

Asymmetric Information in Financial Markets

Introduction and Applications

Ricardo N. Bebczuk



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1 An introduction to asymmetric information problems in financial markets

A **debt contract** establishes the legal rights and obligations for those who receive financing (**borrowers**) and those who provide it (**lenders**). Essentially, the borrower promises to repay the principal plus the required interest in a stipulated amount of time. However, beyond all legal provisions, the contract is compromised once economic considerations are taken into account.

In the first place, the intrinsic **uncertainty** surrounding any investment project puts the borrower's ability to repay in question. As significant as it may seem, this obstacle can be reasonably overcome by estimating the probability of full reimbursement and consequently adjusting the interest rate. The second hindrance, the borrower's fragile promise loyally to obey the contract, can be more difficult to surmount. An experienced observer will note that a borrower can attempt to disguise the true nature of a project or, once in possession of borrowed funds, divert them to other uses or conceal the true outcome of his investment. These issues are known as **asymmetric information** problems. Conflicts of interests will arise if these factors hamper the lender's profitability. The origin of these obstacles and their effects on financial markets are the issues that we will study in this chapter.

1.1 Economic characteristics of financial contracts

In order to understand the implications of asymmetric information on financial markets we first need to explore the fundamental relationship between borrower and lender. A financial contract will be written only if the expected profit of the lender and the borrower is equal to or higher than the next best alternative project. This is the so called **participation constraint** or **individual rationality constraint**: no rational individual will take part in an investment either with negative expected return, or with a profit that does not reach a minimum required level of expected return, determined by the investment opportunity that is forgone for this particular business. This minimum floor is known as the **opportunity cost** or **required return**. Let us look at an example using the notation we will employ throughout the book. We will suppose there is only one productive project, with initial investment $I = \$100$. One year later it offers two possible **cash flows**: if successful, $CF_s = \$300$; if it fails, $CF_f = \$0$. The probability of success α_s , is 0.7 and the probability of failure

$\alpha_f = (1 - \alpha_s)$ is 0.3. The **expected value** EV of the project is:

$$\begin{aligned} EV &= \alpha_s CF_s + \alpha_f CF_f \\ &= 0.7 \times \$300 + 0.3 \times \$0 \\ &= \$210 \end{aligned}$$

Does this project satisfy the conditions for the writing of a financial contract? To answer this question, we need more information. First, let us assume that the **initial investment** is \$100 and the required return r is 10 per cent. This indicates that a lender who finances the project through a \$100 **loan**, L , could obtain a 10 per cent return by investing his money in, for example, government bonds or simply making a bank deposit. He will not lend money at less than 10 per cent; nor will the lender be able to charge a higher interest rate, since borrowers will arrange loans with other banks charging 10 per cent.

The project involves a risk for the bank because, if it fails, the entrepreneur cannot repay the debt and goes bankrupt, transferring CF_f to the bank. However, the borrower is not forced to use personal assets to pay for the capital and interest owed. This feature of the contract is known as **limited liability**. Under the simple case in which $CF_f = 0$, the loan's **interest rate** allows the bank to achieve its opportunity cost $(1 + r)L$.¹

$$\begin{aligned} (1 + r)L &= \alpha_s(1 + r_L)L + \alpha_f CF_f \\ (1 + r)L &= \alpha_s(1 + r_L)L \\ 1 + r_L &= \frac{(1 + r)}{\alpha_s} \end{aligned}$$

In the previous example, the resulting rate is:

$$\begin{aligned} r_L &= \frac{(1 + 0.1)}{0.7} - 1 = \frac{1.1}{0.7} - 1 \\ r_L &= 0.57 = 57 \text{ per cent} \end{aligned}$$

Whenever $CF_f < (1 + r)L$, the loan's interest rate will be greater than the bank's required rate of return, $r_L > r$. Given that the bank will participate in the project, let us see if the borrower is satisfied with the contract. Assuming the borrower does not use personal resources for funding, the project will be attractive as far as it yields any positive return. The borrower's **expected profit** $E\pi$ is:

$$\begin{aligned} E\pi &= \alpha_s[CF_s - (1 + r_L)L] \\ &= 0.7 \times [\$300 - (1 + 0.57) \times \$100] \\ &= \$100.0 \end{aligned}$$

As the project satisfies the economic demands of both parties, we can then conclude that the project will go forward. It is evident that both the borrower and the lender *expect*

¹ This equation implicitly assumes that the bank operates in a competitive market where no abnormal profits beyond the opportunity cost can be reached. This means that the bank is able to just cover the cost of its deposits (left-hand side) with the expected revenue from its loans (right-hand side). Additionally, notice that we assume that the bank has no operating costs.

