# Investment and Capital Market Imperfections

## Motivation

**So far we have assumed that capital markets are perfect**:

==> Potential projects valued according to expected payoff and risk

Undertaken if value > cost of acquiring and installing new capital

Where cost based on economy-wide interest rate

==> **Amount of investment efficient**

**In the real world**, however, capital markets are imperfect. The biggest problem is one of asymmetric information.

**Asymmetric information—firms have more information about their potential projects than the people from whom they borrow money.**

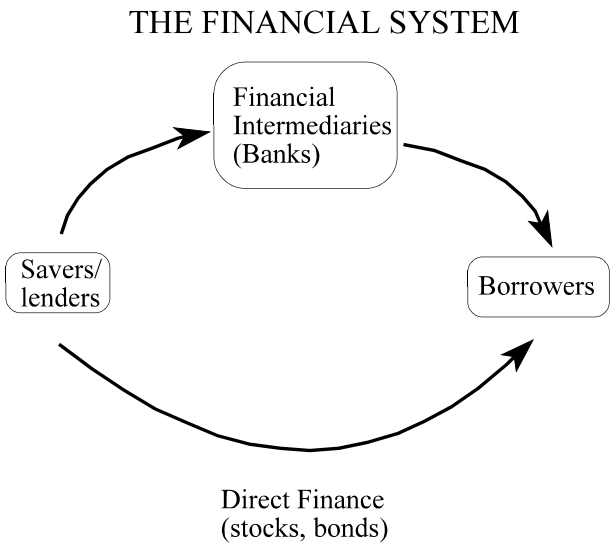
Leads to a couple of specific problems ...

**Adverse Selection: Lenders cannot distinguish good credit risks from bad credit risks and thus the market interest rate reflect the average credit risk. But, the good credit risks generally won't be willing to borrow at this rate so the market will be flooded with bad credit risks. Creates a "lemons problem."**

**Moral Hazard: Once money has been lent, the borrower has the incentive to do things that are not in the lender's interests.**

On area where we see these information problems having a big impact is on the structure of the financial system and the composition of firm financing.

Consider the following diagram of the flow of funds in the economy.




In the real world, the pool of savers consists of firms, households and the government (sometimes), but for the purposes of our course, we are going to think about funds coming from households. (Households are, in fact, the primary type of lenders in the real world.)

In the real world, we find firms, households, and the government as borrowers. But, for right now, we are going to think of borrowers as firms who will use the money for investment.

Anyway—getting back to asymmetric information. It turns out that the problem is particularly bad along the direct finance route because (1) households have much less information about the firm's projects than the firm does and (2) their stakes are not large enough to want to pay for monitoring.

Financial intermediaries basically exist because of the information problems. Institutions like banks become specialists in acquiring information about firms (its more efficient to do this on a large-scale basis) and thus can get around some of the information problems. However, one should keep in mind that even banks cannot do this perfectly, so there is still some asymmetric information along the indirect finance route. (Also, there is some asymmetric information between lenders and banks.)

**Some stylized facts about the composition of firms' financing that are explained by information problems.**

**Sources of External Finance**
**(U.S. Nonfinancial Businesses, 1970-1985)**

| | |
|---|---|
| **Stocks** | **2.1%** |
| **Bonds** | **29.8%** |
| **Loans** | **61.9%** |

What should stand out here is the fact that most financing is actually done indirectly through loans from financial intermediaries. This is a direct outcome from the information problems I just described. (The situation is actually even more skewed than the numbers suggest since a lot of stocks and most of bonds are actually held by financial intermediaries rather than households.)

Also note how unimportant stocks are. The formal model that we go through next will show why it is that a bond contract is generally the optimal type of contract between the lender and the borrower.

## A Formal Model

We will now go through the formal model of financial market imperfections from Romer.

The model is simple and quite specific in its assumptions--for example, it deals with a specific type of information problem, costly state verification--but

- It can be generalized to lots of different types of information problems.
- Romer cites a number of papers that you can read if you want to explore this topic further.

### Assumptions

- **Entrepreneur can undertake project that requires 1 unit of resources**

- **Project output distributed uniformly on [0, 2$\gamma$]**

  - **$\gamma > 0$, heterogeneous across entrepeneurs**
  - **expect output is $\gamma$** (comes right out of the uniform distribution assumption)

- **Entrepreneur's wealth = W**

  - **must borrow 1 - W from outsiders if undertakes the project**

    Note that if the entrepreneur's money is all tied up in the project, then her payment back to lenders cannot exceed the project's output and thus that the lenders bear some of the risk.

- **Risk-free interest rate = r**

  - **Entrepreneur risk neutral**

    **==> Will undertake project if**

    $$\gamma - E[\text{pymt to outsiders}] > (1+r)W$$

  - **Outside investors risk neutral and competitive**

    **==> In equilibrium, their expected rate of return must be r**

**Case 1: Symmetric Information**

**Here, outside investors can observe the project's output without cost**.

In other words, they have the same amount of information as firms.

