14

Mergers and Acquisitions, and the Equilibrium Determination of Asset Values

14.1 Introduction

Capital reallocations across firms serve several purposes. First, and foremost, they move assets from low-productivity uses to higher-productivity ones. There is indeed much empirical evidence in support of the view that capital transactions reflect capital productivity differences between the seller and the acquirer (see, for example, Maksimovic and Phillips 2001; Schoar 2002). Second, and as stressed in several chapters in this book,[1] asset sales may be driven by managerial discipline and concerns surrounding the creation of pledgeable income: management is forced to part with the assets in bankruptcy or when the firm is short of liquidity.

Capital reallocations across firms occur either wholesale, through mergers and acquisitions (M&As) in which the transfer of financial claims brings along that of the underlying assets, or piecewise, through the sale of property, plant, and equipment (the latter transactions tend to be smaller, but dominate M&As because they are also more frequent). Eisfeldt and Rampini's (2003) empirical work shows that such capital reallocations are procyclical even though the gains to capital reallocation, as measured by the cross-sectional deviation of capital productivity, are countercyclical.

This chapter analyzes demand and supply in the market for corporate assets. It studies the determinants of secondary market asset prices and thereby the two-way interaction between *ex ante* borrowing capacity and *ex post* transaction prices. The possibility for the lenders to seize the borrowers' assets in the case of distress or merely to resell these assets in less strenuous times enhances the latter's borrowing capacity. Thus, an important step in credit analysis is the assessment of the value of collateral. Lenders must figure out how much they will recoup from the sale of secured assets (or, occasionally, from managing the assets themselves). Shareholders must similarly extrapolate the return that they will obtain by letting the firm be partly or fully acquired by another corporate entity.

A proper analysis of the return attached to financial claims on the firm must reflect the observation that the relevant collateral value for the lenders is not the average value of the asset over all possible states of nature; for, collateral is seized in the case of distress and so the relevant value of the assets for the lenders is their resale value in bad states of nature.[2] This resale value may differ from the average value because of a correlation between the conditions that gave rise to distress and the external demand for the assets.[3] When distress is caused by industry-wide conditions rather than by firm-idiosyncratic shocks, the assets are unlikely to yield much profit to potential buyers and therefore to fetch a high price. Relatedly, the lenders ought to anticipate the business cycle. A secured loan with maturity of two years may generate a seizure of the

1. See, in particular, the material on collateral pledging in Chapter 3, on liquidity in Chapter 5, and on contingent rights in Chapter 10.

2. Similarly, from the point of view of the borrower's incentives, the relevant value of the assets is their value for the borrower in good states of nature.

3. Another reason why the resale value may differ from the average value is that the borrower may privately receive signals that indicate the imminence of distress. The borrower then has low incentives to maintain assets in good condition as there is a high probability that the assets will be transferred to the lenders. Loan agreements generally impose covenants on the maintenance of secured assets, but they cannot fully prevent some amount of asset depletion just before distress. Asset values may therefore be low in the case of distress for this reason. See Exercise 4.1 for an analysis of credit rationing when assets can be depleted just before distress.

collateralized assets two years from now. The value of the assets as collateral thus depends on the state of the economy two years from now. The stakes involved in properly forecasting asset values can be high. For example, London commercial real estate rental rates fell by 40% between 1990 and 1992, and similar (although more moderate) shocks have occurred in most developed countries. Banks which have tried to seize real estate of companies in distress have found that they were getting low collateral values.

This chapter discusses two innovative contributions by Shleifer and Vishny (1992) and Kiyotaki and Moore (1997), and follow-up work, that go beyond these simple observations by explicitly modeling the feedback between collateral value and investment. Those are equilibrium models: investment depends on collateral value (as in Chapter 4), but in turn a firm's collateral value depends on the level of investment and financial choices by other firms (the firm's environment).

In Shleifer and Vishny (1992), studied in Section 14.2, the relevant environment is the *industry*. Assets are fairly specialized and have value only to other firms in the industry, which have invested in knowledge and are able to operate them. The value of collateral, and thus a firm's borrowing capacity, then hinges on whether there will be other firms in the industry standing by to purchase the assets in the case of distress.[4] In turn, these other firms' value of collateral and incentive to invest depend on whether the firm under consideration is investing. Shleifer and Vishny thus demonstrate the existence of a strategic complementarity[5] between the firms' investments. Consequently, a firm's very existence may enhance the value of other firms' assets and raise these firms' incentives to be present in the industry.

This leads us to a broader discussion of (a) the possibility that firms build, perhaps excessive, "financial muscle," an issue that does not arise in the basic model; (b) other investment design choices by firms that may later enter M&A deals. On the latter issue, it is shown that, for the same reasons that investment decisions are strategic complements, those relative to asset riskiness are strategic substitutes.[6] Intuitively, a firm's incentive to pursue a safe policy increases if profitable acquisitions brought about by the risky choices made by others are in sight; and conversely, the presence of potential buyers alleviates the cost of distress and raises the payoff to risky strategy choices.

In Kiyotaki and Moore's (1997) paper, covered in Section 14.3, the relevant environment is the *economy as a whole*. Assets are perfectly redeployable, that is, nonspecialized, in contrast with Shleifer and Vishny's contribution. To understand the main points, it is useful to make a distinction between *the productive value of assets and their value as collateral*. As discussed above, the assets' value as collateral depends on the state of the economy when the loan matures. Hence, the firm's current borrowing capacity and investment are contingent on the value of the secured assets in the future. Conversely, an increase in the economy-wide level of investment raises the demand for the assets and therefore their price, if the assets are used in the production process. Because high asset prices allow high investments and high investments raise asset prices, there is scope for multiple equilibria (as in Shleifer and Vishny) and cycles. Finally, the section relaxes the Kiyotaki–Moore assumption that productive assets are the only store of value. Their analysis is generalized through the introduction of an alternative store of value (such as Treasury bonds); when in sufficient quantity, the latter eliminates the self-fulfilling prophecies just described.

Our rendering of these contributions takes substantial liberties with the original models.[7] We hope that their spirit has been preserved in the process.

4. Schleifer and Vishny motivate their analysis by noting that failing airlines in the mid 1980s sold their gates, routes, and airplanes at much higher prices than those who failed in the late 1980s, because few airlines wanted to purchase the facilities in the difficult environment of the late 1980s.

5. Two decision variables are strategic complements if a player's choice of a higher level for his decision variable induces an increase in the other player's decision variable (the "reaction curves" are upward sloping).

6. Two decision variables are strategic substitutes if a player's choice of a higher level for his decision variable incentivizes the other player to reduce the level of his own decision variable (the "reaction curves" are downward sloping).

7. For one thing, the modeling is different. For example, we use the standard credit rationing model (in the version developed in Chapter 3), while both contributions assume that profits are not verifiable.

14.2 Valuing Specialized Assets

14.2.1 A Roadmap on Vulture–Carrion Models

Section 4.3.1 on redeployability took the resale price P of assets in distress as given. In practice, and as was discussed in the introduction to the chapter, the resale price depends on whether there are buyers standing by ready to repurchase the assets. This in turn depends on whether other firms that would be potential candidates to purchase the assets (i) have indeed accumulated the knowledge necessary to manage the assets and (ii) have the "financial muscle" to buy the assets.

This section thus focuses on assets (such as equipment, intellectual property, or commercial real estate properties not easily convertible into residential real estate) that have liquidation value only if they are acquired by another firm. What makes such assets interesting is that potential buyers may themselves be financially constrained. The acquisition price then depends on the acquirer's financial structure.

To fix ideas, suppose that firm 1 is in distress and, for the moment, firm 2 is the only possible buyer of its assets. There is scope for an acquisition of firm 1's assets by firm 2 as long as a sellout benefits firm 1's investors. It may be that firm 1's management demonstrated insufficient expertise in running these assets, or else that the activity in which they are employed encountered an adverse shock (a metaphor for the latter situation is that of an airline company, firm 1, owning planes and operating a shuttle between two cities newly connected by a high-speed train).

A negotiation then ensues between the two firms. Firm 2's management can tap its investors and raise funds to acquire firm 1's assets. Investors, though, will not want to bring more funds than what they will receive from their firm's expansion; using a now familiar terminology, they will not accept contributing more than the increase in pledgeable income[8] brought about by the acquisition (they may pay less if firm 2 has power in the negotiation and bargains the price down below the value to investors); put differently, firm 2's investors are never willing to pay the full value of the acquired assets because some of the benefits from acquisitions go to firm 2's insiders:[9] the assets' sale consequently occurs at a discount and leaves a surplus to the acquiring management. This in turn implies that inefficiencies may result: firm 1's *ex ante* investment choices may not be optimal from the point of view of the industry, since they do not internalize the surplus that firm 1 will leave on the table when in distress (see Section 14.2.3).

When firm 2 is the sole acquirer, as in the next subsection, this is the end of the story. Firm 2's management has no incentive to hoard reserves, i.e., build financial muscle, in order to be able to purchase firm 1's assets if the latter enters distress. Its monopsony power secures its ability to acquire the assets, and building financial muscle can only weaken its bargaining position.

Contrast this with the case considered in Section 14.2.5, of multiple potential buyers (firms $2, 3, \ldots$) competing to acquire firm 1's assets. If those buyers content themselves with returning to the capital market for more funds when the acquisition opportunity arises, the resale price, by the same logic, will not exceed the increase in pledgeable income brought about by the acquisition. However, because the acquirers' management derives a surplus from the acquisition and because being able to bid more than the pledgeable value of the acquired assets helps buying them, firms $2, 3, \ldots$ have an incentive to hoard cash in order to outbid each other. This build-up of financial muscle and the resulting bidding raises the acquisition price; it is, however, wasteful from the point of view of the potential acquirers, who could have employed the hoarded cash for other ends (like their own investment).

