’ incentive to use financial intermediaries for asset redeployment. However, by increasing the number of highly productive matches in the credit market, intermediaries decrease the liquidity of the decentralised market. This renders the decentralised market less appealing and increases firms’ incentive to use intermediaries for asset redeployment. When the quality improvement in the decentralised market is

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2 Note however that we do not consider situations in which firms engage in strategic default and bid for their own assets after defaulting; for an analysis of this issue see Bolton and Scharfstein (1996).

3 We show that in our economy intermediated equity and dispersed debt contracts are always (weakly or strongly) dominated.
not too large and the second effect dominates, better matchmaking in the credit market enhances the role of intermediaries as resale markets.

Before we proceed, two caveats are due. First, our analysis is not specific to any type of financial intermediaries. For example, our analysis applies both to generalist financial intermediaries, such as commercial banks, and to intermediaries specialised in financing particular industries, such as business finance companies (e.g., car and aircraft finance firms). Second, the function of financial intermediaries we investigate can have different relevance in different countries, according to the financial structure and to the institutional organisation of the market for corporate assets. For example, it is plausible that this function is especially important in countries where financial intermediaries have tight credit relationships with borrowers (as is allegedly the case in Germany and Japan). Thus, gauging the quantitative relevance of this role of intermediaries becomes an empirical issue.

The remainder of the article is structured as follows. In Section 1, we review the related literature. Section 2 presents the model. In Section 3, we solve for the equilibrium. Section 4 considers some extensions. In Section 5, we discuss predictions and applications of the analysis. Section 6 concludes. Proofs are relegated to the Appendix.

1. Related Literature

This article relates to three strands of literature. The first investigates the origin of financial intermediation. In Diamond and Rajan (2001), banks have better liquidation skills than dispersed investors and their short-term liability structure allows them to commit these skills. We share with Diamond and Rajan (2001) the emphasis on the superior liquidation skills of financial intermediaries. However, in Diamond and Rajan (2001) banks’ liquidation skills are assumed whereas we derive those skills endogenously. In Diamond (1984), financial intermediaries act as delegated monitors of firms, avoiding the need for dispersed investors to duplicate their monitoring effort. Other studies, such as Boyd and Prescott (1986) and Ramakrishnan and Thakor (1984), analyse the role of financial intermediaries in mitigating information asymmetries between savers and firms at the investment stage. We share with these studies the idea of intermediaries as information sharing coalitions of investors. In our context, the ‘coalition’ of lenders develops superior skills in redeploying assets because asset redeployment aggregates information across credit relationships.

The second strand of literature investigates institutions that aggregate information and coordinate decisions in financial markets. Milgrom et al. (1990) investigate the role of merchant courts in the Champagne fairs in the late Middle Ages (twelfth and thirteenth centuries). In particular, they interpret the use of merchant courts as an institution which provides incentives for gathering information and honouring agreements. Boot et al. (2005) provide a theory of credit rating agencies as ‘focal points’ that coordinate agents’ beliefs on one of the possible multiple equilibria in the financial market. In our article, intermediaries also act as agents’ coordination devices in the resale market.

Rubinstein and Wolinsky (1987) analyse the role of agents who can reduce trade frictions in the exchange process.
Finally, the article shares features with the literature on the efficiency of asset liquidation and its implications for firms’ investment and financing choices. In this literature, our article most closely relates to Shleifer and Vishny (1992) that shows that the extensive use of debt in a sector can exacerbate the positive correlation among firms’ financial status and increase the illiquidity of their assets. Intermediaries play no role in Shleifer and Vishny (1992). Campello and Fluck (2005) and Almeida and Campello (2004) are among recent studies that investigate the asset liquidation decisions of firms. Campello and Fluck (2005) study how the efficiency of the liquidation process affects firms’ investment in market shares. Almeida and Campello (2004), in contrast, focus on how asset liquidity affects the link between firms’ cash flows and investment. From an empirical perspective, Maksimovic and Phillips (2001) carry out an analysis of the US market for corporate assets and finds that this market successfully transfers assets from low productivity to high productivity users.

2. The Model

2.1. Goods, Agents, and Technology

Consider a two-date economy \((t = 1, 2)\). There is a final good and distinct, indivisible assets (machines) that produce the final good. The population consists of a continuum of risk neutral agents who derive utility from their date 2 consumption of final good. This population is divided in two groups, unskilled \((u)\) and skilled \((s)\), each of measure one. Unskilled and skilled agents differ in their initial endowment: an unskilled agent starts out with one machine while a skilled agent starts out with an amount \(x\) of the final good. They also differ in their productivity: the probability of success of an unskilled agent when she produces with a machine \((c)\) is lower than that of a skilled one \((k)\). Furthermore, if an unskilled agent does not transfer her machine but she produces with it personally, her probability of success is \(c_0 < c\).

Our objective is to analyse how a resale market for machines operates. The specification of the production technology provides a rationale for this market. Production occurs at date 2 when, for simplicity, each agent can successfully use one machine at most. If production is successful, a machine yields an amount \(U\) of final good; if it is unsuccessful, the machine can be reused by another agent, though with lower return. If reused successfully, the machine yields \(u < U\).

2.2. Markets

The market friction in our economy is the inability of an agent who wants to sell (transfer) a machine to find another agent who wants to buy (use) it. We formalise this friction in a way that is standard in the search literature (Kiyotaki and Wright, 1993). First, there is an exogenous parameter \(x\), with \(0 < x < 1\), that captures the extent to which agents are specialised and is set regardless of the agent being unskilled or skilled.

\(^5\) This assumption will render the trade of used machines meaningful and help to provide a clean intuition for the role of financial intermediaries. It also matches the assumption typically made in the money and search literature that an agent does not like the good she is endowed with, which also serves to motivate trade; see, e.g., Kiyotaki and Wright (1993).

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In particular, we denote by $x$ the proportion of machines that an unskilled (skilled) agent can use and the proportion of unskilled (skilled) agents who can use a particular machine. Second, agents meet in pairs under a uniform random matching technology. In particular, there are two meeting opportunities, a first one at date 1 and a second one at date 2, after agents observe whether production is successful or machines must be redeployed.

We call the market where at date 1 unskilled agents (the financiers or lenders) lend their machines to skilled ones (the borrowers) the credit market. Later in the analysis – see Lemma 2 – we characterise conditions such that at date 1 an unskilled agent prefers meeting a skilled agent than meeting another unskilled agent. At date 2, agents use machines but some agents fail to produce. Therefore, a positive measure of agents have the incentive to exchange machines and this is the rationale for the existence of a resale market.