**Equilibrium:**

- **Entrepreneurs with projects with expected payoff $\gamma > 1+r$**

**get financing and undertake projects.**

- **For projects undertaken, loan contract written such that**

  **E[pymt to investor] = (1-W)(1+r)**

  **For example, contract may guarantee investor the fraction $(1-W)(1+r)/\gamma$ times output. In this case, the expected payment is (1-W)(1+r).**

  **Equilibrium because ...**

  **Outside investors will be happy to take this deal** since they get as much as they could lending their money out at the risk-free rate.

  **Also, entrepreneurs happy to take this deal.**

  **E[income of entrepreneur]** $= \gamma - (1-W)(1+r)$

  $= W(1+r) + \gamma - (1+r)$

  $> W(1+r)$ **since** $\gamma > (1+r)$.

**Case 2: Asymmetric Information**

**Assume:**

- **Outside investors must pay a cost c > 0 to observe entrepreneur's output.**

  Known as **"costly state verification"**

  In the real world, this is not the most important type of asymmetric information, but we do it because it is the most straightforward to analyze. As Romer notes, other information problems have broadly similar effects.

- **Outsider's wealth > 1-W**

**==> One outsider can fund each entrepreneur's project**

Of you don't make this assumption, you get into complications with the model. In particular, a free-rider problem arises because lenders try to free ride on the verification costs paid by others.

**Optimal contract minimizes E[verification costs]**

**Why?**

**E[pymt to investor] must = (1+r)(1-W) + E[verification costs]**

**Entrepreneur keeps remaining output**

**==> Entrepreneur's income maximized by minimizing E[verification costs]**

**Form of optimal contract: a debt contract (bond)**

**Outsider gets some fixed payment if output high enough to pay it (no verfication necessary) or--if output not high enough--outsider takes all available resources (must verify).**

**Outsider gets:**

1. **D if output ≥ D**

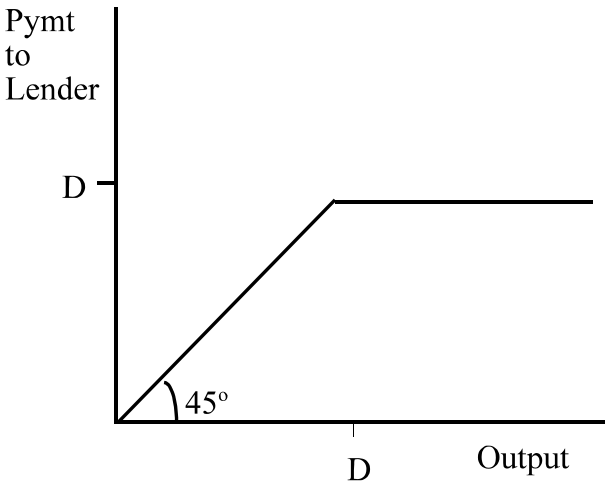
   **No verification costs paid**.

2. **All output if output < D**

   **Outsider must pay costs of verfication.**

Note that D is endogenous to the problem—we are going to solve for

it.




**See Romer for discussion of proof.** I will not go through his points here because we are short on time and they are somewhat complicated and--even if I could convince you of them--you probably would not find them satisfying, since they don't constitute a formal proof. (Romer contains the reference for the formal proof.)

The important thing to recognize is that it generally will not be optimal for the outsider to always have to verify since it is costly to do so. However, if the lender is not verifying, the payment cannot depend on output (because the entrepreneur would always lie and say that things had turned out badly).

**Solve for the equilibrium value of D**

**We know this must hold:**

$$\text{E}[\textit{payments to lender}] - \text{E}[\textit{verification costs}] = (1 + r)(1 - W)$$

Call the LHS "**expected net receipts.**"

To solve for the equilibrium D, we first need to find the relationship between the LHS above and D and then find the value of D that makes the LHS equal to the RHS.

**Suppose $D > 2\gamma$** (lender gets all output, but always have to verify)

**E[net receipts] = $\gamma$ - c**

**Suppose $D < 2\gamma$**

**With probability $(2\gamma - D)/2\gamma$, output > D**

**Lender receives D; doesn't pay c**

**With probability $D/2\gamma$, output < D**

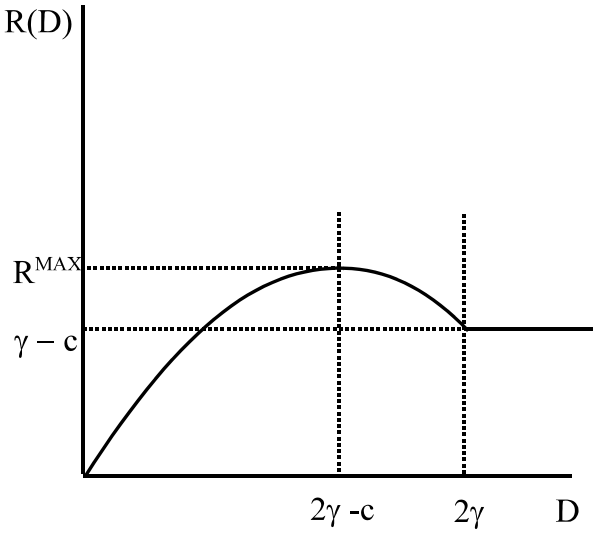
**E[net receipts] = D/2 - c**

**Thus expected net receipts are given by:**

$$R(D) = \begin{cases} \dfrac{2\gamma - D}{2\gamma} D + \dfrac{D}{2\gamma}\left(\dfrac{D}{2} - c\right) & \text{if } D \le 2\gamma \\ \gamma - c & \text{if } D > 2\gamma \end{cases}$$