We will assume throughout this section that the acquiring firm's investors are well-informed as to the value of the acquisition target and that they exert proper governance. A new set of issues arises when their management has superior information about the acquisition's impact on securities' values. Whether management is able to cajole investors into potentially costly acquisitions then depends on the factors that were studied in Section 10.3.

8. ρ_0 per unit of investment in the notation of this book.

9. $\rho_1 - \rho_0$ per unit of investment in the notation of this book.

14.2.2 Industry-Wide Shocks and Distress Sales: The Shleifer–Vishny Model

This subsection, building on Shleifer and Vishny (1992), endogenizes the resale price in the two-firm, continuous-investment version of the model of Section 4.3.1. Let us restate the key ingredients of this model.

Investment and redeployability. There are two firms in the industry. The "industry" is here defined as a group of symmetric firms using the same equipment/assets. For simplicity, we assume that the two firms do not compete in the same product market (see below for a discussion of this hypothesis). Each firm is run by an entrepreneur, who has initial cash A_i.

Initially, firm i invests I_i, and therefore borrows $I_i - A_i$ from some *ex ante* competitive lender ("lender i"). Then, there is a costless "learning period." At the end of the learning period, each firm learns whether it is "productive" (which has probability x), or "unproductive," i.e., "in distress" (which has probability $1 - x$). Being unproductive means that the firm will always be unsuccessful regardless of whether the entrepreneur behaves. For example, there may be no demand for the firm's output. Its assets are then useless if left in place. A productive firm is described as in the variable-investment model of Section 3.4 (which, incidentally, corresponds to the case $x = 1$).

If both firms are productive, each manages its initial investment. Firm i's profit is either 0 or RI_i. Borrower i's private benefit is 0 (if she behaves) or BI_i (if she does not). The associated probabilities of success are p_H and p_L, respectively.

If firm j is in distress, it sells its assets, which now have no internal use.[10] We assume that potential buyers outside the industry do not have the knowledge to operate these assets. Only firm i (if it itself is not in distress) can buy it. There has been no initial contract that would specify the transfer price in the case of distress. Rather, this transfer price is determined through bargaining after distress occurs. We will later determine the per-unit transfer price P. The entrepreneur in firm i then manages $(I_1 + I_2)$ units of assets, and obtains private benefit 0 (if she behaves) or $B(I_1 + I_2)$ (if she does not). Similarly, the income is either 0 or $R(I_1 + I_2)$. Probabilities of success are p_H if the entrepreneur behaves and p_L if she does not. Firm i has just grown bigger through the acquisition.

As usual, we assume that in the absence of adverse shock ($x = 1$), projects are viable only if the borrower behaves,

$$\rho_1 \equiv p_H R > 1 > p_L R + B, \tag{14.1}$$

and we make a further assumption guaranteeing that loans are finite (even for x close to 1):

$$p_H R < 1 + \frac{p_H B}{\Delta p} \quad \text{or} \quad \rho_0 \equiv p_H\left(R - \frac{B}{\Delta p}\right) < 1. \tag{14.2}$$

(The reader will here recognize inequalities (3.7)–(3.9).)

Loan agreements. Lender i and entrepreneur i secretly sign at the start a loan agreement specifying the amount of the loan $I_i - A_i$ and the stake R_{bi} of entrepreneur i in the case of success (in the absence of purchase of firm j's assets). Two remarks are in order here. First, the other parties (lender j and entrepreneur j, $j \neq i$) in equilibrium anticipate correctly the loan agreement, even though they do not observe it. Second, it can be checked that entrepreneur i and lender i cannot sign better contracts than those which will be considered here (more precisely, we are looking for a Nash equilibrium in which each loan agreement belongs to this class, and no loan agreement can be improved upon by a loan agreement inside or outside this class).

Summary of timing. The timing is summarized in Figure 14.1 (where "MH_i" stands for "moral hazard in firm i").

Correlation of shocks. The shocks affecting the demands for the two products may be correlated. We allow for an arbitrary level of correlation. The conditional probabilities (given firm i's state) that firm j is productive or in distress are stated in Table 14.1.

For consistency, the parameters must be such that the probability that firm j is productive is x:

$$x\mu + (1-x)(1-\nu) = x \iff x(1-\mu) = (1-x)(1-\nu). \tag{14.3}$$

Let us illustrate this correlation structure with two polar cases that we will use later on.

10. In particular, the entrepreneur in firm j cannot enjoy private benefit BI_j by keeping the assets.

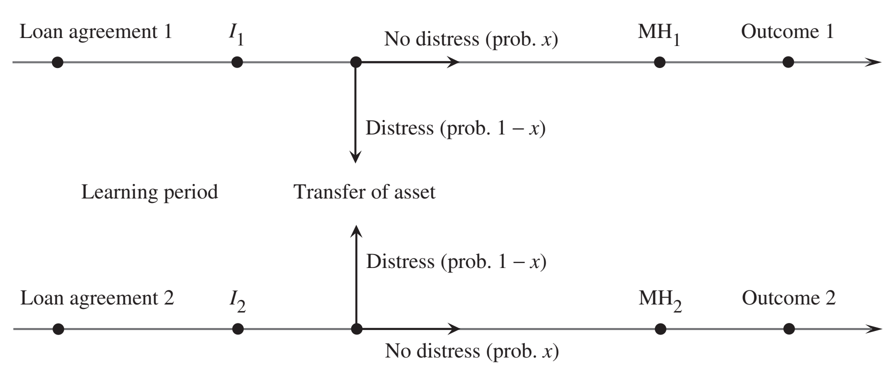

Figure 14.1

Table 14.1

	Conditional probability that firm j is	
when firm i is	productive	in distress
productive (prob. x)	μ	$1 - \mu$
in distress (prob. $1 - x$)	$1 - \nu$	ν

Nonconcurrent risks. In the first polar case, at most one firm is in distress. Put differently, if firm i is in distress then firm j is not: $\nu = 0$. The consistency condition (14.3) then implies $\mu = (2x - 1)/x$ (which naturally requires that $x \geqslant \frac{1}{2}$).[11]

Identical shock. The other polar case is that of perfectly correlated environments. There are only two states of nature: either both firms are productive or both are in distress. This corresponds to $\mu = \nu = 1$.

We now solve for equilibrium. First, we must endogenize the resale price assuming that the firms have invested I_1 and I_2 and distress occurs in one of the firms.

Transfer price. If both firms are in distress (which has probability $(1 - x)\nu$), the four participants (entrepreneurs, lenders) receive no *ex post* revenue. If neither is in distress (which has probability $x\mu$), no sale occurs and the model is the standard variable-investment one.

So let us consider the more interesting case in which *firm 1*, say, *is in distress and firm 2 is not.* We then assume that *lender 1 makes a take-it-or-leave-it offer to lender 2* (see the third remark below for more general bargaining powers). Let P denote the per-unit price demanded by lender 1.

Note that lender 2 must adjust entrepreneur 2's incentive scheme to account for the increased investment and therefore for the increased private benefit from not behaving (now equal to $B(I_1 + I_2)$ instead of BI_2). Assume that entrepreneur 2's incentive compatibility constraint is binding in the absence of a purchase ($(\Delta p)R_{b2} = BI_2$), which actually turns out to be optimal. Then, lender 2 must raise entrepreneur 2's income in the case of success by δR_{b2} such that[12]

$$(\Delta p)(\delta R_{b2}) = BI_1.$$

So, entrepreneur 2's rent increases by $[p_H B/\Delta p]I_1$ and the transfer price is

$$PI_1 = p_H\left[R - \frac{B}{\Delta p}\right]I_1 = \rho_0 I_1.$$

The transfer price is simply the pledgeable income:

$$P = \rho_0.$$

The per-unit pledgeable income can be called the "competitive price" since this price would obtain if there were multiple acquirers bidding competitively for the assets (but see Section 14.2.5). From (14.2), we see that

$$P < 1.$$

11. There are really only three states of nature here, since the state in which both firms are in distress has probability 0. One way to represent this stochastic environment is to envision an underlying random variable ω uniformly distributed on $[0, 1]$. If $\omega \leqslant 1 - 2(1 - x)$, both firms are productive; if $1 - 2(1 - x) < \omega \leqslant 1 - (1 - x) = x$, firm 1 is in distress and firm 2 is productive; if $\omega > x$, firm 2 is in distress and firm 1 is productive.

Nonconcurrent risks generalize the situation in which the environments are perfectly negatively correlated (which corresponds to $x = \frac{1}{2}$).

12. The new incentive constraint is $(\Delta p)(R_{b2} + \delta R_{b2}) \geqslant B(I_2 + I_1)$.

So, the asset is sold at a discount even though the seller has the bargaining power. In this sense, the asset market exhibits some degree of *illiquidity*. Indeed, while reallocation of assets is here efficient as assets in the firm in distress have a zero productivity, it could be inefficient in an environment in which productivity does not fall to 0, but is still lower than the productivity following a reallocation to the other firm (see Exercise 14.4).[13]

Entrepreneur 2 is able to manage more assets because firm 1 is willing to sell its sunk investment I_1 at a discount (its opportunity cost is then equal to 0.) Because firm 1 has the bargaining power, lender 2 actually gains nothing from firm 1's distress, while entrepreneur 2 pockets the extra agency rent $p_H BI_1/\Delta p = (\rho_1 - \rho_0)I_1$.

Entrepreneurs' expected utility. Suppose entrepreneur i maximizes her net utility. As usual, the lenders' zero-profit condition implies that the borrower receives the full surplus associated with investment:

$$U_{bi} = [xp_H RI_i - I_i] + [(1-x)(1-\nu)PI_i] + \left[x(1-\mu)\frac{p_H B}{\Delta p} I_j\right]. \quad (14.4)$$

The first term in brackets in the expression of U_{bi} corresponds to the case in which distress sales are impossible. The second term comes from lender i's revenue from the sales of assets if only firm i is in distress. The third term represents the expected windfall gain from firm j's distress.