(as opposed to *obtain* with certainty) a profit, because financial contracts are claims on *uncertain* future revenues. The project's actual value will be either \$300 or \$0, and not the expected value of \$210. Uncertainty, however, means that probabilities need to be assigned *a priori* to every possible result, and both lender and borrower rely on such probabilities at the time of deciding to enter the contract. Accordingly, even though it may look counterintuitive, they do not care about the effective outcome but only the expected one.

In this example, we have assumed that the bank and the borrower are indifferent to risk, that is to say **risk neutral**. The bank makes no distinction between a safe income of \$110 and an uncertain income that can be either \$157 or nothing, with an expected value of \$110; similarly, the borrower will obtain either \$143 or nothing with an expected value of \$100. As opposed to risk neutrality, most individuals exhibit **risk aversion**, meaning that they would prefer a safe income over an expected income of the same magnitude. Conversely, the risk averse individual will take on the risky option only if he is compensated with a *risk premium*, that is, he will be indifferent between a safe income of \$110 and an uncertain, expected income of \$120, where the risk premium is the \$10 extra income from the second alternative. However, for the moment we will assume risk neutrality because, as we will see, it is entirely possible to analyse asymmetric information problems without introducing risk aversion, thus avoiding unnecessary complications. In later parts of the book, we will give risk aversion a meaningful role in our investigation.

This contract is relatively simple to establish and analyse, since the lender knows for certain both the cash flows and their associated probabilities. The risk of failing is present, but the lender appropriately responds by charging a higher interest rate. If both the borrower and the lender have access to the same information regarding the contract, we say the agreement is realized under symmetric information. Here we examine a case where borrowers and lenders do not have access to the same information. There is **asymmetric information** in a financial contract when the borrower has information that the lender ignores or does not have access to. Although we will be more detailed later on, for the moment we want to identify the crucial factors surrounding the problem of asymmetric information. This asymmetry concerns the lender whenever the borrower can use this information profitably at the lender's expense, and is connected with the following circumstances:

- (i) The borrower violates the contract by hiding information about the characteristics and the revenues of the project
- (ii) The lender does not have sufficient information or *control* over the borrower to avoid cheating
- (iii) There is debt repayment risk and the borrower has limited liability.

We can illustrate the problem with the prior example, presuming that (i) the borrower knows the true probability of success to be 70 per cent, but reports 90 per cent to the lender; (ii) the lender has no way to verify what the borrower maintains; (iii) as before, if the project fails, the loan is not paid. Based on this information, the lender charges an interest rate $r_L = 22.2$ per cent ($1.1/0.9 = 1.222$), so that the borrower's expected benefit rises:

$$E\pi = 0.7 \times [\$300 - 1.222 \times \$100] = \$124.5 > \$100.0$$

and the lender's expected income falls:

$$EI_{Lender} = 0.7 \times (1.222 \times \$100) = \$85.5 < \$110$$

It follows that if the borrower had not misrepresented the information, none of the above would have happened. The importance of repayment risk becomes clearer with a counterexample. We will suppose that the announced probability of success is again lower than the real one, but in the worst scenario the cash flow is $CF_f = \$110$. In that case, the lender can recover principal and interest in any event, regardless of whether the borrower states the probability of success as 70 per cent or 90 per cent. In other words, *if the debt is safe, asymmetric information is irrelevant*, since the borrower is unable to rely on her limited liability.