### 2.3. Contractual Structure

Suppose that at date 1 in the credit market an unskilled agent meets a skilled agent and transfers her machine. The two agents sign a contract specifying:

1. the upfront payment in final good due by the skilled agent to the unskilled one at date 1;
2. the allocation of the property rights over the machine in the event of failure at date 2;
3. the repayment in final good due by the skilled agent to the unskilled one in the event of success at date 2.

We consider two polar types of contract. An equity contract specifies that the skilled agent makes an upfront payment to the unskilled one, acquires full property rights over the machine and gives no repayment in the event of success. This can be interpreted as a 100% equity contract whereby the skilled agent becomes the full owner of the machine. A debt contract specifies that the unskilled agent receives no upfront payment, retains full property rights over the machine in the event of failure, and receives a repayment in the event of success. This can be interpreted as a debt contract whereby the unskilled agent lends her machine to the skilled one in exchange for future payments.

Enforcement is guaranteed by a court which punishes agents when it receives evidence that a contract was not honoured. Since in a decentralised economy the outcome of a meeting is private information, we assume that, after signing a contract, an unskilled and a skilled agent stay together and collect evidence on the outcome of production.

### 2.4. Intermediation

For both debt and equity we distinguish between intermediated and dispersed contracts. We construe intermediation as a technology through which unskilled agents (the lenders) can aggregate the information collected in the credit market. Specifically, if in the credit market an unskilled and a skilled agent sign an intermediated contract,
the unskilled agent can thereafter make available information on the type of machine exchanged and the types of machines suitable for her and for her skilled partner. This decision to make information available is non-contractible.\(^6\) At date 2, in the resale market, this information is released to all the unskilled agents who made information available at date 1.\(^7\) This implies that an unskilled agent who made information available about her match can distinguish the type of any other unskilled agent who also made information available as well as the type of her skilled partner. Put differently, the intermediation technology generates a resale market where matching is not random. Thus, the intermediation technology eliminates trade frictions in the resale market by aggregating the information collected in the credit market.

2.5. Summary

The timing of the model is as follows.

\textit{Date 1.} Skilled and unskilled agents randomly meet in pairs in the credit market. When she meets a skilled agent whose specialisation is consistent with the type of her machine, an unskilled agent can transfer the machine. In this case, the agents choose whether to sign an intermediated debt contract (\(\text{ID}\)), an intermediated equity contract (\(\text{IE}\)), a dispersed debt contract (\(\text{DD}\)), or a dispersed equity contract (\(\text{DE}\)). If the agents sign an intermediated contract, the unskilled agent can thereafter share information on the type of machine exchanged and on the types of machines suitable for the two agents.

\textit{Date 2.} Machines produce or fail. Machines that fail can be reused by other agents. Agents meet in pairs in the resale market and exchange these machines. Unskilled agents who have shared information gain access to the information released by the intermediary. Redeployed machines produce or fail. Agents consume.

3. Equilibrium

To solve for the equilibrium we proceed in four steps. In Section 3.1, we analyse the resale market. In Section 3.2, we provide preliminary observations on the contracts. In Section 3.3, we analyse the credit market. Finally, in Section 3.4 we characterise the equilibrium.

3.1. Resale Market

We call the resale market ‘decentralised’ if it operates without the intermediation technology. An ‘internal’ resale market is generated by the intermediation technology.

3.1.1. Decentralised market

First, we consider the case in which only agents with machines meet each other in the decentralised resale market. In Lemma 1, we show that indeed, when the productivity

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\(^6\) The idea that the collection and transmission of information are non-contractible is common in the literature on financial intermediation (Holmstrom and Tirole, 1997).

\(^7\) Note that all in all unskilled agents (the financiers) differ from skilled ones in having machines, being less productive and being able to process information. This characterisation of financiers can be found in Diamond (1984), for example.

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gap between skilled and unskilled agents is not too large, an agent with a machine has an incentive to meet another agent with a machine in the decentralised market.

**Lemma 1.** Let $\gamma > \lambda/2$. In the decentralised resale market an agent with a machine will always prefer meeting another agent with a machine.

*Proof.* See the Appendix.

We now derive agents’ value functions in the decentralised resale market. For this purpose, we first write down the endogenous probability of meeting a skilled agent in this market. As we will show in Section 3.2 and in the Appendix, intermediated equity contracts (IE) and dispersed debt contracts (DD) are always weakly or strongly dominated so that we can restrict our attention to dispersed equity (DE) and intermediated debt (ID). The probability $\pi_s(m_{DE})$ of meeting a skilled agent in the decentralised market is

$$\pi_s(m_{DE}) = \frac{xm_{DE}(1-\lambda)}{xm_{DE}(1-\lambda) + (1-x)(1-\gamma')}, \quad (1)$$

where $m_{DE}$ denotes the share of matched agents who signed a dispersed equity contract. The measure of skilled agents with machines in the decentralised market equals the probability $x$ that a skilled agent received a machine from an unskilled one at date 1 times the share $m_{DE}$ of matched skilled agents who signed dispersed equity contracts, times the probability $1-\lambda$ that a skilled agent failed to produce. The measure of unskilled agents with machines equals the probability $1-x$ that an unskilled agent did not match and transfer her machine at date 1, times the probability $1-\gamma'$ that she failed. Note that at date 2 there is a third group of agents with redeployable machines, i.e. the unskilled agents who signed intermediated debt contracts and repossessed machines after failure. These agents resell machines in the internal market (see below).

It is worth observing that, unlike the measure $xm_{DE}(1-\lambda)$ of skilled agents, the measure $(1-x)(1-\gamma')$ of unskilled agents in the decentralised market is independent of the distribution of dispersed equity and intermediated debt contracts. This is so because only agents with machines participate in the decentralised market. Moreover, for a pair of agents matched in the credit market it is inefficient to sign a dispersed debt contract. In fact, for given trade frictions, an unskilled agent expects a lower return from trading the failed machine than a skilled one. All in all, this implies that the only unskilled agents with machines in the decentralised market are those who did not match in the credit market and failed to produce. The measure $(1-x)(1-\gamma')$ of these agents is independent of the distribution of contracts and depends only on the degree of trade frictions (the inverse of $x$) and on properties of the production technology ($\gamma'$). Finally, observe that the qualitative results continue to hold in an extended environment where the measure of unskilled agents in the decentralised resale market depends on the distribution of contracts – see Section 4.\(^8\)

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\(^8\) In particular, in the extended environment of Section 4 some agents without machines participate in the decentralised resale market. This will also enable us to analyse the role of liquidity effects in this market.