We can rewrite (14.4) as

$$U_{bi} = [x\rho_i + (1-x)(1-\nu)\rho_0 - 1]I_i + [x(1-\mu)(\rho_1 - \rho_0)]I_j. \quad (14.5)$$

So let

$$\alpha \equiv x\rho_1 + (1-x)(1-\nu)\rho_0 - 1$$

and

$$\kappa \equiv x(1-\mu)(\rho_1 - \rho_0) > 0.$$

13. Two different contributions to the literature have examined the efficiency of the reallocation process, both in an infinite-horizon context. Vayanos (1998) posits transaction costs and derives the price kernel in such an environment. In Eisfeldt (2004), illiquidity stems from asymmetric information between the seller and the buyer (the secondary market for assets suffers from a lemons problem *à la* Akerlof (1970)—see Chapter 6). In her model, economic agents have fewer reasons in good times to trade for informational (rather than efficiency) motives and so the secondary market is less subject to adverse selection, that is, liquidity is procyclical.

Using (14.4), we can rewrite borrower i's net utility U_{bi} as

$$U_{bi} = \alpha I_i + \kappa I_j. \quad (14.6)$$

Borrowing capacity. Because lender i expects no surplus from the purchase of firm j's assets when the latter is in distress, lender i's expected profit is

$$xp_H(RI_i - R_{bi}) + (1-x)(1-\nu)PI_i - (I_i - A_i) = 0,$$

where R_{bi} is borrower i's income when firm i does not purchase firm j's assets and is successful. Incentive compatibility requires that

$$(\Delta p)R_{bi} \geqslant BI_i,$$

and, as usual, this inequality is satisfied with equality in order to maximize pledgeable income and therefore debt capacity. Using these two equations, firm i's maximal investment is

$$I_i = kA_i,$$

where

$$k = \frac{1}{1 - \rho_0[x + (1-x)(1-\nu)]}. \quad (14.7)$$

Note that the multiplier k (whose denominator is positive since $\rho_0 < 1$) coincides with that given by expression (3.12) when $\nu = 0$ (firm j is never in distress when firm i is—the case of nonconcurrent risks). In particular, that the assets must be sold at a discount when firm i is in distress does not affect the firm's debt capacity even though it reduces the borrower's individual incentive to invest (see the expression of α). The intuition for this result is that the discount is a mere transfer of rent from one entrepreneur to the other and does not affect the lenders' profit.

We also see that the multiplier decreases with ν. That is, *a firm's borrowing capacity decreases with the degree of correlation between firms.* A higher correlation means that the assets are less redeployable.

As we noted, the correlation of shocks reduces the desirability of investment ($\partial\alpha/\partial\nu < 0$). Let ν^* denote the level of ν (if it exists) such that $\alpha = 0$.[14] We consider two cases:

(a) *Low correlation* ($\nu < \nu^*$). Then $\alpha > 0$ and the firms invest up to their borrowing capacity:

14. If α is positive (respectively, negative) for all ν, adopt the convention that $\nu^* = 1$ (respectively, $\nu^* = 0$).

$I_i = kA_i$. While each firm's investment is independent of the existence of the other firm, each firm derives a positive externality from this existence in the form of asset redeployability.

(b) *High correlation* ($\nu > \nu^*$). Then $\alpha < 0$, and no firm invests, even though coordinated investment could be profitable (if $\alpha + \kappa > 0$).

The latter conclusion hinges on the possibility for a firm "not in the business" (that is, that has not invested) to take over and operate the assets of the other firm. Suppose in contrast that an entrepreneur can operate the other firm's equipment only if she herself has invested "enough" (this assumption is consistent with the view that outsiders cannot operate equipment). Namely, she must invest at least $I_i \geqslant \underline{I} > 0$ herself, where $\underline{I} \leqslant kA_i$ for all i. So, we assume that the third term in brackets in the expression of U_{bi} in equation (14.4) ($[x(1-\mu)(\rho_1 - \rho_0)]I_j$) is multiplied by 1 if $I_i \geqslant \underline{I}$ and by 0 if $I_i < \underline{I}$.

Then there exists $\nu^{**} > 0$ (ν^{**} is such that $\alpha + \kappa = 0$) such that, for all $\nu \in [\nu^*, \nu^{**}]$, *two pure-strategy equilibria exist*:

- the good equilibrium ("coordinated one," "vulture equilibrium") in which both firms invest $\underline{I}$ only because that will allow them to get a good deal if the other firm falls in distress;
- the bad equilibrium in which neither invests.[15]

Remark (decreasing returns to scale). Investment externalities are here positive. A firm's investment allows it to stand by to purchase the other firm's assets if the latter is in distress. On the other hand, if (due to entrepreneurial limited attention, for example) returns to investment were decreasing rather than constant,[16] investment externalities could become *negative*, as a more active firm is less eager to take on new tasks. That is, the transfer price a firm in distress can get for its assets is lower, the higher the level of existing investment by the other firm.

Remark (product-market competition). If the firms competed in the product market, the absence of correlation would reduce on average the intensity of competition, and raise the incentive to invest (as it would in the absence of financing constraints[17]).

Remark (alternative distributions of bargaining power). The analysis above, and the rest of Section 14.2 unless otherwise stated, assumes that the acquired firm's investors have full bargaining power and thereby can charge a price equal to the acquiring investors' willingness to pay ($P = \rho_0$). More generally, depending on the two parties' relative bargaining powers, the transaction price can fall anywhere in the range between 0 (the acquired firm's opportunity cost) and ρ_0 (the acquiring firm's investors' willingness to pay).

Allowing for more general distributions of bargaining power does not affect the qualitative results (see Exercise 14.2). Quantitatively, a firm benefits more from the other firm's investment since it purchases it when in distress at an even bigger discount; the same effect also implies that one's own investment is less profitable. So, relative to the case $P = \rho_0$, α decreases and κ increases ($\alpha + \kappa$ remains constant). The other key point is that firm i's borrowing capacity depends on firm j's investment if $P < \rho_0$: the prospect of a cheap acquisition raises the investors' willingness to lend. We therefore conclude that, whenever $P < \rho_0$, investments are strategic complements even in the absence of threshold (minimum) investment. On the other hand, the value of firm i's collateral decreases by $(\rho_0 - P)I_i$ in the case of a transaction. In *symmetric* equilibrium (for $A_1 = A_2 = A$), the two effects cancel, and the borrowing capacity is independent of the distribution of bargaining power.

14.2.3 Underdeveloped Resale Markets

This subsection makes the simple point that in the absence of *ex ante* coordination, the volume of acquisitions is likely to be suboptimal even if financial markets are frictionless. The intuition can be grasped from the treatment in Section 14.2.2, on which we will build: distress creates an *acquisition opportunity* and thereby a windfall surplus for other

15. Entrepreneurs always (weakly) prefer the other entrepreneur to invest, because the latter's investment may create an opportunity for asset acquisition.

16. See Exercise 3.5 for a formalization.

17. This does not imply that, ignoring asset resale benefits, industry profit decreases with the extent of correlation. In particular, in the presence of a threshold investment, $\underline{I}$, a small increase in correlation may transform the industry structure from duopoly to monopoly.

corporate entities. If the competitive price ($P = \rho_0$) obtains, the management of the acquiring firm derives a per-unit-of-investment surplus $\rho_1 - \rho_0$ from the transaction; the windfall surplus is even larger if the acquiring firm has some bargaining power (it is, per unit, $(\rho_1 - \rho_0) + (\rho_0 - P) = \rho_1 - P$). This *ex post* externality generates an *ex ante* externality if we allow firms to determine their probability of distress through investment design choices.

To illustrate this (general) point in a simple manner, let us make the following three assumptions:

- *Nonconcurrent risks.* The two firms are never simultaneously in distress ($\nu = 0$, $\mu = (2x-1)/x$).
- *Ex ante riskiness choice.* Each firm can configure its investment in two ways: (a) the *risky* version considered up to now, in which scale I_i involves up-front cost I_i, but ends up being productive only with probability x; and (b) the *safe* version, scale I_i involves higher up-front cost XI_i, where $X > 1$, but is never in distress. Thus, firms can select to pay more up front and reduce (actually, eliminate) the risk of distress.
- *Symmetry.* $A_1 = A_2 = A$.

We maintain the assumption that the acquired firm's investors have the bargaining power and so $P = \rho_0$ in the case of a transaction.

Coordinated solution. Let us first investigate investment design when firms coordinate *ex ante.*[18] Intuitively, the risky design choice for both is collectively optimal since assets are always productive for at least one of the firms under nonconcurrent risks; thus there is no risk that the assets end up not being used. And the investment cost is lower for a given scale. To check that risky choices are optimal, note that, with the risky design, the per-entrepreneur utility is

$$U_b^r = (\rho_1 - 1)I,$$

where I is given by the investors' breakeven condition:

$$\rho_0 I = I - A.$$

And so

$$U_b^r = \frac{\rho_1 - 1}{1 - \rho_0} A.$$

18. We here focus on coordination of investment designs. They could further agree *ex ante* on a resale price P *ex post*, but in a symmetric outcome, the choice of P does not affect borrowing capacity or NPV (see Exercise 14.2).

Compare this with the safe choice for both. The firms then operate "in autarky" since they need not transfer assets to each other. The formulae are the same as in the risky case (which are those given in Section 3.4), except that the unit investment cost is X rather than 1:[19]

$$U_b^s = \frac{\rho_1 - X}{X - \rho_0} A < U_b^r.$$

Similarly, it is easily shown that it is suboptimal to have one of the two firms select the safe design.