Important lessons can be learned by looking at the problem more formally. Let us rewrite the borrower's expected profit and the expected income of the lender:

$$\begin{aligned} E\pi &= \alpha_s[CF_s - (1 + r_L)L] \\ &= \alpha_s CF_s - \alpha_s(1 + r_L)L \\ &= EV - \alpha_s(1 + r_L)L \end{aligned}$$

The bank's expected income EI_{Lender} is given by:

$$EI_{Lender} = \alpha_s(1 + r_L)L$$

The formulas reveal the potential conflict of interests that lie between borrower and lender. First note that $E\pi + EI_{Lender} = EV$: The contract establishes how the cash flows of the project are distributed between the two parties. If the borrower can conceal the true risk of the project and deliberately overestimate the probability of success, then $\alpha'_s > \alpha_s$ (in our example, $0.9 > 0.7$), the borrower will retain a larger part of the expected value. The expected value is:

$$\begin{aligned} E\pi &= \alpha_s[CF_s - (1 + r_L)L] \\ &= \alpha_s \left[CF_s - \frac{(1 + r)}{\alpha'_s} L \right] \\ &= \alpha_s CF_s - \frac{\alpha_s}{\alpha'_s} (1 + r)L \\ &= EV - \frac{\alpha_s}{\alpha'_s} (1 + r)L \end{aligned}$$

where we use the lender's income statement introduced earlier to define r_L (note that the bank determines the interest rate based on the declared probability of success, α'_s). The ratio α_s/α'_s is a good measure of the level of asymmetric information. The lower this ratio, the larger the benefit of the borrower at the expense of the lender. It can be easily seen that, under symmetric information, the announced probability of success coincides with the real one and the expected profit becomes:

$$E\pi = EV - (1 + r)L$$

Table 1.1 *Project properties*

	Before disbursement	After disbursement
Pre-determined project	Adverse selection	Monitoring costs
Choosing between projects		Moral hazard

The borrower appropriates the expected value of the project, *net* of the lender's required return. Because this profit is smaller than under cheating, there is a clear incentive to exploit the information advantage.

1.2 Forms of asymmetric information

Asymmetric information in financial markets can adopt any of the following types: adverse selection, moral hazard, or monitoring costs. A lender suffers **adverse selection** when he is not capable of distinguishing between projects with different credit risk when allocating credit. Given two projects with equal expected value, the lender prefers the safest one and the borrower the riskiest. In this context, those undertaking risky activities find it convenient to hide the true nature of a project, thereby exploiting the lender's lack of information. By **moral hazard** we mean the borrower's ability to apply the funds to different uses than those agreed upon with the lender, who is hindered by his lack of information and control over the borrower. As in the moral hazard case, **monitoring costs** are tied to a *hidden action* by the borrower, who takes advantage of his better information to declare lower-than-actual earnings.

Before continuing, we need to highlight the differences between these three types of asymmetric information. Adverse selection appears before the lender disburses the loan, in contrast to moral hazard and monitoring costs. In these cases the problem takes place after having conceded the capital. In adverse selection and monitoring costs the borrowers are assumed to have previously chosen the project, while in moral hazard they can opt for a different project once in possession of the funds. Table 1.1 summarizes these properties.

Adverse selection

To study the effect of adverse selection on the borrower–lender relationship, we shall use some simplifying assumptions. There are two types of productive projects, *A* and *B*, with the characteristics shown in table 1.2.

As before, *I* is the initial investment, totally financed with a loan *L*, *CF* is cash flow, and the subscripts *s* and *f* represent success and failure, respectively. Naturally, $(\alpha_{a,s} + \alpha_{a,f}) = (\alpha_{b,s} + \alpha_{b,f}) = 1$. Entrepreneurs are risk neutral. Supposing both projects have the same expected value *EV*:

$$\begin{aligned} EV_a &= EV = \alpha_{a,s} CF_{a,s} \\ EV_b &= EV = \alpha_{b,s} CF_{b,s} \end{aligned}$$

Table 1.2 *Project characteristics*

Project	Initial investment	Cash flow
A	I	$CF_{a,s}$ with probability $\alpha_{a,s}$ 0 with probability $\alpha_{a,f}$
B	I	$CF_{b,s}$ with probability $\alpha_{b,s}$ 0 with probability $\alpha_{b,f}$

with $CF_{b,s} > CF_{a,s}$, which, given the equivalent expected value of the two projects, implies that $\alpha_{a,s} > \alpha_{b,s}$. In the case without asymmetric information, the bank will charge a different interest rate for every project type:

$$(1 + r_{L,a}) = \frac{(1 + r)}{\alpha_{a,s}}$$

$$(1 + r_{L,b}) = \frac{(1 + r)}{\alpha_{b,s}}$$

Note that $\alpha_{a,s} > \alpha_{b,s}$ implies $r_{L,b} > r_{L,a}$, that is, the riskiest projects from the bank's perspective are penalized with a higher rate. But, no matter their differential risk, the expected profit is the same for both of them, that is, $E\pi_a = E\pi_b$.²

$$E\pi_a = EV - \alpha_{a,s}(1 + r_{L,a})L = EV - (1 + r)L$$

$$E\pi_b = EV - \alpha_{b,s}(1 + r_{L,b})L = EV - (1 + r)L$$

Note carefully that the lender receives $(1 + r)L$ in both cases, which suggests that the higher interest rate charged on the riskier type B just compensates for that risk: although the type B projects are asked to pay more than A if successful, the probability of success – and, correspondingly, of repayment – is lower. Ultimately, the expected payment to the lender is the same under both types:

$$\alpha_{a,s}(1 + r_{L,a}) = \alpha_{a,s} \frac{(1 + r)}{\alpha_{a,s}} = \alpha_{b,s}(1 + r_{L,b}) = \alpha_{b,s} \frac{(1 + r)}{\alpha_{b,s}} = 1 + r$$

It is also noteworthy that this means that, as long as we do not know the repayment risk of a particular firm, we are unable to assert if such a firm is facing worse financial conditions than others just by looking at the interest rate demanded on its loans.

Things change if the lender experiences adverse selection. Type B entrepreneurs have an incentive to ‘camouflage’ themselves to appear like those of type A and get the same low interest rates. On the other hand, the lender, though knowing the characteristics of each type of project, is incapable of observing to which type the entrepreneur pertains when seeking financing. The lender's only piece of information is the proportion of existing projects of

² This is a consequence of the competitive nature of the lenders' market, as no lender can charge an interest rate yielding an expected return higher than r . Also, bear in mind that the higher interest rate on the riskier projects does not constitute a risk premium but just the compensation for the lower repayment risk (since the lender is risk neutral, it requires a return equal to r on both types).

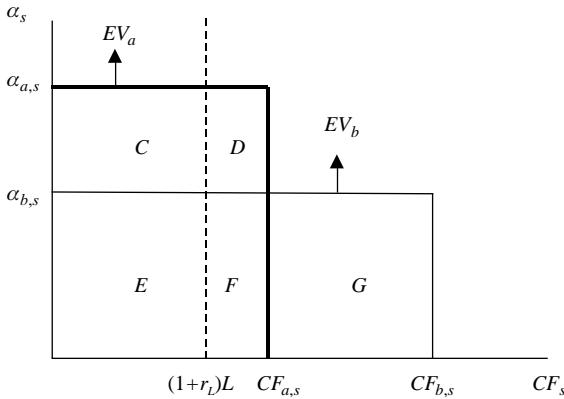


Figure 1.1 Distribution of EV under adverse selection

type A and B in the population, p_a and p_b , with $p_a + p_b = 1$, which allows her to infer that the probability of choosing randomly A or B is precisely p_a and p_b .³ Provided that all entrepreneurs claim to be type A and the lender is unable to ascertain this, she will use these probabilities to establish a *single* interest rate for both types of projects in order to secure an expected return r :

$$\begin{aligned}(1+r) &= p_a[\alpha_{a,s}(1+r_L)] + p_b[\alpha_{b,s}(1+r_L)] \\(1+r) &= [p_a\alpha_{a,s} + p_b\alpha_{b,s}](1+r_L) \\(1+r_L) &= \frac{(1+r)}{p_s}\end{aligned}$$

where $p_s = p_a\alpha_{a,s} + p_b\alpha_{b,s}$ is the weighted probability of success anticipated by the lender. As $\alpha_{a,s} > p_s > \alpha_{b,s}$, the new, unique interest rate is an intermediate value between the rates that would prevail in absence of asymmetric information:

$$r_{L,b} > r_L > r_{L,a}$$

Type B borrowers' strategy is therefore partially successful, since they achieve a reduction in their financing costs but they do not get the looked-for rate $r_{L,a}$. Meanwhile type A borrowers suffer an increase in their interest rates, which is precisely what makes it possible for type B borrowers to reap an extra profit, as we shall see later. Combining the fact that the contract is more attractive for risky borrowers than for safe ones, the lender is prone to make an *adverse selection*, leaning toward the projects that are *a priori* less favorable for her interests.