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Now let $W_s$ be the value function of a skilled agent and $W_u$ be the value function of an unskilled agent in the decentralised market (both net of any final good carried from date 1). We have

$$W_s = \pi_s(\cdot)x\hat{\gamma}u + [1 - \pi_s(\cdot)]x\frac{\hat{\lambda} + \gamma}{2}u,$$

(2)

$$W_u = \pi_s(\cdot)x\frac{\hat{\lambda} + \gamma}{2}u + [1 - \pi_s(\cdot)]x\gamma u.$$

(3)

Consider $W_s$ ($W_u$ can be obtained in an analogous manner). There is a probability $\pi_s(\cdot)$ that a skilled agent meets another skilled agent with a machine. In this case, with probability $x^2$ the machine that either agent carries matches the specialisation of the other. In such a meeting, with probability $\hat{\lambda}^2$ both agents produce and, assuming throughout symmetric Nash bargaining, the output $2u$ is equally divided; with probability $2\hat{\lambda}(1 - \hat{\lambda})$ only one agent produces and the output $u$ is equally divided. A skilled agent can also meet another skilled agent in a meeting where only one carries a machine consistent with the specialisation of the other. Such a meeting occurs with probability $2x(1 - x)$. In this case, there is a probability $\hat{\lambda}$ that the output $u$ is produced and equally divided. Summing the payoffs, we obtain $x\hat{\lambda}u$. A skilled agent can also meet an unskilled agent with probability $1 - \pi_s(\cdot)$. Following a similar reasoning, and taking into account that now the agents have different productivity, we obtain that the expected payoff of the skilled agent is $x(\hat{\lambda} + \gamma)u/2$.

### 3.1.2. Internal market

We now consider the resale market generated by the intermediation technology. Suppose that a positive measure $x\mu_{ID}(1 - \hat{\lambda})$ of unskilled agents have signed intermediated debt contracts and have the right to repossess failed machines. These agents access the information aggregated though the intermediation technology and can overcome frictions in the resale market. There are two ways in which this information can be used by these unskilled agents under the original debt contracts. First, unskilled agents can meet each other and exchange machines, in which case each agent has an expected payoff of $\gamma u$. Second, an unskilled agent can meet a skilled agent without machines, in which case her expected payoff is $\hat{\lambda}u/2$. This strategy is dominated by the first one as long as $\gamma > \hat{\lambda}/2$, that is the productivity gap between skilled and unskilled agents is not too large. This is also the condition in Lemma 1 that guarantees that only agents with machines participate in the decentralised market.9

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9 The reader may wonder whether there would be scope for a renegotiation of the initial debt contract such that an unskilled agent who has the right to repossess the machine leaves the machine with the skilled agent who has already tried to produce with it. As we explain in the Appendix (see ‘Redundancy of Dispersed Debt and Intermediated Equity’), even if renegotiation is feasible and there are no renegotiation costs, renegotiation will fail because of the decentralised nature of our economy. In a related vein, Shleifer and Vishny (1992) and Bolton and Scharfstein (1996) argue that an industry outsider (an unskilled agent) will face high agency costs in hiring the current bankrupt producer for continuing to run the activity.

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3.2. Contracts

When two agents meet in the credit market at date 1 and have to decide the type of contract to sign, they have four options: intermediated debt, intermediated equity, dispersed debt and dispersed equity. As anticipated in Section 3.1, dispersed debt (DD) and intermediated equity (ID) contracts are always weakly or strongly dominated. The intuition for this result is straightforward (see ‘Redundancy of Dispersed Debt and Intermediated Equity’ in the Appendix for a formalisation of these arguments). Consider first dispersed debt. Unlike dispersed equity, dispersed debt transfers control of a failed machine from a skilled agent to an unskilled one. Thus, dispersed debt entails a lower expected surplus from redeployment than dispersed equity because, being less productive, an unskilled agent expects a lower return than a skilled one from trading machines in the resale market.

Consider next intermediated equity. Although this contract gives unskilled agents access to the intermediation technology, de facto it is equivalent to dispersed equity. Since unskilled agents only benefit from information if they repossess machines at date 2, the information released through the intermediation technology would be useless for equity holders who do not participate in the exchange of machines at the redeployment stage. Indeed, if we allowed for an even arbitrarily small cost for writing intermediated contracts, dispersed equity would strictly dominate intermediated equity.

3.3. Credit Market

We now analyse the credit market and the choice between intermediated debt and dispersed equity at date 1. Denote by $V_s$ ($V_u$) the value function of a skilled (unskilled) agent at the beginning of date 1 net of endowments of final good. We have

$$V_u = V_o + \frac{x}{2} \max(V_s^{ID} + V_u^{ID} - V_o, V_s^{DE} + V_u^{DE} - V_o),$$

$$V_s = \frac{x}{2} \max(V_s^{ID} + V_u^{ID} - V_o, V_s^{DE} + V_u^{DE} - V_o),$$

where $V_u^{ID}$ ($V_s^{ID}$) is the value function of an unskilled (skilled) agent under an intermediated debt contract, $V_u^{DE}$ ($V_s^{DE}$) is the value function of an unskilled (skilled) agent under a dispersed equity contract, and $V_o$ is the value of the outside option of an unskilled agent.

The intuition is as follows. The expected payoff of an unskilled agent equals the probability that she keeps her machine at date 1, in which case she exercises her outside option and obtains $V_o$, plus the probability that she meets a skilled agent who can produce with her machine times the expected net payoff from exchanging with her. In turn, the latter equals her outside option $V_o$ plus half the maximum between the surplus associated with a debt contract and that associated with an equity contract. The outside option of an unskilled agent is

$$V_o = \gamma' U + (1 - \gamma') W_u.$$
At date 2, the unskilled agent can produce with her machine. With probability \(\gamma'\) she succeeds and obtains \(U\) while with probability \(1 - \gamma'\) she fails and resells the machine with an expected return of \(W_u\).

Consider now the value function \(V_{ID}^{u}\) of an unskilled agent under an intermediated debt contract. The non-trivial case occurs when the pair of matched agents believe that a positive measure of matched agents sign intermediated debt contracts and make information available, i.e. believe that the internal resale market is not empty. In Proposition 1, we characterise a region of the parameter space where indeed a positive measure of agents may sign intermediated debt contracts. In this case,

\[
V_{ID}^{u} = \lambda u_{ID} + (1 - \lambda)\gamma u. \tag{7}
\]

With probability \(\lambda\) production is successful and the unskilled agent receives a repayment \(u_{ID}\) at date 2. With probability \(1 - \lambda\) production fails and the unskilled agent recovers the machine and resells it using the information obtained through the intermediation technology, with an expected payoff of \(\gamma u\).

Consider next the value function \(V_{DE}^{u}\) of an unskilled agent under the equity contract. This is \(V_{DE}^{u} = u_{DE}\) because the unskilled agent receives an upfront payment of \(u_{DE}\).