Lack of ex ante coordination. Let us now show that it may be individually rational for each firm to select the safe design when, as in the Shleifer–Vishny model, firms do not coordinate their investment choices. Suppose, therefore, that in equilibrium both entrepreneurs adopt the safe design and therefore obtain utility

$$U_b^s = \frac{\rho_1 - X}{X - \rho_0} A.$$

If a firm deviates and chooses the risky design, its utility becomes (using $P = \rho_0$)

$$U_b = [x\rho_1 + (1 - x)\rho_0 - 1]I,$$

where its investment, I, is obtained from the investors' breakeven condition:

$$\rho_0 I = I - A$$

(the investors receive ρ_0 per unit of investment regardless). And so

$$U_b = \frac{[\rho_1 - (1 - x)(\rho_1 - \rho_0)] - 1}{1 - \rho_0} A.$$

Hence, $U_b^s > U_b$ (firms strictly prefer the safe design) if and only if

$$(1 - x)(X - \rho_0) > X - 1,$$

a condition that holds, for instance, if X is close to 1. More generally, if the latter inequality holds, both firms' choosing the safe option is the only equilibrium.

The lack of coordination therefore yields an inefficiently low volume (here a complete absence) of transactions.

To reach efficiency, the firms must contract *ex ante.* Either they contractually obligate each other

19. The NPV per entrepreneur is $U_b^s = (\rho_1 - X)I$, and the investors' breakeven condition is $\rho_0 I = XI - A$.

to choose the risky design or they provide incentives that induce each to make this choice. An example of the latter approach consists in giving each party a *put* option at price $P = \rho_1$ (or slightly lower).[20] Note that this option requires each firm i to hoard liquidity at least equal to $(\rho_1 - \rho_0)I$, where I is the per-firm investment, since investors will not want *ex post* to contribute more than $\rho_0 I$ for the acquisition of firm j's assets (see Chapter 5 for a treatment of liquidity management). Each solution faces its own difficulties: it may be hard to specify *ex ante* the exact design choice. And the put option, for example, creates moral hazard in quality choices (initial investment quality and maintenance).

14.2.4 Risk Attitudes as Strategic Substitutes

Building on Perotti and Suarez (2002), let us pursue the investigation of risk attitudes begun in the previous subsection. The general point is that risk attitudes give rise to strategic substitutabilities: a firm is more prone to take risks if the other does not, and conversely. Intuitively, choosing a risky strategy is more appealing if one is more likely to find an acquirer for the assets when one falls into distress, i.e., if the other firm chooses a safe strategy. Conversely, the safe strategy has more appeal if there are more frequent opportunities for an acquisition, i.e., if the other firm chooses a risky strategy. This strategic substitutability did not arise in the nonconcurrent risk version of Section 14.2.3 since firms were never simultaneously in distress. Introducing a positive probability of simultaneous distress under risky choices creates a strategic substitutability in riskiness choices. For conciseness, we will make this general point in the context of the risky/safe choice model introduced in Section 12.2.3, but in the specific, polar case of *identical shock*: if both firms choose the risky strategy, then either both firms are productive or both are in distress ($\mu = \nu = 1$).

Let y_i denote the probability that firm i chooses the risky strategy. So $y_i = 1$ if it chooses the risky strategy and $y_i = 0$ if it chooses the safe strategy. At the financing stage each firm contracts with its investors on its choice of strategy; financing contracts are simultaneous, and so firms do not observe their rival's choice of strategy (they can only anticipate its equilibrium value). We continue to assume that asset sales take place at per-unit price $P = \rho_0$. Let us first compute the firms' borrowing capacities. Recall that, from $P = \rho_0$, the borrowing capacity does not depend on acquisition opportunities. And so the breakeven condition is

$$[x + (1-x)(1-y_j)]\rho_0 I_i = I_i - A_i \quad \text{if firm } i \text{ chooses the risky strategy,}$$

$$\rho_0 I_i = X I_i - A_i \quad \text{if firm } i \text{ chooses the safe strategy.}$$

Borrower i's utility (i.e., firm i's NPV) is

$$\begin{aligned} U_{bi}(y_i, y_j, I_j(y_i^*)) &= y_i[x\rho_1 + (1-x)(1-y_j)\rho_0 - 1] \\ &\quad \times \left[\frac{A_i}{1 - [x + (1-x)(1-y_j)]\rho_0}\right] \\ &\quad + (1-y_i)[\rho_1 - X]\left[\frac{A_i}{X - \rho_0}\right] \\ &\quad + (1-y_i)y_j(1-x)(\rho_1 - \rho_0)I_j(y_i^*), \end{aligned}$$

where

$$I_j(y_i^*) = \left[\frac{A_j}{1 - [x + (1-x)(1-y_i^*)]\rho_0}\right].$$

The first term in the expression of U_{bi} is the NPV gross of the potential acquisition for the risky choice ($y_i = 1$), the second its counterpart for the safe choice ($y_i = 0$), and the third the windfall gain from a possible acquisition (which occurs with probability $(1-y_i)y_j(1-x)$). When strategies are chosen simultaneously, firm j's investment I_j depends on the anticipated (i.e., equilibrium) choice y_i^* and not on the actual decision y_i of firm i (recall that investment I_j is independent of y_i due to the assumption that the target firm has the bargaining power in an M&A).

Strategic substitutability is equivalent to

$$\frac{\partial}{\partial y_j}\left(\frac{\partial U_{bi}}{\partial y_i}\right) < 0,$$

which indeed holds; it is due to two effects:[21]

20. Let us say that the manager decides *ex post* whether to sell the firm's assets to the other firm, and the proceeds of the sale mostly go to investors (at most $\rho_1 - \rho_0$ per unit goes to management, otherwise the manager might decide to sell the assets even when the firm is not in distress).

21. Beware: when computing $\partial U_{bi}/\partial y_i$, one should take $I_j(y_i^*)$ as given. The reason for this is that we are computing firm i's reaction curve (how y_i optimally reacts to y_j and I_j).

- the "rescue effect," which corresponds to the cross derivative of the first of the three terms in the expression of U_{bi}: $y_j = 0$ increases both the NPV and the pledgeable income when the risky strategy is selected by firm i;
- the "acquisition opportunity effect," which corresponds to the cross derivative of the third term.

It can be checked that an equilibrium with differentiated strategies exists under some parameter configurations.[22]

As in Section 14.2.3, the equilibrium risk choices need not be efficient and *ex ante* coordination may be needed to achieve an industry optimum.

14.2.5 Financial Muscle

14.2.5.1 Two Motivations for Building Financial Muscle

We have not yet needed to discuss how liquidity management interacts with mergers and acquisitions. For two distinct reasons, a corporate entity may hoard liquidity in order to purchase assets in the future, or, put differently, may not content itself with going back to the financial market in order to seize acquisition opportunities, unlike in the environments considered in the last three subsections.

First, the acquiring firm may compete with other potential acquirers. Having extra cash on hand beyond what can be raised through seasoned offerings may help win the bidding war. This motivation is illustrated below, where we emphasize the collective wastefulness of financial muscle.

Second, the acquiring firm may need to reinvest in order to make the acquired assets operational for its own use. This motivation is also illustrated below, where it is further noted that when the selling firm has bargaining power, a Williamsonian holdup problem may arise (see Williamson 1975, 1985). Building financial muscle in order to be able to retool acquired assets is akin to a specific investment. This (sunk) investment may be expropriated through haggling over the transfer price P. This may discourage the potential acquirer from hoarding financial muscle when the latter involves an opportunity cost (the hoarded liquidity could be used for alternative purposes). We consequently note that firms may acquire insufficient financial muscle.

14.2.5.2 Bidding for Assets: Too Little or Too Much Financial Muscle?

Let us now investigate (building on Holmström and Tirole (2005)) whether potential acquirers accumulate (collectively) too little or too much financial muscle. For the sake of simplicity we will assume that there are two distinct classes of firms: safe firms, which are never in distress, and risky firms, which may become distressed, in which case they may be purchased by the safe firms.[23]

14.2.5.3 Bilateral Monopoly: Is Liquidity Hoarding Held Up?

Let us first describe the model in the case of a single risky firm and a single safe firm. The two firms choose investment sizes J and I, respectively. To simplify notation without altering the basic insights, the two firms are identical, except for the probability of distress, which is 0 for the safe firm and $1 - x$ for the risky one. Both are run by risk-neutral entrepreneurs with initial cash on hand A each and protected by limited liability. The timing is summarized in Figure 14.2.

We further assume that when buying the J units of asset from the risky firm when the latter is in distress, the safe firm must pay a known retooling cost ρJ to adapt these assets to its own production process. Letting P denote the unit acquisition price, the total cost of the acquisition is thus $(P + \rho)J$. To limit

22. Suppose symmetric net worths ($A_1 = A_2 = A$). An equilibrium in which one chooses the safe strategy and the other the risky one exists if and only if

$$\frac{\rho_1 - X}{X - \rho_0} + (1 - x)\left(\frac{\rho_1 - \rho_0}{1 - \rho_0}\right) \geqslant \frac{x\rho_1 - 1}{1 - x\rho_0}$$

and

$$\frac{x\rho_1 + (1 - x)\rho_0 - 1}{1 - \rho_0} \geqslant \frac{\rho_1 - X}{X - \rho_0}.$$

Eliminating the term $(\rho_1 - X)/(X - \rho_0)$, it is easily shown that these two inequalities are satisfied for $X \in [\underline{X}, \bar{X}]$ with $\underline{X} > 1$.

23. For conciseness, we rule out the purchase of distressed firms' assets by risky, but intact, firms. In the first application of the model, in which there is a single risky firm, this question obviously does not arise. To endogenize this assumption when there are multiple risky firms, one can assume either that the risky firms' shocks are correlated, and so they fall into distress at the same time; or else (contrary to what is assumed below for notational simplicity) that the expected return on their investment is higher than that of safe firms, and so risky firms have more incentives to invest themselves than to hoard reserves to purchase assets from other firms.