Figure 1.1 illustrates the problem.

As the vertical axis represents the probability of success and the horizontal the corresponding cash flow, the rectangles $(C + D + E + F)$ and $(E + F + G)$ represent the expected

³ This is an application of the statistical law of large numbers. If the lender knows that among the, say, 10,000 candidates soliciting credit, there are 7,000 of type A and 3,000 of type B , he can trust that a randomly picked borrower will be type A with a probability 0.7 and a type B with probability 0.3.

Table 1.3 *Distribution of the expected value of projects A and B*

	Borrower	Lender	Total
Project A	$D + F$	$C + E$	$EV_a = C + D + E + F$
Project B	$F + G$	E	$EV_b = E + F + G$

Table 1.4 *How outcomes vary with the existence of adverse selection*

	Project A	Project B
CF_s	300	700
CF_f	0	0
α_s	0.7	0.3
α_f	0.3	0.7
EV	210	210
I	100	100
r	0.1	0.1
p	0.5	0.5
Without adverse selection:		
r_L	0.57	2.67
$E\pi$	100	100
EI_{Lender}	110	110
With adverse selection:		
r_L	1.2	1.2
$E\pi$	56	144
EI_{Lender}	154	66

value of projects A and B , respectively. Knowing that project A has a higher probability of success, but that both have the same expected value, rectangle EV_a is taller with a shorter base than EV_b . In both cases, the cash flow in the favourable scenario exceeds the amount of the debt and interest payments, $(1 + r_L)L$.

As stated in the contract, the lender receives a fixed revenue, $(1 + r_L)L$, weighted by the project's probability of success, which yields an expected income of $(C + E)$ for project A , and E for project B . The type A borrower receives the remaining part of EV_a , $(D + F)$, while the area $(F + G)$ corresponds to the type B borrower (table 1.3).

As $EV_a = EV_b$, $C + D + E + F = E + F + G$, which implies that $C + D = G$. Hence, we deduce that $G > D$, or, equally, $F + G > D + F$, confirming that a type B borrower's expected benefit exceeds that of a type A borrower.⁴

Table 1.4 presents a numerical example that should reinforce the understanding of the idea and fix the notation.

⁴ To observe the distribution of the expected value in absence of adverse selection, we can modify the chart by eliminating $(1 + r_L)L$ and replacing it by lines specific to each project; that is, $(1 + r_{L,a})L$ to the left and $(1 + r_{L,b})L$ to the right, recalling that $r_{L,b} > r_L > r_{L,a}$.

Table 1.3 shows how outcomes vary depending on the existence of adverse selection.⁵ In absence of adverse selection: (a) the interest rate for risky projects is greater than for those with a higher probability of repayment; (b) independently of the project type, the lender obtains the required return r on each dollar or pound lent, while the borrower receives the remaining part of the expected value. The situation changes radically under adverse selection: (a) the interest rate is the same for both projects, specifically an average of the rates without adverse selection; (b) the lender's expected return is higher than the required return in project A and less than the required return in project B but, on average, the lender gets the required return. Consequently, the risky borrower obtains a larger benefit when there is imperfect information, with the opposite, naturally, happening for a type A borrower.

Moral hazard

We say there is moral hazard when the debtor invests in a different project than the one that was agreed upon with the lender. Let us suppose there are two projects, H and L , with the following expected values:

$$\begin{aligned}EV_h &= \alpha_{h,s} CF_{h,s} \\EV_l &= \alpha_{l,s} CF_{l,s}\end{aligned}$$

with $EV_h > EV_l$ – that is why we term them H and L (for high and low). We will also assume that $CF_{l,s} > CF_{h,s}$ and $\alpha_{h,s} > \alpha_{l,s}$. If the project succeeds, the loan is repaid, while in a negative event, the cash flow is zero. Regardless of the final use of the funds, every prospective borrower will announce that she will undertake type H projects, since in that way she will be charged $r_{L,h}$, which is lower than $r_{L,l}$. If the borrower, hiding the real type from the lender, embarks on project L , the lender will get an expected return lower than the required one. In light of that, unlike the case of adverse selection, as the borrower can choose the project in which the capital is invested, the lender needs to make sure that project H is more attractive than project L in the borrower's eyes. Thus, by ensuring that $E\pi_h > E\pi_l$ (the so-called **incentive compatibility constraint**), the interest rate will be $r_L = r_{L,h}$:

$$1 + r_L = 1 + r_{L,h} = \frac{1 + r}{\alpha_{h,s}}$$

However, for this situation to be an equilibrium in which the lender as well as the borrower have the correct incentives to participate in project H , it is essential that the loan interest rate r_L is such that:

$$E\pi_h = \alpha_{h,s}[CF_{h,s} - (1 + r_L)L] > E\pi_l = \alpha_{l,s}[CF_{l,s} - (1 + r_L)L]$$

from which we can extract the *maximum* interest rate consistent with $E\pi_h > E\pi_l$:

$$(1 + r_L)_{\max} < \frac{\alpha_{h,s} CF_{h,s} - \alpha_{l,s} CF_{l,s}}{(\alpha_{h,s} - \alpha_{l,s})L}$$

⁵ Note that the example is not very realistic, as the interest rates are exorbitant as a consequence of the high risk of the projects: not only are probabilities of success low, but also in the case of failure the lender does not get a cent. To make up for this, the lender takes possession of an important portion of the income in case of success by means of a high interest rate.

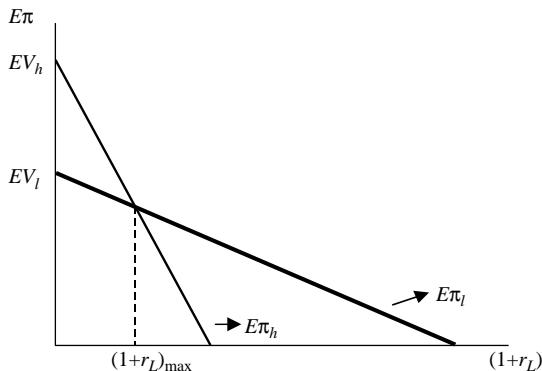


Figure 1.2 Project selection under moral hazard

According to this formula, the tolerance of project H to the interest rate increases with its expected value, but decreases with its probability of repayment. If $(1 + r_{L,h})$ is less than this limit, the asymmetric information problem will be irrelevant, as borrowers have no incentive to break the promise of taking on project H , and the lender will receive the expected return r . Conversely, a rate $(1 + r_{L,h})$ higher than $(1 + r_L)_{\max}$ will attract all borrowers to type L projects, under the false pretence of choosing type H ones, in order to benefit from the lower available interest rate.⁶ We can show this by observing the trajectory of the expected benefit as the interest rate rises (figure 1.2).

$$\begin{aligned} E\pi_h &= EV_h - \alpha_{h,s}(1 + r_L)L \\ E\pi_l &= EV_l - \alpha_{l,s}(1 + r_L)L \end{aligned}$$

When $(1 + r_L) = 0$, the expected benefit is equal to the project's expected value, falling gradually until reaching the rate $(1 + r_L)_{\max}$, after which $E\pi_h < E\pi_l$. The cause of the rapid fall of $E\pi_h$ compared to $E\pi_l$ is, once again, the structure of the debt contract: *for the same interest rate, the higher the probability of repayment (that is, the lower the repayment risk), the lower the borrower's limited responsibility.*⁷ In other words, for type H borrowers it is more difficult to elude their financial obligations. To illustrate the point, let us observe how the debt service (capital of \$100 plus interest) changes when the interest rate rises from 20 per cent to 30 per cent and $\alpha_{a,s} = 0.7$ and $\alpha_{b,s} = 0.3$ (table 1.5).

It can be seen that type H 's expected profit suffers the most. Let us now verify with a numerical example that the expected value of the project is not the only decision variable at the time of choosing the most profitable project from the borrower's point of

⁶ Notice how different the lender's attitude is in the face of adverse selection and moral hazard: in the first situation, as the borrower sticks to the original project, it is feasible to set a higher interest rate for type A entrepreneurs, while under moral hazard the ability of the borrower to switch between projects forces the lender to set an interest rate as low as possible to indirectly control the borrower.

⁷ In the case of adverse selection, the problem is more acute because both projects are assumed to have the same expected value EV , which means that the project with a lower probability of repayment will always be preferred if the debtor is able to choose the project type.