We are implicitly assuming that the output \(U\) and endowment \(\omega\) never constrain \(u_{ID}\) and \(u_{DE}\). Similar reasoning leads to the value functions \(V_{ID}^{s}\) and \(V_{DE}^{s}\) of a skilled agent, i.e.

\[
V_{ID}^{s} = \lambda(U - u_{ID}), \tag{8}
\]
\[
V_{DE}^{s} = \lambda U + (1 - \lambda)W_s - u_{DE}. \tag{9}
\]

Under the following conditions unskilled agents prefer meeting skilled ones in the credit market.

**Lemma 2.** If \(\gamma' > \gamma/2\) and \(\lambda - \gamma > \gamma - \gamma'\), at date 1 an unskilled agent will always prefer meeting a skilled one than meeting another unskilled agent.

**Proof.** See the Appendix.

Unskilled agents have the incentive to transfer machines to skilled ones in the credit market if the productivity gap between skilled and unskilled agents \(\lambda - \gamma\) exceeds the threshold \(\gamma - \gamma'\).

### 3.4. Equilibrium Characterisation

Figure 1 summarises the activity in the credit market and in the resale market. Let \(M\) denote the set of date 1 meetings between unskilled and skilled agents in the credit market.

\[\begin{align*}
u_{DE} &= \frac{V_0 + \lambda U + (1 - \lambda)W_s}{2}, \\
u_{ID} &= \frac{V_0 + \lambda U - (1 - \lambda)\gamma u}{2\lambda}.
\end{align*}\]

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market. Consider a generic point \( i \) in this set and let \( A_s \times A_u \) be the profile of actions where \( A_s \) indicates the decision of the skilled agent and \( A_u \) indicates the decision of the unskilled one. We have \( A_s = A_u = \{ ID, DE \} \). Now, define \( C(i, a_s, a_u, v) \) as the final outcome of the \( i \)th meeting, where the skilled agent chooses \( a_s \), the unskilled agent chooses \( a_u \) and the distribution of contracts in the economy is \( v = (m_{ID}, m_{DE}) \), with \( m_{ID} + m_{DE} = 1 \). More precisely,

\[
C : M \times A_s \times A_u \times [0, 1] \rightarrow \{ ID, DE, N \}
\]

(10)

where, for all \( i \),

\[
c(i, a_s, a_u, v) = \begin{cases} 
  a_s & \text{if } a_s = a_u \\
  N & \text{if } a_s \neq a_u.
\end{cases}
\]

(11)

Whenever there is agreement on the contract, it is implemented. Otherwise, no contract \( (N) \) is signed. Since agents’ objective is to maximise surplus, in equilibrium agents never disagree.

**Definition 1.** A Nash equilibrium is a pair \((C, v)\) such that:

(i) In any meeting \( i \in M \), agents’ decision \( c(i, a_s, a_u, v) \) maximises surplus.

(ii) The aggregation of agents’ decisions across meetings generates a distribution of contracts \( v \).

Proposition 1 presents the main result of the article.

**Proposition 1.** Suppose that an unskilled and a skilled agent meet at date 1. Then, they will sign an intermediated debt contract if and only if
\[ \frac{\gamma}{x} > \pi_s(m_{DE})\lambda + [1 - \pi_s(m_{DE})]\frac{\lambda + \gamma}{2} \]  

(12)

and they believe that a positive measure of agents also sign an intermediated debt contract. Otherwise, the two agents will sign a dispersed equity contract.

Using the expression in (1) to substitute for \( \pi_s(m_{DE}) \), one of the following cases is realised:

(i) If \( x > 2\gamma/(\lambda + \gamma) \), there is a unique equilibrium in which only dispersed equity contracts are used.

(ii) If \( 2\gamma/(\lambda + \gamma) + (\lambda - \gamma)\pi_s(1) < x \leq 2\gamma/\lambda + \gamma \), there is an equilibrium in which only intermediated debt contracts are used, an equilibrium in which only dispersed equity contracts are used, and a mixed equilibrium in which some agents use dispersed equity contracts and others use intermediated debt contracts.

(iii) If \( x \leq 2\gamma/(\lambda + \gamma) + (\lambda - \gamma)\pi_s(1) \), there is an equilibrium in which only intermediated debt contracts are used and another equilibrium in which only dispersed equity contracts are used. The equilibrium with dispersed equity does not constitute a trembling-hand perfect Nash equilibrium.

**Proof.** See the Appendix.

The intuition behind constraint (12) is as follows. The intermediation technology acts as an information aggregator, solving trade frictions in the resale market. By contrast, the decentralised market is affected by trade frictions and, hence, allows for less successful matches than the internal market. However, the role of intermediaries as information aggregators hinges on debt contracts which provide lenders (the unskilled agents) with the incentive to share information. Since under debt contracts unskilled agents repossess machines in the event of failure, at the redeployment stage machines are reallocated without frictions across unskilled agents, who are less productive than skilled ones. In the decentralised market, instead, second-hand users comprise both skilled and unskilled agents. All in all, intermediation arises when the degree of trade frictions is sufficiently high (\( x \) is sufficiently low) and the average productivity of users in the internal resale market (\( \gamma \)) is not too low relative to the average productivity in the decentralised market – the right-hand side of constraint (12).

The intuition for the second part of the Proposition is as follows. As more agents choose dispersed equity (\( m_{DE} \) rises), the average quality of matches in the decentralised market increases. In fact, more skilled agents retain machines after failing and access the decentralised resale market (\( \pi_s(\cdot) \) increases). If the degree of trade frictions is low enough (case (i)), even at the minimum average quality of the decentralised market, the return from this market will exceed that from the internal market and only dispersed equity will be used. If the degree of frictions is high enough (case (iii)), an equilibrium with only intermediated debt and an equilibrium with only dispersed equity will coexist. In this region, matched agents will obtain a higher expected return from an equilibrium with only debt. Moreover, the equilibrium with only equity will not survive if agents are sure that a positive measure of agents use the internal market, as it occurs when we adopt a trembling-hand refinement of the Nash equilibrium. Finally, in
an intermediate region of $x$ (case (ii)), an equilibrium with only debt, an equilibrium with only equity, and a mixed equilibrium will coexist.

To conclude, it is worth reminding the reader that we have not allowed for a cost for writing intermediated contracts. If we allowed for such a cost of intermediation, dispersed equity would dominate intermediated debt in a broader region of the parameter space.

4. Extensions

4.1. Intermediation in the Credit Market

We now analyse how the matchmaking role of intermediation in the credit market affects its role in asset redeployment. In this Section, we distinguish between the degree of frictions in the credit market $x_c$ and the degree of frictions in the resale market $x_r$. We then interpret a higher value of $x_c$ as better matchmaking in the credit market and carry out an exercise of comparative statics on inequality (12) with respect to $x_c$. Since we are only exploring changes of trade frictions in the credit market, we keep $x_r$ fixed.