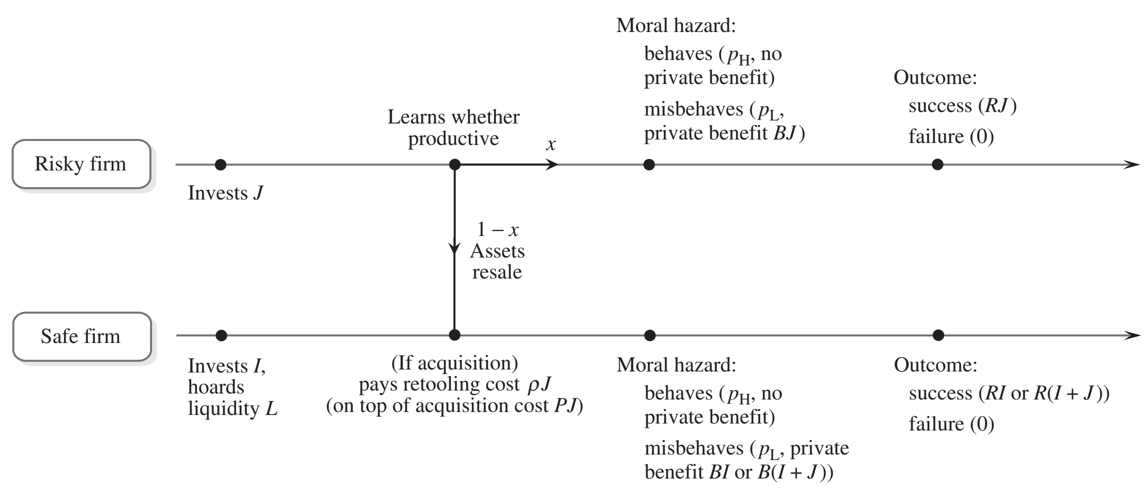

Figure 14.2

the number of cases to be considered, we assume that $\rho \leqslant \rho_0$.

The treatment of the bilateral monopoly case, compared with the simpler competitive asset resale market case considered below, involves conceptually difficult, but interesting, twists. As we want to allow for a wide range of bargaining powers, let us assume that in the case of distress of the risky firm:

- with probability z, the risky firm makes a take-it-or-leave-it resale offer to the safe firm;
- with probability $1-z$, the safe firm makes a take-it-or-leave-it purchase offer.

Thus z is a measure of the selling firm's bargaining power.

Bargaining and the choice of financial muscle. The case in which the safe firm makes the offer is a no-brainer: it offers 0 (or just above), the opportunity cost of the risky firm's assets when in distress. By contrast, the situation in which the risky firm makes the offer requires more thinking. Let us assume that the amount of liquidity L hoarded by the safe firm (say, the credit line that the firm secures from its bank[24]) is *not* observed by the risky firm. We look for conditions under which the following is an equilibrium:

- the risky firm demands per-unit price ρ_0 for its assets;
- the safe firm, anticipating this and knowing that it will be able to raise $\rho_0 J$ on the asset market, hoards liquidity $L = \rho J$.

Making offer ρ_0 is clearly optimal for the seller since $\rho_0 J$ is the pledgeable income on the acquired assets and thus the upper bound on what new investors are willing to contribute in a seasoned offering.

Let us next investigate whether it is indeed in the safe firm's interest to hoard liquidity. Let $y = 1$ if it hoards the necessary amount (ρJ) and $y = 0$ if it does not. Noting that liquidity is not needed to acquire the assets when the acquirer makes the offer (since $\rho \leqslant \rho_0$), the safe firm's NPV is then

$$U_b^s = (\rho_1 - 1)I + (1-x)[z[\rho_1 - (\rho_0 + \rho)]y + (1-z)(\rho_1 - \rho)]J.$$

The second term on the right-hand side is the expected gain from acquisitions, and uses the fact that the total acquisition cost is $(\rho_0 + \rho)J$ when the seller makes the offer and only ρJ when the acquirer makes the offer.

24. We adopt the convention that the safe firm's entrepreneur can raise ρ_0 in a seasoned security offering, to which L is added to form total available cash. Alternatively, and as we discussed in Chapter 5, one could ban seasoned offerings and provide the firm with a bigger credit line.

The safe firm's investors must break even, and so

$$\rho_0 I + (1-x)[z[\rho_0 - (\rho_0+\rho)]y + (1-z)(\rho_0-\rho)]J = I - A.$$

The investors' breakeven condition yields the investment level I:

$$I = \frac{A + [(1-z)(\rho_0-\rho) - z\rho y](1-x)J}{1-\rho_0}.$$

Note that hoarding liquidity ($y = 1$) reduces the investment scale. Substituting into the NPV equation,

$$U_{\mathrm{b}}^{\mathrm{s}} = (\rho_1 - 1)\frac{A + [(1-z)(\rho_0-\rho) - z\rho y](1-x)J}{1-\rho_0} + (1-x)[z[\rho_1 - (\rho_0+\rho)]y + (1-z)(\rho_1-\rho)]J.$$

We conclude that it is an equilibrium for the safe firm to hoard liquidity to purchase assets if and only if $U_{\mathrm{b}}^{\mathrm{s}}$ is increasing in y, or

$$\rho_1 - (\rho_0+\rho) \geqslant \frac{(\rho_1-1)\rho}{1-\rho_0}$$

or

$$1 \geqslant \rho_0 + \rho.$$

We thus obtain the simple result that the potential acquirer builds the necessary financial muscle if and only if the total per unit cost of acquisition when the acquired firm has bargaining power is lower than the safe firm's own cost of investment. The potential acquirer simply compares the costs of the two alternative approaches to investing: internal growth and acquisitions. Intuitively, when the seller has the bargaining power, 1 unit of hoarded liquidity allows the purchase of $1/\rho$ units of distressed assets (the remaining cost, ρ_0 per unit when the seller has the bargaining power, is self-financing to the extent that it can be raised through a secondary offering). But it also has opportunity cost $1/(1-\rho_0)$ since 1 unit of assets allows the financing of $1/(1-\rho_0)$ units of investment. In the "make-or-buy" choice, the buy option is attractive if

$$\frac{1}{1-\rho_0} < \frac{1}{\rho}.$$

Note that this inequality is always satisfied if ρ_0 is small: the opportunity cost of hoarding liquidity and thereby reducing the net worth that can be used for one's own investment is then small as the multiplier is close to 1.

In this simple model the equilibrium is in general not unique: there are lots of other self-fulfilling equilibria in which the firm hoards $L^* \neq \rho J$ and the seller demands P^* such that $P^* + \rho = L^* + \rho_0$. The seller does not want to demand more than $P > P^*$ because being too greedy prevents the potential acquirer from buying the assets. Conversely, the potential acquirer is willing to hoard $L = L^*$, as long as $P^* + \rho \leqslant 1$ (note that ρ_0 is in the interior of the range of equilibrium prices).[25]

Equilibrium selection. Exercise 14.3 describes one appealing way of breaking this indeterminacy: adding *ex ante* uncertainty about the level of the retooling cost. Namely, the retooling cost $\tilde{\rho}$ is, as the liquidity shock in Chapter 5, drawn from a cumulative distribution function $F(\tilde{\rho})$; Exercise 14.3 further assumes that the safe firm's entrepreneur privately observes its realization. It shows that

(i) the safe firm is granted a credit line that allows it to withstand all shocks $\tilde{\rho} \leqslant \rho^*$ for some cutoff ρ^*;

(ii) the equilibrium credit line and the acquisition price P demanded by the seller satisfy

$$P + \rho^* = 1$$

(in words, in (the unique) equilibrium, the costs of investment in the make-or-buy choice are equalized!);

(iii) when the distribution of $\tilde{\rho}$ converges to a spike at ρ (is close to the deterministic specification posited earlier), then P converges to $1-\rho$. Interestingly, this solution is the *competitive* solution described below! Furthermore, the probability of striking a deal converges to 1.

Intuitively, hoarding reserves that are left unused is costless to the acquirer (as long as the latter returns these reserves to the investors when unused). The seller then knows that the acquirer will hoard reserves that are sufficient to support (from his point of view) efficient continuations, that is, whenever $\rho \leqslant 1 - P$, where P is the anticipated price. And P is determined by the standard monopoly tradeoff

25. Relatedly, the potential acquirer has an incentive to claim that it has shallow pockets ($L = 0$) so as to force the seller to make a low offer. It is, however, difficult to "prove" shallow pockets since the bank and the firm may contract for a secret credit line.

between being greedy/running the risk of not selling and ensuring a sale by charging a low price.

Let us finally turn to a brief analysis of externalities. In this uncertain retooling cost version, *for a given investment J* by the risky firm, the efficient volume of trade occurs whenever the assets are sold at their opportunity cost, i.e., are given away ($P = 0$). Except in the limit in which the retooling cost is highly predictable (result (iii) above), the volume of trade is suboptimally low. This inefficiency could be alleviated by

(i) either an *ex ante* agreement between the two firms mandating a costless transfer of assets in the case of distress;[26]

(ii) or an *ex ante* agreement between the two parties that the acquirer builds more financial muscle than he would build to maximize his own profit.[27]

In a nutshell, the seller is too greedy (like in any monopoly problem) and the buyer too stingy.

Another set of externalities arises when considering the investment level J. An increase in J augments the value of the acquisition opportunity for the safe firm. The safe firm therefore might want (perhaps in exchange for an option to freely acquire assets in the case of distress) to subsidize J's investment. Alternatively, it might want to commit to hoard more liquidity than it does when acting in a noncooperative way, since an increase in financial muscle raises the risky firm's revenue in distress and boosts its investment.

14.2.5.4 Make-or-Buy Decision in a Competitive Environment: Excessive Financial Muscle

Let us now consider the case with many risky firms and many safe firms. We assume that the risky (respectively, safe) firms are all identical and as described previously. The productivity shocks encountered by the risky firms are independent and so, by the law of large numbers, the equilibrium is deterministic. We no longer need to describe bargaining: asset transfers occur at some per-unit market price P.