Table 1.5 *Changes in debt service*

Borrower type	$r_L = 20\%$	$r_L = 30\%$	Difference
Type H	84	91	7
Type L	36	39	3

Table 1.6 *Decision variables*

	Project H	Project L
CF_s	200	400
CF_f	0	0
α_s	0.7	0.3
α_f	0.3	0.7
EV	140	120
J	100	100
r	0.1	0.1

view (table 1.6).

$$(1 + r_L)_{\max} < \frac{\$140 - \$120}{(0.7 - 0.3) \times \$100} = 0.5$$

As $(1 + r_L)$ is necessarily greater than 0.5, the borrower will prefer project L , even though the expected value of project H is much higher than that of project L . Let us now imagine that $CF_{h,s} = \$265$ and $EV_h = \$185.5$, in which case the entrepreneur will choose project H , provided the interest rate does not exceed the following limit:

$$(1 + r_L)_{\max} < \frac{\$185.5 - \$120}{(0.7 - 0.3) \times \$100} = 1.6375$$

The interest rate on project H is 57.1 per cent ($1.1/0.7 = 1.571$). Observe how wide the difference in expected value must be for the project H to be accepted in this particular example. Furthermore, if the required return r rises, not even this difference is sufficient. If r goes from 10 per cent to 15 per cent, elevating $r_{L,h}$ to 64.3 per cent ($1.15/0.7 = 1.643$), this again pushes the balance in favour of the risky project.

Much like the interest rate, the incentive to adopt riskier projects grows with the amount of debt L . It can be seen that the graph in figure 1.2 would look the same if we were to replace $(1 + r_L)$ by L on the horizontal axis. This finding should not surprise us because it is in line with our previous discussion: in the end, the temptation to dishonesty increases with the total amount of debt owed, including both capital and interest.

Monitoring costs

If the borrower takes advantage of his better information to deceive the lender by deliberately underreporting profits, the lender, who cannot directly observe the investment outcome, will be forced to monitor the borrower every time he declares himself unable to repay the whole debt. To do this, the contract stipulates that every time this borrower announces default, the lender has the right to audit the borrower and seize the whole verified cash flow. Every audit has cost c , devoted to hiring accountants and lawyers to do the job. For reasons explained later, we suppose there are three (instead of two) possible states described by:

$$CF_3 > CF_2 > (1 + r)L > CF_1$$

and the associated probabilities are α_1, α_2 and α_3 , with $\alpha_1 + \alpha_2 + \alpha_3 = 1$. The lender knows both cash flows and probabilities, but has no information about the borrower's honesty. The possibility that the bank may seize the revenues at any time will prevent the borrower from declaring CF_1 when the true cash flow is CF_2 or CF_3 . At the same time, declaring CF_2 when the actual value is CF_3 is irrelevant from the bank's perspective since in either case the bank receives full repayment of the debt. For this reason, the lender will carry out an audit every time the debtor declares CF_1 , which will happen with probability α_1 , with monitoring costs amounting to $\alpha_1 c$. The loan's interest rate is determined, as usual, by the following equation, with the only modification being that the lender's net income in the bad state 1 is reduced by the auditing costs:

$$(1 + r)L = (\alpha_2 + \alpha_3)(1 + r_L)L + \alpha_1(CF_1 - c)$$

$$(1 + r_L) = \frac{(1 + r)L - \alpha_1(CF_1 - c)}{(\alpha_2 + \alpha_3)L}$$

It is crucial to emphasize that the borrower's apparent information advantage can be self-defeating, because in the end it increases the cost of debt, once the expected monitoring costs are a component of the interest rate – the lender is determined to reach a *net* expected return equal to r . Also noteworthy is that both the dishonest and the honest borrower, who is always willing to announce the true cash flow, endure the interest rate increase.

Graphically, the problem takes the following form (figure 1.3).