Lower frictions in the credit market increase the average quality of matches in the decentralised resale market: the derivative of the right-hand side of inequality (12) with respect to $x_c$ is positive. In fact, when matches are easier to form in the credit market, the number of skilled agents who participate in production and access the resale market increases whereas the number of unskilled agents who access the resale market drop. Therefore, an improvement of intermediation in the credit market enhances the quality of the decentralised resale market, rendering it relatively more appealing. This result appears interesting but it should be interpreted with caution. In fact, in Section 4.2 we show that it may no longer hold once we account for liquidity effects.

4.2. Market Liquidity

We now investigate the role of the liquidity of the decentralised resale market, meant as the ratio of agents with machines over the total number of agents. Our objective is two-fold. First, we check the robustness of the results. For example, as anticipated in Section 3.1.1, we want to verify whether the results carry through in an extended environment where the measure of unskilled agents in the decentralised market depends on the distribution of contracts. Second, we analyse further the impact of the matchmaking role of intermediation in the credit market on asset redeployment when we allow for liquidity effects.

From Lemma 1 we know that agents with machines prefer meeting other agents with machines. In order to investigate the role of liquidity, we allow agents who can use failed machines, including those without machines, to participate in the resale market. In particular, we assume that with probability $\phi$ an agent without a machine cannot be distinguished as such in the decentralised market (for $\phi = 0$ the analysis collapses to the basic case). This implies that unskilled agents who signed equity (debt) contracts and were paid upfront (were repaid) may participate in the decentralised resale market. Moreover, skilled agents who were unmatched in the credit market and unsuccessful skilled agents who signed intermediated debt contracts may also participate in
this market. Note instead that skilled agents who were successful in production do not participate in the decentralised market because agents can produce only once at most.

As in the basic framework, intermediated equity and dispersed debt are not used. Let $W^m_u (W^m_s)$ be the value function of an unskilled agent with (without) a machine and $W^m_s (W^m_u)$ be the value function of a skilled agent with (without) a machine in the decentralised resale market. Moreover, let $\pi^m_u (\pi^m_s)$ be the probability of meeting an unskilled agent with (without) a machine and $\pi^m_s (\pi^m_u)$ be the probability of meeting a skilled agent with (without) a machine in the decentralised market. We have

$$W^m_u = \pi^m_s (\gamma) x_\gamma u + \pi^m_u (\gamma) x_\gamma \frac{\lambda + \gamma}{2} u + \pi^m_s (\gamma) x_\gamma \frac{\lambda}{2} u + \pi^m_u (\gamma) x_\gamma \frac{\gamma}{2} u,$$

$$W^m_s = \pi^m_s (\gamma) x_\gamma \frac{\lambda}{2} u + \pi^m_u (\gamma) x_\gamma \frac{\gamma}{2} u,$$

$$W^m_u = \pi^m_s (\gamma) x_\gamma \frac{\gamma}{2} u + \pi^m_u (\gamma) x_\gamma \frac{\gamma}{2} u,$$

where

$$\pi^m_s (\cdot) = \frac{\varphi}{\varphi + \chi (1 - \lambda) m_{DE} + (1 - \chi) (1 - \gamma)},$$

$$\pi^m_u (\cdot) = \frac{(1 - \chi)(1 - \gamma)}{\varphi + \chi (1 - \lambda) m_{DE} + (1 - \chi) (1 - \gamma)},$$

$$\pi^m_s (\cdot) = \frac{\varphi \{1 - \chi [\lambda + (1 - \lambda) m_{DE}]\}}{\varphi + \chi (1 - \lambda) m_{DE} + (1 - \chi) (1 - \gamma)},$$

$$\pi^m_u (\cdot) = \frac{\varphi \chi [\lambda + (1 - \lambda) m_{DE}]}{\varphi + \chi (1 - \lambda) m_{DE} + (1 - \chi) (1 - \gamma)}. $$

Consider $W^m_u (W^m_s, W^m_u$, and $W^m_s$ can be obtained in an analogous manner). With probability $\pi^m_s (\cdot) x_\gamma$, an unskilled agent without machines meets a skilled agent whose machine she likes. In this case, they equally split the surplus $\gamma u$. She can also meet an unskilled agent whose machine she likes, which happens with probability $\pi^m_u (\cdot)$. Similarly, they equally split the surplus $\gamma u$. Finally, if she meets another unskilled agent without machines, no transaction occurs.

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In this extension, agents’ value functions at date 1 change because agents without machines have also the opportunity to trade in the decentralised resale market. It is easy to show that two agents matched in the credit market will expect \( V_{ID}^s + V_{ID}^u > V_{DE}^s + V_{DE}^u \) and, hence, will sign an intermediate debt contract if and only if

\[
\frac{\gamma}{x_c} > \pi_s^m(\cdot)\left(\frac{\lambda - \phi}{2} - \gamma\right) + \pi_u^m(\cdot)\left(\frac{\lambda + \gamma}{2} - \phi - \frac{\lambda - \gamma}{2}\right) + \pi_s^m(\cdot)\frac{\lambda}{2} + \pi_u^m(\cdot)\frac{\gamma}{2} \tag{21}
\]

and they believe that a positive number of agents also sign intermediate debt contracts. Inequality (21) implies that the expected return from using the decentralised resale market is lower than in the basic framework (i.e. the right-hand side of (21) is lower than the right-hand side of (12)). This occurs because now agents expect to engage in matches with one or no machines. These matches are inefficient, generating at most a surplus \( k_u \).

Inspection of (17)–(21) reveals that changes in \( m_{DE} \) or in \( x_c \) have now three effects in the decentralised market. First, as in the basic framework, they affect the average quality (composition skilled/unskilled) of the group of agents with machines. Second, they affect the average quality (composition skilled/unskilled) of the group of agents without machines. Third, they affect the liquidity of the market given by the ratio (agents with machines)/(agents without machines). It is easy to show that the derivative of the right-hand side of (21) with respect to \( m_{DE} \) is always positive and there is a region of the parameter space where a proposition analogous to Proposition 1 holds, except for changes in the thresholds in (i), (ii), and (iii). Thus, our main result carries through. More interestingly, better matchmaking in the credit market can enhance the role of intermediaries as internal markets. In fact, as in the previous analysis, an increase of \( x_c \) improves the average quality of the group of agents with machines. However, an increase of \( x_c \) also increases the share of agents without machines, reducing the liquidity of the market. Finally, an increase of \( x_c \) reduces the average quality of the group of agents without machines. The latter two effects tend to depress the expected return from the decentralised market and render the internal market relatively more appealing. It can be shown that a non-empty subset of the parameter space exists where the latter two effects dominate. Therefore, when market liquidity plays a role, both the ability of intermediaries to aggregate information and to match agents in the credit market can enhance their role as internal markets.