26. Provided that distress can be verified in court. Otherwise, when in distress, the risky firm might continue to operate and engage in a war of attrition in order to force the acquirer to pay a positive price.

27. Of course, an increase in L induces an increase in P. But the pass-through coefficient is smaller than 1 (see Exercise 14.3).

Building on the previous analysis, and now calling $\mathcal{J}$ the total amount purchased by the representative safe firm, the latter's NPV is

$$U_b^s = (\rho_1 - 1)I + [\rho_1 - (P + \rho)]\mathcal{J},$$

where ρ is the (deterministic) per-unit retooling cost. The investors' breakeven condition is

$$\rho_0 I + [\rho_0 - (P + \rho)]\mathcal{J} = I - A.$$

And so

$$U_b^s = (\rho_1 - 1)\frac{A - (P + \rho - \rho_0)\mathcal{J}}{1 - \rho_0} + [\rho_1 - (P + \rho)]\mathcal{J}.$$

The derivative of U_b^s with respect to $\mathcal{J}$ must be equal to 0 in a competitive equilibrium, which yields the condition of indifference between making and buying:

$$P + \rho = 1.$$

It can be argued that (fixing the risky firms' total investment) the safe firms collectively invest too much in financial muscle. Indeed they would be better off if they could agree not to hoard any liquidity at all. This buyer cartel would then acquire the distressed assets for free. Cartelization would not, of course, result in a Pareto-improvement as the sellers would suffer from a concerted lack of buyer financial muscle.

Pareto-improving concerted reductions in liquidity hoarding do arise in Holmström and Tirole (2005), who

- consider a symmetric version of this model (all firms are risky), without retooling cost;
- assume that liquidity is costly to hoard (hoarding L costs $g(L)$, with $g'(0) = 1$ and $g'' > 0$).

Over a range of parameters, firms invest too little and hoard too much liquidity (indeed, because here hoarding, and not only using, liquidity is costly, the collectively optimal amount of hoarding is equal to 0).

14.3 General Equilibrium Determination of Asset Values, Borrowing Capacities, and Economic Activity: The Kiyotaki–Moore Model

The paper by Shleifer and Vishny explores one determinant of the value of collateral, namely, the correlation among shocks affecting a group of firms within which assets can be redeployed. It demonstrates the linkage between firms' borrowing capacities and investments through the demand for secured assets in the case of distress. The Kiyotaki and Moore (1997) paper also focuses on the equilibrium value of assets as collateral, but with an emphasis on the forecast of *future* economy-wide activity and firms' borrowing capacity. In Kiyotaki and Moore, uncertainty about the demand for assets plays no role; actually, there is a large number (an infinity) of firms among which assets can be redeployed; these firms face independent shocks, and "by the law of large numbers" the economy follows a deterministic path. A firm's borrowing capacity at date t depends, positively, on the value of assets at date $t+1$ (because assets are used as collateral), and, negatively, on the assets' rental rate at date t (because assets are used as inputs into production). In turn, the borrowing capacity determines investment and therefore the productive use of the asset, which affects the rental rate. The economy can have multiple steady states, some with high asset value, rental rate, borrowing capacities, and economic activity, and others with lower values of each of these variables. The economy may also exhibit cycles, fluctuating between a state of high activity and high asset value and a state of low activity and low asset value.

14.3.1 The Model

To study the interaction between economic activity and asset value, it is convenient to use an infinite-horizon model. For simplicity, the rate of time preference of the agents in the economy (lenders and entrepreneurs) determines the rate of interest (although not, as we will see, the price of assets):

Preferences. The horizon is infinite: $t = 0, 1, 2, \ldots$. All agents have linear preferences:

$$\sum_{t\geqslant 0} \beta^t c_t,$$

where c_t is their date-t consumption and β is the discount factor ($\beta = 1/\gamma$ and $\gamma = 1 +$ interest rate).

Goods. There are two goods: durable and nondurable. The durable good will be labeled "real estate" and the nondurable one the "good." There are A units of real estate in the economy. Real estate neither depreciates nor expands and can be used as commercial or residential real estate. Real estate is the only store of value from one period to the next. There is no transaction cost involved in affecting real estate to one use or another.

The perishable consumption good lasts at most one period. This good is received as an endowment at the beginning of the period and can either be consumed immediately or invested. If invested, it may yield more units of the good (or none) at the end of the period, but these units will need to be consumed because the good cannot be stored until the next period.

Agents. There is the usual "mismatch between ideas and resources." There are two classes of agents (there is a continuum of agents in each class). *Entrepreneurs* can operate productive activities. They, however, receive no endowment of the good, and therefore they must borrow the entire amount of their investment. On the other hand, they can own real estate that they held or purchased in the previous period and use it as collateral. Indeed, we will look for an equilibrium in which entrepreneurs own the entire stock of real estate.

Lenders or investors receive a (large) endowment of date-t good at the beginning of period t. They consume some of it immediately and lend the rest to entrepreneurs against a claim on end-of-period income and possibly collateralized assets.

Production technology. Consider an entrepreneur with a units of real estate at the start of date t. Let this entrepreneur invest (and therefore borrow) i units of date-t good. (We use lowercase letters at the firm level, and will later use uppercase ones when we aggregate at the economy level.) Production requires using λi units of commercial real estate during the period.

The remaining real estate ($a - \lambda i$) can be rented as residential real estate at rental rate r_t. Let $D_{\mathrm{R}}(r_t)$ denote the aggregate demand for residential real estate (from lenders or third parties, say).[28] We assume

28. It is straightforward to endogenize this demand function. For example, one could assume that agents have intertemporal utilities

$$\sum_{t\geqslant 0} \beta^t [c_t + \Phi(z_t)],$$

where z_t is their date-t consumption of residential real estate, and $\Phi(z_t)$ is the gross surplus they derive from this consumption ($\Phi' > 0$, $\Phi'' < 0$, $\Phi'(0) = \infty$, $\Phi'(\infty) = 0$). The individual demand for residential

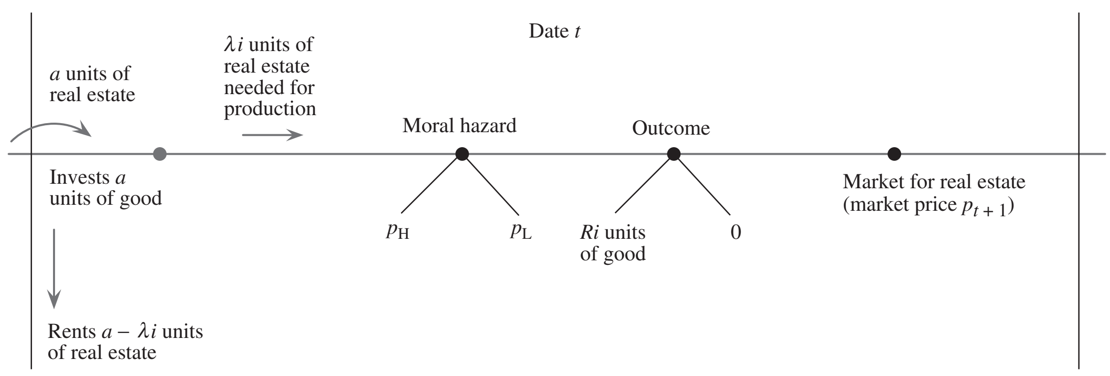

Figure 14.3

that this demand is downward sloping. Rental therefore generates a flow of income $(a - \lambda i)r_t$.

The entrepreneur either succeeds and obtains Ri units of date-t good at the end of the period or fails and obtains 0. The probability of success is p. There is moral hazard. The entrepreneur can either work, in which case she enjoys no private benefit and the probability of success is p_{H}, or shirk, in which case she enjoys private benefit Bi and the probability of success is p_{L}. Let $\Delta p = p_{\mathrm{H}} - p_{\mathrm{L}} > 0$.

Loan agreements. The contract between an entrepreneur and her lenders is a within-period contract. The entrepreneur receives R_{b} units of good in the case of success and 0 otherwise. Let us also adopt the conventions that (i) lenders receive the residential real estate income $(a - \lambda i)r_t$, and (ii) assets a at the end of the period go to the entrepreneur in the case of success and to the lenders in the case of failure. These conventions impose no loss of generality.

End-of-period market for real estate. At the end of period t, owners of real estate (successful entrepreneurs, investors who have seized the collateral) can sell (or buy more) real estate at price p_{t+1} on a competitive market. The proceeds of the sale are immediately consumed because the good is perishable.

The timing is summarized in Figure 14.3. We will look for an equilibrium in which investors do not carry real estate from one period to the next. When they seize assets, they sell them immediately to successful entrepreneurs, who thus spend part of their income expanding (and consume the rest).

real estate is then $z_t = (\Phi')^{-1}(r_t)$, and total demand is obtained by aggregation of individual demands.

Remark (entrepreneur selection). Entrepreneurs who fail disappear (they receive no endowment and have no asset, so will be unable to borrow); their continuation utility is equal to 0. So, ownership of the stock A of assets is more and more concentrated over time among entrepreneurs. If one does not like this conclusion, one can assume parthenogenesis; an "entrepreneur" is a dynasty of entrepreneurs. Each entrepreneur has several children, among whom she distributes the assets (the distribution of assets has no effect in this model because of the linearity).

Remark (no-agency-cost case). In the absence of credit market imperfections (that is, if there were no moral hazard), credit would not be rationed to entrepreneurs, and, given constant returns to scale, the rental rate would need to adjust so that investment yields zero profit; so, $r_t = r$, where

$$p_{\mathrm{H}}R - 1 - \lambda r = 0.$$

The economy would be in steady state, and so the phenomena of multiple equilibria and cycles investigated below are entirely due to credit rationing.