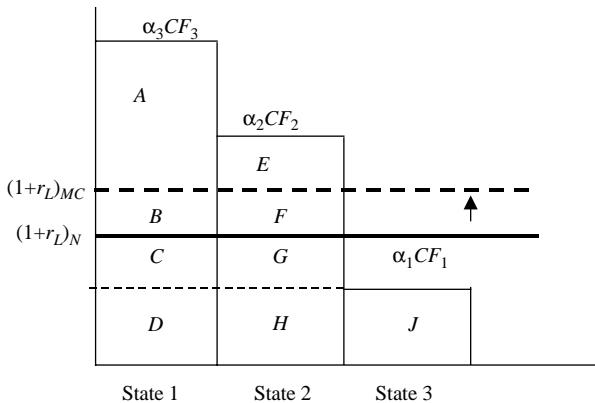
From figure 1.3 we can establish the borrower's expected profit and the lender's and auditor's expected revenues (table 1.7).

The root of the problem is the borrower's temptation to declare a cash flow CF_1 that, even when true, the lender cannot verify without incurring monitoring costs. The common extra cost for all types of borrowers is the higher debt service, which jumps from $[(1 + r_L)L]_N$ to $[(1 + r_L)L]_{MC}$. By reading the first row in table 1.7, we find that under no monitoring, dishonesty pays off (the dishonest borrower earns $(C + G)$ more than the honest one) at the expense of the lender's expected income, but cheating stops being convenient under monitoring. As the lender threatens to audit, the dishonest borrower reviews his strategy – that is, monitoring aligns the incentives of both lender and borrower.⁸

⁸ Actually, as far as the lender seizes enough cash flow to reduce the dishonest borrower's expected profit below $(A + E)$ – the honest borrower's profit – and not necessarily zero, the incentive compatibility is restored.

Table 1.7 *Expected profit and expected revenues*

	Without monitoring		With monitoring	
	Honest	Dishonest	Honest	Dishonest
$E\pi$	$A + B + E + F$	$A + B + E + F + C + G$	$A + E$	0
EI_{Lender}	$C + D + G + H + J$	$D + H + J$	$C + D + G + H + J$	$C + D + G + H + J + A + E$
$EI_{Auditor}$	0	0	$B + F$	$B + F$

Figure 1.3 Distribution of EV under monitoring costs

A new aspect of the asymmetric information problem is the appearance of the auditor, who obtains the portion ($B + F$) of the expected value of the project. Although it is the lender who carries out the control, the monitoring arising out of asymmetric information represents a social waste of resources that could end up in the hands of the entrepreneur.

1.3 Discussion

Is asymmetric information a relevant concept for understanding capital markets? We have argued here that in order for this to happen, uncertainty about the project outcome and a potential financial damage to the lender arising from his lack of information must be present. Both phenomena affect the majority of financial contracts. Every investment involves risk – moreover, competition between firms guarantees that there cannot be risk-free investment opportunities offering returns higher than the interest rate. At the same time, cases in which the lender is immunized from opportunist actions on the part of the borrower are rare. Thousands of bankruptcies every day are clear evidence that both the borrower's and lender's fortunes are intimately intertwined.

Having validated the existence and significance of the problem, let us briefly consider its dynamics. The borrower's incentive strategy rests on extracting an extra gain at the expense of an uninformed lender. But rational lenders are aware of their informational inferiority and cover themselves in different ways. In the final equilibrium, *it is the better-informed group (borrowers) that are supporting the costs of asymmetric information and, what is more*

unfortunate, low-risk and honest borrowers end up involuntarily providing a cross-subsidy to high-risk and dishonest borrowers.

It is necessary to clarify that the sanctions are economic and not legal. In our analysis, the borrower who defaults does not face trial and her assets are not expropriated. The choice of a risky project in place of an agreed-upon conservative endeavour is a matter difficult to prove in a court, because it is always possible to attribute the eventual failure to a stroke of bad luck, since in the end all projects are to some extent risky. When dishonesty is in the form of misrepresenting revenues, and the lender can prove this through an audit, this can give rise to legal action. In fact, the adopted solution (seizing control of the effective revenues if deceit is verified) has an effect similar to an executive legal action that penalizes the lender who fails to fulfil his part of the contract.

Before finishing, the ethical aspect of financial contracts must be addressed. Our borrower is an individual who does takes the opportunity to fool the lender by hiding risk or profits. The economic and financial theory revolves around individuals whose sole objective is to maximize monetary gain, and thus have no morals. The undeniable existence of asymmetric information behaviour in the real world leads us sadly to admit that such representation is not just a theoretical simplification.

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