5. Discussion

5.1. Empirical Predictions

The analysis yields empirical implications for the structure – bank-based or market-based – of the financial system. Proposition 1 reveals that in our model-economy two factors determine the financial structure: the degree of trade frictions in the asset resale market, as captured by the (inverse of the) parameter \( x_c \), and the productivity gap.

11 To save space, we do not report a formal proof (available upon request). A parameterisation under which the derivative of the right-hand side of (21) with respect to \( x_c \) is positive is for example \( \lambda = 0.8, \gamma = 0.5, \gamma = 0.3, x_c = 0.9, \phi = 0.2 \).
between skilled and unskilled agents, as captured by the difference \( \lambda - \gamma \). Consider trade frictions first. These can reflect both the efficiency of the resale market (higher efficiency, less trade frictions) and the specificity of the assets sold in this market (more specificity, more trade frictions). Therefore, the analysis predicts that countries and sectors with an inefficient asset market and scarce information on displaced assets show a strong presence of financial intermediaries.\(^{12}\) In fact, in these contexts the role of financial intermediaries as information aggregators is particularly valuable at the redeployment stage. Analogously, the analysis predicts that countries and sectors where assets are more specific rely more on financial intermediaries. Consider next the productivity gap \( \lambda - \gamma \). The analysis implies that countries and sectors where workers’ (or entrepreneurs’) education level is more heterogeneous and, hence, the productivity gap between skilled and unskilled workers is larger show a weaker presence of financial intermediaries. In fact, in these contexts the cost associated with intermediated debt, i.e. the redeployment of assets from high to low productivity users, should be higher. Besides yielding predictions for the financial structure, the article also implies that, for a given degree of trade frictions, the share of skilled agents among the unemployed is higher in bank-based financial systems than in market-based ones. This occurs because under intermediated debt contracts skilled agents are not active in reusing assets of failed firms, while under dispersed equity contracts they access the decentralised resale market.

To the best of our knowledge, these implications have not been investigated empirically. However, there is a growing body of literature that relates structural features of the financial system, such as the relative importance of banks and securities markets, to variables such as wealth distribution; see papers in law and finance, e.g. Perotti and von Thadden (2006) and Pagano and Volpin (2005). Drawing on the implications of this article, one could extend this literature and, for example, test whether the average level and the dispersion of education across workers help to predict the importance of financial intermediaries. Moreover, focusing on the experience of selected countries, one could explore whether the expansion of the market for corporate assets that recently occurred in Japan\(^{13}\) can help to rationalise changes in the financial system of that country. Our analysis predicts that such an expansion should render the role of Japanese main banks less essential and favour the growth of securities markets, a phenomenon that has indeed been observed in the last decade or so.

5.2. Debt and Asset Redeployment

In our economy, debt offers benefits and costs for asset redeployment. On the one hand, debt is crucial for financial intermediaries to take an active role at the redeployment stage. In fact, debt attributes the ownership of machines to lenders after default, providing them with the incentive to collect information on assets. The idea that debt provides incentives for gathering information on the asset second use has

\(^{12}\) Ramey and Shapiro (2001) discuss institutional failures that hinder the diffusion of information on displaced assets, rendering the asset market inefficient (such as costly advertising or poor institutions and instruments for inspection and negotiation).

\(^{13}\) For a discussion of this trend, see, e.g., Kikutani et al. (2006).
been extensively explored by the literature (Habib and Johnsen, 1999; Rajan and Winton, 1995). Habib and Johnsen (1999) maintain that ‘both parties – borrower and lender – gain from secured debt’s ability to motivate the redeployer to identify a higher-order alternative use’ and, with reference to the aircraft industry, ‘secured debt was and is instrumental in allowing aircraft and other asset redeployers to capture the returns to their ex ante investments in redeployment’.14

In our economy, however, debt also features a cost at the redeployment stage. In fact, under debt contracts skilled agents return assets to lenders after defaulting and do not participate in the resale market. In turn, this implies that assets are reallocated across unskilled (second-best) users. This feature of debt has also been explored by the literature. Shleifer and Vishny (1992), for example, show that the extensive use of debt in a sector can exacerbate the positive correlation among firms’ financial status and decrease the liquidity of their assets.

5.3. Contractual Structure

Our framework is too stylised to capture the real world richness of financial contracts. In the model, the terms ‘debt’ and ‘equity’ are meant to capture which party has the residual right to control assets. Under an equity contract a skilled agent acquires the ownership of a machine while under a debt contract an unskilled agent retains its ownership. Note that debt and equity could stand for a whole range of debt-like and equity-like contracts. For example, though most airlines prefer financing themselves with standard secured debt (Habib and Johnsen, 1999), aircraft finance companies make extensive use of financial leases that, according to Habib and Johnsen (1999, p. 703), ‘[…] are virtually equivalent to secured debt except for special tax treatment […]’15

A feature of our equilibrium is the complete specialisation of intermediated finance in debt contracts and dispersed finance in equity contracts. This polarisation captures the fact that the contracts between firms and financial intermediaries (e.g., banks) generally consist of debt while dispersed finance comprises both non-contingent bonds and equity. Moreover, when firms borrow from banks and issue bonds at the same time, banks are almost universally senior to bond-holders. While the seniority of banks has been rationalised in several ways, this is consistent with our idea of financial intermediaries as internal markets for assets and with the role that lenders’ right to repossess assets plays for this function. Clearly, all these arguments should be treated with great caution. For example, venture capital partnerships constitute examples of equity-based financial intermediation. Yet, it is perhaps interesting to observe that venture capital partnerships often finance enterprises, such as new technologies, with assets that are specific to the innovative firm. For these enterprises an efficient technology evaluation

14 These papers motivate why debt gives good incentives for the acquisition of information on the asset second use. However, they do not imply that in general only debt is information sensitive. Indeed, there is an important literature on the information sensitivity of equity.

15 The aircraft industry is considered a sector in which assets are highly specific. Therefore, the ample use of debt and debt-like contracts by aircraft finance companies (Habib and Johnsen, 1999) appears to fit the predictions of our analysis.
is very important, while the evaluation of the resale opportunities of the assets may be less important because the assets are intrinsically hard to resell.

5.4. Specialised Redeployers

Some types of dispersed investors can have intrinsic advantages in asset redeployment. For example, trade creditors can use the experience matured in the production of assets for their borrowers to identify suitable second hand users (Longhofer and Santos, 2003). This is consistent with our model. In fact, we propose a theory of the superior redeploying ability that, all else equal, financial intermediaries develop relative to dispersed financiers, but this does not rule out advantages specific to particular types of dispersed financiers. Therefore, a correct test of our theory could be performed by comparing banks with dispersed bond/equity-holders rather than with trade creditors.