Thus, if $D \le 2\gamma$,

$$R'(D) = \left(1 - \frac{c}{2\gamma}\right) - \frac{D}{2\gamma}$$



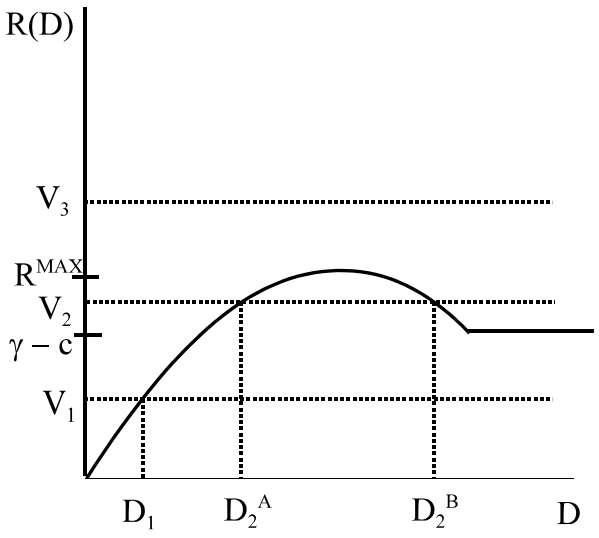

which implies that R is increasing if $1 - c/2\gamma > D/2\gamma$ or $2\gamma - c > D$. Thus, R increases until $D = 2\gamma - c$ and then decreases.

At $D = 2\gamma$, R(D) levels out.

You can also show that

$R^{MAX} = [(2\gamma - c)/2\gamma]^2\gamma$.

Now, consider some different values for the lender's required net revenues, (1+r)(1-W)




**At $V_1$, the equilibrium value of D is given by $D_1$.**

**At $V_2$, there are two possible values of D. However, $D_2^B$ is not a competitive equilibrium because other investors will undercut anyone who chooses it. So the equilibrium at $V_2$ is $D_2^A$.**

**Finally, at $V_3$, there is no lending** because entrepreneur cannot meet investor's required return in expected value terms.

**One can solve R(D) = (1+r)(1-W) to show that:**

$$D^* = 2\gamma - c - \sqrt{(2\gamma - c)^2 - 4\gamma\,(1+r)(1-W)}\ .$$

The final step is to **determine whether the entrepreneur undertakes the project.**

She does if $(1+r)(1-W) \le R^{MAX}$ and:

$\gamma$ - expected pymts to lender > (1+r)W

$$\gamma - (1+r)(1-W) - E[\text{verification costs}] > (1+r)W$$

Since the investor verifies when output is less than $D^*$ and this occurs with probability $D^*/2\gamma$, expected verification costs are:

$$A = \frac{D^*}{2\gamma} c$$
$$= \left[ \frac{2\gamma - c}{2\gamma} - \sqrt{\left( \frac{2\gamma - c}{2\gamma} \right)^2 - \frac{(1+r)(1-W)}{\gamma}} \right] c \ .$$

**You can differentiate to show $A_c > 0$, $A_r > 0$, $A_W < 0$, $A_\gamma < 0$.**

Romer notes that you will get similar results for agency costs for model besides the costly state verification one. For example, you would get qualitatively similar results for a model with moral hazard or adverse selection.

**Four Implications**

1) **Agency costs raise the cost of external finance and reduce I**

   Note that investment only occurs if:

   $$\gamma > 1 + r + A(c, r, W, \gamma)$$

2) **Output and interest rate movements now have indirect effect on I**

   The q model implies that output and interest rates have direct effects on I as we already saw.

   With agency costs, we have output changing the firm's current profitability and hence their ability to provide internal finance, W.

   We also have interest rates changing D and thus changing expected verification costs.

**3) Many variables not in the q-model can affect I**

One example would be cash-flow (W). Firms with higher Ws will be able to fund projects less expensively.

The literature testing the link between cash-flow and I is extensive. Most papers do find a strong link.

Problem, however, is that movements in cash-flow are often correlated with movements in profitability, which should affect I even if information is symmetric.

Romer discusses some interesting recent papers that attempt to get around this problem. Read his discussion.

**In a nutshell: literature exploring link between cash-flow and investment shows that cash-flow is an important determinant of I for some firms.**

Another example would be average tax rates. Again, these affect firms' cash flow and their ability to use internal finance.

**4) Changes in the financial system can make it harder/easier to verify, which can change I.**

Ex: Collapse of banking system during Great Depression made it harder to evaluate projects ==> investment more expensive, so it fell.