14.3.2 Borrowing Capacities and Asset Values in Equilibrium

In this model there is no aggregate uncertainty. The path of the economy will be characterized by the price and rental rate of real estate (p_t, r_t).

We look for an equilibrium in which the "continuation valuation" $V_t(a)$ (expected present discounted consumption from date t on) of an entrepreneur owning a units of real estate at the beginning of date t is proportional to a:

$$V_t(a) = v_t a. \tag{14.8}$$

Arbitrage among successful entrepreneurs on the real estate market at the end of period t then implies that

$$p_{t+1} = \beta v_{t+1}. \tag{14.9}$$

The borrowing capacity of an entrepreneur with assets a at the start of period t is given, as usual, by the two conditions that the entrepreneur is induced to work and that the investors break even:

$$(\Delta p)(R_b + p_{t+1}a) = Bi \tag{IC$_b$}$$

and

$$p_H(Ri - R_b) + (1 - p_H)p_{t+1}a + (a - \lambda i)r_t = i. \tag{IC$_l$}$$

So

$$i = k_t a, \tag{14.10}$$

where the multiplier is given by

$$k_t \equiv \frac{p_{t+1} + r_t}{1 - [p_H R - \lambda r_t - p_H B/\Delta p]} = \frac{p_{t+1} + r_t}{(1 + \lambda r_t) - \rho_0}, \tag{14.11}$$

where, as usual, $\rho_0 \equiv p_H(R - B/\Delta p)$. Furthermore, the zero-profit condition for the investors implies that the entrepreneur receives the expected profit from the date-t production. Because of the arbitrage condition, we can always assume, *for the purpose of computing the valuation function* $V_t(a)$, that, if the entrepreneur succeeds at date t, she sells her assets at the end of the period:

$$\begin{aligned} V_t(a) &= [p_{t+1} + r_t]a + [p_H R - \lambda r_t - 1]i \\ &= v_t a = \left[\frac{\rho_1 - \rho_0}{(1 + \lambda r_t) - \rho_0}\right][p_{t+1} + r_t]a, \end{aligned} \tag{14.12}$$

where $\rho_1 \equiv p_H R$. Using (14.9) and (14.12), we obtain

$$\begin{aligned} p_t &= \left[\frac{p_H B/\Delta p}{1 - [p_H R - \lambda r_t - p_H B/\Delta p]}\right]\beta(p_{t+1} + r_t) \\ &= \frac{\rho_1 - \rho_0}{[(1 + \lambda r_t) - \rho_0]}\beta(p_{t+1} + r_t). \end{aligned} \tag{14.13}$$

Note that

$$k_t = \frac{\Delta p}{\beta p_H B}\, p_t = \frac{p_t}{\beta(\rho_1 - \rho_0)}. \tag{14.14}$$

The multiplier is proportional to the price of real estate! This may sound counterintuitive because high real estate prices increase production costs. But one should recall that assets are in equilibrium held by the entrepreneurs, who, first, are *net* suppliers of real estate services, and, second, can use highly valued assets as collateral to boost their borrowing capacity.

The second equilibrium condition (besides equation (14.13)) is obtained from the *equilibrium in the real estate market.* The demand for residential use is equal to the supply. Total investment in the economy is $I_t = k_t A$, and thus

$$\begin{aligned} D_R(r_t) &= A - \lambda I_t \\ &= A - \lambda k_t A, \end{aligned}$$

or, using (14.14),

$$\begin{aligned} D_R(r_t) &= \left[1 - \frac{\lambda \Delta p}{\beta p_H B} p_t\right] A \\ &= \left[1 - \frac{\lambda p_t}{\beta(\rho_1 - \rho_0)}\right] A. \end{aligned} \tag{14.15}$$

Existence of this equilibrium imposes conditions on the parameters. First, it must be the case that real estate is more productively held by entrepreneurs than by investors, that is, its rate of return must not exceed that implied by discount factor β (i.e., $(1 - \beta)/\beta$), or equivalently

$$p_t \geqslant \beta(p_{t+1} + r_t).$$

From (14.13) and recalling that $\rho_1 = p_H R$ we must therefore have

$$p_H R \geqslant 1 + \lambda r_t. \tag{14.16}$$

That is, the marginal productivity of investment gross of agency cost must be positive. On the other hand, the multiplier k_t must be positive, meaning that the marginal productivity of investment net of the agency cost is negative:

$$p_H R < 1 + \lambda r_t + \frac{B p_H}{\Delta p}. \tag{14.17}$$

Lastly, the total net supply of real estate should be positive:

$$p_t \leqslant \frac{\beta p_H B}{\lambda \Delta p}. \tag{14.18}$$

14.3.3 Dynamic Analysis

The dynamic system is defined by (14.13) and (14.15). From (14.15), we obtain an increasing function,

$$r_t = \mathcal{R}(p_t), \tag{14.19}$$

on $[0, \bar{p}]$, where the upper bound $\bar{p}$ is defined by $\bar{p} = \beta p_H B/\lambda\Delta p$. Note that by choosing $D_R(\cdot)$ judiciously, one can generate any increasing function $\mathcal{R}(\cdot)$. Substituting (14.19) into (14.13), one obtains

$$p_t = \frac{p_H B/\Delta p}{1 - [p_H R - \lambda\mathcal{R}(p_t) - p_H B/\Delta p]} \times \beta[p_{t+1} + \mathcal{R}(p_t)]. \quad (14.20)$$

It is also easy to show that in the relevant range (defined by (14.16)–(14.18)), equation (14.13) implies that p_t is increasing in $r_t = \mathcal{R}(p_t)$. This implies that the mapping from p_t into p_{t+1} defined by (14.20) can have a fairly arbitrary slope. Indeed, p_{t+1} decreases with p_t if the slope of $\mathcal{R}(\cdot)$ is big enough. Figure 14.4 illustrates the possibilities.

First, one notes that there may exist several steady-state equilibrium prices (four of them, indicated by an asterisk, in Figure 14.4). Interestingly, *economic activity*, *investment*, *leverage* (from (14.14)), *real estate price*, and *rental rate all covary across steady states*. Second, there may exist cycles such as the $\{p_1, p_2\}$ cycle in Figure 14.4. The economy then alternates between a state of high activity and high asset price and a state of low activity and low asset price.[29]

To recap, we have seen that (i) current economic activity depends on the firms' current borrowing capacity and therefore on the future market price of durable investments (here real estate), (ii) the latter depends on future activity (or borrowing capacity), (iii) consequently, economic activity in the present and in the future are linked through the mechanism of borrowing capacity and asset value, and (iv) this creates a covariation of several economic variables, and further may generate cycles and multiple equilibria.

14.3.4 Adding a Competing Store of Value

Let us conclude the study of the Kiyotaki–Moore model with the following point, which will serve as an introduction to the next chapter. The possibility of multiple steady states and cycles in the Kiyotaki–

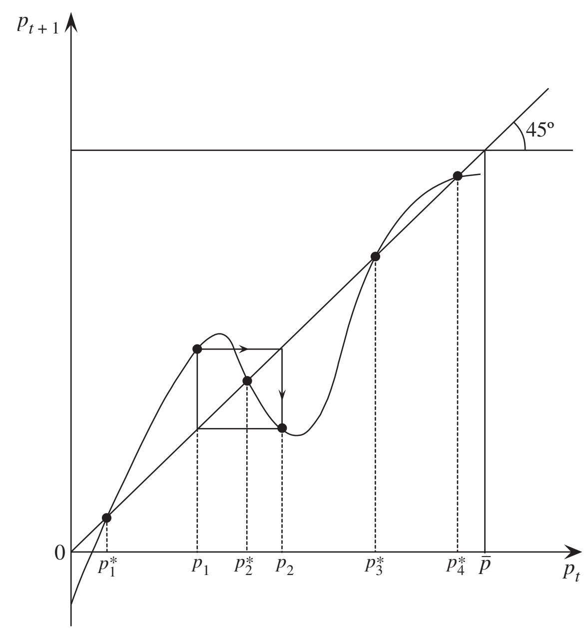

Figure 14.4

Moore model hinges on the dual role of the assets as inputs into the production process and as stores of value, i.e., liquidity instruments that help the (successful) entrepreneurs "bridge" the periods (store their retained earnings in order to reinvest later).[30] If we introduce into the economy another store of value that is not directly used in the production process (for example, Treasury bonds, as discussed in the next chapter), the productive asset (real estate here) now competes with the alternative store of value and loses part or all of its value as a bridge across periods.

To see this, let us introduce a *pure store of value* in quantity L. One unit of this pure store of value delivers 1 unit of nonstorable consumption good in each period, forever.

Dynamics. Letting q_{t+1} denote the price of the pure store of value at the end of period t (by analogy with p_{t+1}, the price of real estate at the end of period t), and l the individual holding of the store of value by the representative (surviving) entrepreneur, we can generalize the previous analysis. The date-t

29. See Freixas and Rochet (1997) for more on cycles in such models. For more on cycles in credit-constrained economies in a closed and an open context, respectively, see Aghion et al. (1999, 2004) as well as Sections 13.4 and 13.5.

30. In this sense, Kiyotaki and Moore's paper is related to the Woodford (1990) paper discussed in the next chapter.

borrowing capacity becomes[31]

$$i = \frac{(p_{t+1} + r_t)a + (q_{t+1} + 1)l}{(1 + \lambda r_t) - \rho_0},$$

where the numerator is the value of assets held by the entrepreneur at the beginning of date t and the denominator is as usual the difference between the unit production cost and the unit pledgeable income.