5.5. Applications

The categories of ‘skilled’ and ‘unskilled’ agents that we have used throughout the analysis can be broadly interpreted. One could apply the model to a scenario in which financial intermediaries fund firms in related sectors or regions. Consider the following example. Assume that financial intermediaries fund firms in the automobile sector and in the sector that produces machine tools for producing cars. Suppose now that a negative shock hits the automobile sector. Using their knowledge of both sectors, intermediaries will be able to redeploy machine tools of distressed car manufacturers to the best second hand users in the industrial machinery sector. However, the extensive use of intermediated debt in the automobile sector will exclude most car manufacturers from the resale market for tool machines. Since car manufacturers are likely to have an intrinsic advantage over other firms in reusing machine tools, this will induce a loss (captured in the model by the productivity gap $\lambda - \gamma$).

6. Conclusion

We have constructed a model in which financial intermediaries act as internal markets for corporate assets. By aggregating information on firms in the credit market, intermediaries ease asset reallocation. However, the financial instrument that supports this role, debt, damages the average quality of second hand asset users. We have characterised conditions under which intermediation arises, showing that agents’ beliefs play a role in the selection of the financial structure. We have also analysed how intermediation between savers and producers at the investment stage relates to intermediation among firms at the restructuring stage. The model can be extended to explore the role of financial institutions in the process of aggregate restructuring. In particular, one could embed the analysis in an aggregate environment and investigate how different financial structures (intermediated versus dispersed ones) can affect the process of reallocation of productive factors. This constitutes the objective of our current research.
Appendix

Proof of Lemma 1. Denote by $\pi_s(\cdot)$ the probability of meeting a skilled agent with a machine. Consider first a skilled agent with a machine. If she chooses to meet an agent with a machine, she expects

$$\pi_s(\cdot)x \lambda u + \left[1 - \pi_s(\cdot)\right]x \frac{\lambda + \gamma}{2} u. \quad (22)$$

There is a probability $\pi_s(\cdot)$ that the agent is skilled. In this case, with probability $x^2$ there is a meeting in which the machine that either agent carries matches the specialisation of the other. In such a meeting, with probability $\lambda^2$ both agents produce and, assuming throughout symmetric Nash bargaining, the output $2u$ is equally divided; with probability $2\lambda(1-\lambda)$ only one agent produces and the output $u$ is equally divided. A skilled agent can also meet another skilled agent in a meeting where only one carries a machine consistent with the specialisation of the other. Such a meeting occurs with probability $2x(1-x)$. In this case, there is a probability $\lambda$ that the output $u$ is produced and equally divided. Summing the payoffs, we obtain

$$x^2 \left[\lambda^2 u + 2\lambda(1-\lambda) \frac{u}{2}\right] + 2x(1-x)\lambda \frac{u}{2} = x\lambda u. \quad (23)$$

A skilled agent can also meet an unskilled agent with probability $1 - \pi_s(\cdot)$. Following a similar reasoning, the expected payoff of the skilled agent is $x(\lambda + \gamma)u/2$.

Now denote the probability of meeting a skilled agent without a machine by $\pi_u(\cdot)$. If a skilled agent with a machine chooses to meet an agent without a machine, she expects

$$\pi_u(\cdot)x \lambda u + \left[1 - \pi_u(\cdot)\right]x \frac{\lambda + \gamma}{2} u. \quad (24)$$

Equation (22) is bigger than (24) for any value of $\pi_s(\cdot)$ and $\pi_u(\cdot)$.

Now consider an unskilled agent with a machine. If she chooses to meet another agent with a machine, she expects

$$\pi_s(\cdot)x \lambda u + \left[1 - \pi_s(\cdot)\right]x \frac{\lambda + \gamma}{2} u, \quad (25)$$

while, if she chooses to meet an agent without a machine, she expects

$$\pi_u(\cdot)x \lambda u + \left[1 - \pi_u(\cdot)\right]x \frac{\lambda + \gamma}{2} u. \quad (26)$$

If $\gamma > \lambda/2$, (25) is bigger than (26) for any value of $\pi_s(\cdot)$ and $\pi_u(\cdot)$.

A.1 Redundancy of Dispersed Debt and Intermediated Equity

Dispersed Debt: We show that, for any distribution of contracts, dispersed debt is dominated. Assume that a pair of agents decide to sign a dispersed debt contract. Since a success in production always yields $U$, regardless of the type of contract signed, we need to focus on the expected return after unsuccessful production. Under a debt contract the lender has the right to repossess the machine, in which case she expects $W_u$. First, consider the case in which dispersed equity has a higher expected payoff than intermediated debt, i.e. $W_i > \gamma u$. Inspection of the expressions for $W_i$ and $W_u$ reveals that $W_i$ is always higher than $W_u$, regardless of the values of $\pi_s$ and $\pi_u$. Therefore, the agents will not sign a dispersed debt contract. Next, consider the case in which intermediated debt has a higher expected payoff than dispersed equity. This implies $\gamma u > W_i$. Since $W_i > W_u$, we have $\gamma u > W_u$. Therefore, the agents will not sign a dispersed debt contract.

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Intermediated Equity. Under an equity contract an unskilled agent expects no positive return from making information available at date 1. In fact, at date 2 any information obtained through the intermediation technology is useless for her because she obtains no return from the redeployment of machines and she is inactive in the internal resale market. A fortiori, if we allowed for an even arbitrarily small cost (say cu) for transmitting information, under an equity contract an unskilled agent would expect a negative return from making information available. This reasoning implies that intermediated equity contracts do not lead to the aggregation of information and, hence, are de facto equivalent to dispersed equity contracts. Therefore, when we consider equity contracts, we can focus on dispersed equity. Indeed, dispersed equity would strictly dominate intermediated equity if we allowed for an exogenous cost for writing intermediated contracts.

We now show that, as observed in Section 3.2, even if feasible and costless, any renegotiation of the original debt contract would fail. Suppose that the debt contract is renegotiated and the unskilled agent leaves the failed machine with the skilled agent. Thereafter, the unskilled agent transmits to the skilled agent the information necessary to meet another skilled agent in a double-coincidence meeting. In principle, skilled agents could meet and exchange machines and, after producing, share the returns with the unskilled agents. However, we know that this is not feasible in a decentralised economy. In fact, first of all, after the original match is dissolved, an unskilled agent cannot identify her original partner among agents of the same type. Second, even if we allowed returns to be transferred to unskilled agents through the court, in a decentralised economy the outcome of a meeting is private information. Hence, skilled agents could always claim that production has failed. Since unskilled agents do not participate in the meeting where machines are resold, they would be unable to provide the court with evidence of this misreport. To sum up, no repayment to the unskilled agents can be made which is contingent on the occurrence of a double-coincidence meeting between two skilled agents. Therefore, no unskilled agent has the incentive to transmit information to her skilled partner and, expecting this, skilled and unskilled agents will not attempt a renegotiation of the debt contract.