The valuation function is

$$V_t(a, l) = \left[\frac{\rho_1 - \rho_0}{(1 + \lambda r_t) - \rho_0}\right] \times [(p_{t+1} + r_t)a + (q_{t+1} + 1)l].$$

Thus, whether they are held solely by the entrepreneurs or jointly by entrepreneurs and consumers (a question that we will briefly analyze below), the two assets (real estate and pure store of value) must command the same return, and this rate of return must be at least equal to the one that consumers are willing to accept:

$$\frac{p_{t+1} + r_t}{p_t} = \frac{q_{t+1} + 1}{q_t} \geqslant \frac{1}{\beta}.$$

This equalization of rates of return is obvious if consumers hold part of those assets: the rates of return must then be equal to the inverse of the discount factor (i.e., $1/\beta$). But, from the optimization condition at the end of period $t - 1$, rate-of-return equalization holds even if all assets are held by entrepreneurs. Indeed, the latter allocate their wealth $p_t a + q_t l$ so as to solve

$$\max\{\beta V_t(a, l) - p_t a - q_t l\}.$$

As earlier, the rental rate for real estate is given by

$$D_{\mathrm{R}}(r_t) = A - \lambda I_t.$$

The difference between this and the earlier treatment is that the aggregate investment I_t is now larger due to the availability of the alternative store of value. In particular, if the pure store of value is entirely held by the entrepreneurs, which, starting from the equilibrium for $L = 0$ studied in Section 14.3.3, requires that L not be too large,[32] then

$$I_t = \frac{(p_{t+1} + r_t)A + (q_{t+1} + 1)L}{(1 + \lambda r_t) - \rho_0}.$$

Glut of stores of value. To illustrate the impact of an alternative store of value in the Kiyotaki–Moore model, suppose that L is large and so stores of value are in part held by consumers. Then the rate of return on the stores of value must be equal to the consumers' rate of discount:

$$\frac{p_{t+1} + r_t}{p_t} = \frac{q_{t+1} + 1}{q_t} = \frac{1}{\beta},$$

and so

$$q_t = q = \frac{\beta}{1 - \beta}$$

(in contrast, p_t increases over time as the economy grows and thus the industrial use of real estate drives the rental rate r_t up).

Suppose that entrepreneurs at date 0 start with a small amount of assets.[33] Then, as long as the NPV is strictly positive, that is, as long as

$$\rho_1 > 1 + \lambda r_t,$$

successful entrepreneurs do not want to consume. They accumulate assets until their firms are wealthy enough that their investment and the concomitant demand for commercial real estate drives the rental rate to its steady-state value r^* and the NPV to 0:

$$\rho_1 = 1 + \lambda r^*.$$

To see why successful entrepreneurs indeed hoard assets until the economy reaches its steady state, note that, for $\rho_1 > 1 + \lambda r_t$,

$$q_t < \beta\left[\frac{\rho_1 - \rho_0}{(1 + \lambda r_t) - \rho_0}\right](q_{t+1} + 1),$$

31. The date-t investors' breakeven condition becomes

$$p_{\mathrm{H}}\left[Ri - \frac{Bi}{\Delta p} + p_{t+1}a + q_{t+1}l\right] + (1 - p_{\mathrm{H}})[p_{t+1}a + q_{t+1}l] + ar_t + l = [1 + \lambda r_t]i.$$

32. This is the case whenever

$$\frac{p_{t+1} + r_t}{p_t} = \frac{q_{t+1} + 1}{q_t} < \frac{1}{\beta},$$

where

$$D_{\mathrm{R}}(r_t) = A - \lambda\frac{(p_{t+1} + r_t)A + (q_{t+1} + 1)L}{(1 + \lambda r_t) - \rho_0}.$$

To see when this holds, one can *a contrario* assume that

$$\frac{p_{t+1} + r_t}{p_t} = \frac{q_{t+1} + 1}{q_t} = \frac{1}{\beta}$$

and

$$D_{\mathrm{R}}(r_t) > A - \lambda\frac{(p_{t+1} + r_t)A + (q_{t+1} + 1)L}{(1 + \lambda r_t) - \rho_0}.$$

This latter set of conditions holds if and only if $L > \bar{L}$ for some $\bar{L} > 0$. Conversely, the former set holds if and only if $L < \bar{L}$.

33. But not equal to 0; otherwise, having no endowment in each period, they would never "get started."

and so an entrepreneur with retained earnings, say, 1 unit of pure store of value, at the end of period $t-1$ is better off saving it, which will allow her to borrow $(q_{t+1}+1)/[(1+\lambda r_t)-\rho_0]$ and enjoy payoff $\rho_1-\rho_0$ on each unit of investment, rather than selling it at price q_t and consume the proceeds.

The steady-state values (indexed by an asterisk) are then given by

$$\rho_1 = 1+\lambda r^*,$$

$$p^* = \frac{\beta}{1-\beta} r^*,$$

$$q^* = \frac{\beta}{1-\beta},$$

$$D_{\mathrm{R}}(r^*) = A-\lambda I^*.$$

The economy converges to the steady state in finite time, and its path is uniquely determined. This result illustrates the role played by the Kiyotaki–Moore assumption that there is no (or, more generally, little) alternative store of value.[34]

The next chapter analyzes the equilibrium determinants of the quantity of stores of value in the economy and emphasizes the theme (touched upon in this subsection) that an increase in the volume of stores of value (liquidity) reduces liquidity premia and interest rates and benefits the productive sector.

14.4 Exercises

Exercise 14.1 (investment externalities in an industry with decreasing returns to scale). Suppose that the entrepreneur's limited attention, say, induces decreasing returns to scale. Income in the case of success is $R(I)$, where $R'>0$, $R''<0$, $R'(0)=\infty$, $R'(\infty)=0$. Redo the analysis of the Schleifer–Vishny model with this modification, and determine the sign of the investment externality.

Exercise 14.2 (alternative distributions of bargaining power in the Shleifer–Vishny model). Perform the analysis of Section 14.2.2 for an arbitrary unit price $P\in[0,\rho_0]$ of resale of a distressed firm's assets to a productive one. (Assume that bargaining occurs between the two firms' investors, and that the acquiring firm's investors then redesign their managerial incentives. Thus the per-unit surplus ρ_0-P goes to the acquiring firm's investors.)

Exercise 14.3 (liquidity management and acquisitions). Consider the model of Section 14.2.5 when the retooling cost is random. Suppose that this retooling cost is drawn from cumulative distribution function $F(\rho)$ on $[0,\infty)$, with density $f(\rho)$ and monotonic hazard rate ($f(\rho)/F(\rho)$ is decreasing). The level of the retooling cost is privately observed by the potential acquirer (the safe firm). The timing is as described in Figure 14.2.

Assume that the safe firm's entrepreneur and investors *ex ante* secretly agree on an investment level I and a credit line L. This credit line can be used if needed for the acquisition by the entrepreneur and completed by the liquidity, $\rho_0 I$, that can be raised through a seasoned offering that dilutes the initial investors. (Fixing a credit line L of this sort is indeed an optimal policy.)

One will assume that the seller always has the bargaining power ($z=1$ in the notation of Section 14.2.5) and therefore sets price P. Lastly, let ρ^* denote the equilibrium threshold for the retooling cost (that is, assets in equilibrium are acquired and retooled if and only if $\rho\leqslant\rho^*$).

(i) Write the entrepreneur's optimal liquidity management (to this end, follow the steps described in Chapter 5). Show that given (anticipated) equilibrium price P, the threshold ρ^* satisfies the "indifference between make and buy" equation:

$$P+\rho^* = 1.$$

(ii) Write the objective function of the risky firm when in distress. Compute the equilibrium price P. Note that $P<1$. What happens to P if for some reason the anticipated level L increases?

(iii) Suppose that the cumulative distribution function $F(\rho)$ converges to a spike at $\bar{\rho}$.[35] Show that

$$P+\bar{\rho} = 1,$$

and that $F(\rho^*)$ converges to 1.

34. Comparing this steady state with one that prevails when $L=0$, the rental rate is larger due to the large investment afforded by the introduction of the pure store of value.

35. While still satisfying the monotone hazard rate property.

Exercise 14.4 (inefficiently low volume of asset reallocations). This exercise applies the logic of corporate risk management developed in Chapter 5 to show that, even with frictionless resale markets, there will be an inefficiently low volume of transactions in the secondary market.

There are three dates, $t = 0, 1, 2$, and at least two firms $i = 1, 2$.

Firm 1, the firm of interest, is managed by a risk-neutral entrepreneur, who owns initial wealth A at date 0 and is protected by limited liability. This firm invests at a variable investment level $I \in [0, \infty)$. The per-unit profitability of investment is random and learned at date 1. The investment yields RI with probability $p + \tau$ and 0 with probability $1 - (p + \tau)$. The random variable τ is drawn from a continuous distribution. The variable p is equal to p_H if the entrepreneur behaves (no private benefit) and p_L if the entrepreneur misbehaves (private benefit BI). Let

$$\rho_1 = (p_H + \tau)R$$

and

$$\rho_0 = (p_H + \tau)\left(R - \frac{B}{\Delta p}\right) \equiv \rho_1 - \Delta\rho$$

denote the random continuation per-unit NPV and pledgeable income when the entrepreneur behaves and the realization of profitability is τ. The distribution on τ induces a cumulative distribution function $F(\rho_0)$ on $[\underline{\rho}_0, \bar{\rho}_0]$.

At date 1, the firm may either continue or resell assets I to firm 2 (or to a competitive market). Firm 2 has a known level $\hat{\rho}_0$ of per-unit pledgeable income per unit of investment (its NPV per unit of investment is in general larger than this).

Firms 1 and 2 do not contract with each other at date 0. Rather, investors in firm 1 make a take-it-or-leave-it offer to firm 2 at date 1 if firm 1's initial contract specifies that assets ought to be reallocated.

Assume for simplicity that the contract between firm 1's investors and the entrepreneur can be contingent on the realization of ρ_0.

Show that at the optimal contract assets are resold whenever $\rho_0 < \rho_0^*$, where

$$\rho_0^* < \hat{\rho}_0,$$

and so the volume of asset reallocations is inefficiently low.

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