Proof of Lemma 2. First, notice that the condition \( \gamma' > \gamma/2 \) implies that when two unskilled agents meet at date 1, they prefer exchanging machines when there is a double-coincidence of wants and keeping their machines in any other situation. In fact, if only one of the two agents likes the machine of the other the surplus from transferring this machine will be \( \gamma U + (2-\gamma) W_a \). The surplus from not exchanging machines will be \( \gamma'2U + 2(1-\gamma') W_a \), which will be strictly greater than \( \gamma U + (2-\gamma) W_a \) whenever \( (2\gamma'-\gamma)(U-W_a) > 0 \). The latter condition certainly holds if \( \gamma' > \gamma/2 \).

Now, consider the problem faced by an unskilled agent at the beginning of date 1. Since she can recognise agents with machines from agents without machines, she can choose between meeting a skilled agent and meeting an unskilled one. If she meets a skilled agent, her payoff is \( V_u \) while if she meets an unskilled agent her payoff is

\[
\Delta^2 [\gamma U + (1-\gamma)W_a] + (1-\Delta^2) V_o. \tag{27}
\]

Since \( \gamma' < \gamma \), \( V_o \) is necessarily smaller than \( \gamma U + (1-\gamma) W_a \). Therefore, a sufficient condition under which unskilled agents always prefer meeting skilled ones is

\[
V_u > \Delta [\gamma U + (1-\gamma)W_a] + (1-\Delta) V_o. \tag{28}
\]

The value \( V_u \) depends on the actual contract written by the agents and on the proportion of skilled agents with machines in the resale market (\( \pi_s \)). Fix a generic value for \( \pi_s \). By the definition of \( V_u \), we know that

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\[
V_u > (1 - x)V_o + x \left[ V_o + \frac{1}{2} (V_{DE}^u + V_{DE}^u) \right].
\]

(29)

In what follows we provide conditions such that

\[
V_o + \frac{1}{2} (V_{DE}^u + V_{DE}^u) > \gamma U + (1 - \gamma) W_u
\]

(30)

or, alternatively,

\[
V_o + \frac{1}{2} [(\lambda U + (1 - \lambda) W_r - V_o)] > \gamma U + (1 - \gamma) W_u.
\]

(31)

From the expressions for \(W_u\) and \(W_r\), we have \(W_r = W_o + [(\gamma - \gamma') xu]/2\). After some algebraic manipulation, we can rewrite the above inequality as

\[
\frac{1}{2} [(\lambda - \gamma) - (\gamma - \gamma')] (U - W_o) + (1 - \lambda) \frac{(\lambda - \gamma)xu}{2} > 0.
\]

(32)

Since \(U > W_o\), a sufficient condition for this inequality to hold is \(\lambda - \gamma > \gamma - \gamma'\).

Proof of Proposition 1. When agents believe that \(m_{DE} = 0\) and the internal resale market is empty, regardless of the contract signed, they expect to resell failed machines in the decentralised resale market. Thus, matched agents expect the same payoff under an intermediated debt contract as under a dispersed debt contract. Since dispersed equity dominates dispersed debt, no agent will sign an intermediated debt contract. All in all, this implies that there is always an equilibrium with only dispersed equity.

Observe now that the expected payoff from intermediated debt is higher than the expected payoff from dispersed equity as long as \(V_{ID}^u + V_{ID}^u > V_{DE}^u + V_{DE}^u\). Substituting the expressions of the value functions, we can rewrite this as \(\gamma U > W_o\) or, replacing \(W_o\), as (12). Now set \(m_{DE} = 0\) so that the expected payoff from the decentralised market is minimised. Inequality (12) becomes \(x \leq 2\gamma / (\lambda + \gamma)\): in this region of the parameter space, besides an equilibrium with only dispersed equity, there is always an equilibrium with only intermediated debt. If, instead, \(x > 2\gamma / (\lambda + \gamma)\) it is never a best reply to choose intermediated debt and the equilibrium with only dispersed equity is the unique equilibrium (case (ii)). Next, set \(m_{DE} = 1\) so that the expected payoff from the decentralised market is maximised. Inequality (12) becomes

\[
x < \frac{2\gamma}{(\lambda + \gamma) + (\lambda - \gamma) \pi_i(1)}.
\]

(33)

In this region of the parameter space, a pair of matched agents expect a lower payoff under an equilibrium with only dispersed equity than under an equilibrium with only intermediated debt. Hence, these are the only two equilibria and for matched agents the latter dominates the former (case (iii)). Finally, consider the case

\[
\frac{2\gamma}{(\lambda + \gamma) + (\lambda - \gamma) \pi_i(1)} \leq x \leq \frac{2\gamma}{\lambda + \gamma}.
\]

(34)

In this region of the parameter space, because the right hand side of (12) is a continuous and increasing function of \(m_{DE}^i\) there is a value \(m_{DE}^i\) such that agents are indifferent between signing an intermediated debt contract and signing a dispersed equity contract. For this value of \(m_{DE}^i\), there exists a mixed equilibrium in which both dispersed equity and intermediated debt contracts circulate. \(m_{DE}^i\) solves the equation

\[
x \left\{ \pi_i(m_{DE}) \lambda + \left[ 1 - \pi_i(m_{DE}) \right] \frac{(\lambda + \gamma)}{2} \right\} = \gamma.
\]

(35)

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To conclude the proof, we show that in the region defined by (33) the equilibrium with only equity is not robust to the refinement of Nash equilibrium known as trembling-hand perfect Nash equilibrium. Consider the strategy profile where, for any meeting \( i \) in the set \( M \), a dispersed equity contract is signed. Now assume that there is a probability \( e_i^D(e_i^N) > 0 \) that the agents make a mistake and sign an intermediate debt contract (do not sign any contract). Clearly, this implies that, for all \( e_i^D(e_i^N) > 0 \), there will be a positive number of agents in the internal resale market. Hence, for all \( e_i^D(e_i^N) > 0 \), it is a best reply to choose an intermediate debt contract. In other words, it is not possible to construct a sequence of totally mixed strategies such that signing a dispersed equity contract is a best reply to the elements of this sequence. We can then use Proposition 8. F. 1 in Mass-Colell et al. (1995, p. 259) to conclude that the strategy profile where all agents sign dispersed equity is not a trembling-hand perfect Nash equilibrium.

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