Lecture IV:

The Credit Channel of Monetary Transmission

The Credit Channel

- Models discussed so far had only two assets at most – money, yielding a return (Rm), and government bonds (yielding a return R).

- There is however some consensus that monetary policy has additional effects on aggregate spending via credit markets.

- More specifically, credit markets add an amplification mechanism to monetary policy.

The Credit Channel

- This “credit view” essentially says that information asymmetries, costly financial intermediation, and balance sheet structures matter for how money affects the real economy.

- This can be via the supply of credit to firms;

- Or via the demand for “external” financing to the firm.

- Loans are “different”: they cannot be easily substituted by either internal funds or issuance of riskless bonds, at interest rate R, by (non-financial) firms.

The Credit Channel

- Under the broad label "credit view", the profession has in mind two types of *monetary transmission mechanism*

- One is the financial-accelerator mechanism: it relates balance sheet fragilities (e.g. high indebtedness of the firm) to the "*interest rate spread" or "external financing premium"* it pays over R to obtain "external" financing from all kinds of financial intermediaries (not just banks).

- The other is the bank lending channel: emphasizes the peculiar nature of bank credit.

The Credit Channel

- Key question: “Are banks special, and really all that different from butcher shops?” (Diaz-Alejandro, 1985)

- Bank credit is typically “informationally intense”

- E.g.: a firm can get cheaper (than otherwise credit) because it knows the local bank.

- This means that, if the local bank is not there -- or is going through difficult times, you (the firm) has to go elsewhere and this often implies costlier credit.

The Credit Channel

- The latest global financial crisis provided an illustration of that. Previous financial crises too, including in EMs.
- Banks suddenly had a harder time to obtain funds in money markets.
- So, they “cut” lending (credit supply curve moves inward).
- Firms cannot easily substitute that for other sources of financing → investment and employment suffer.

The Credit Channel

- In short, bank credit is different from other goods in two dimensions.

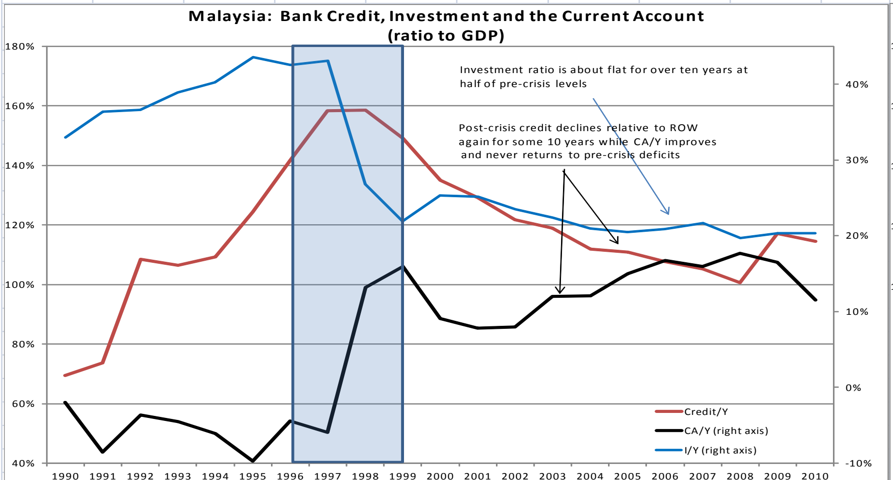
- <u>Asymmetric information</u>: Inability to other lenders to monitor borrowers as well: banks have an information advantage over other lenders but still cannot fully monitor borrowers.

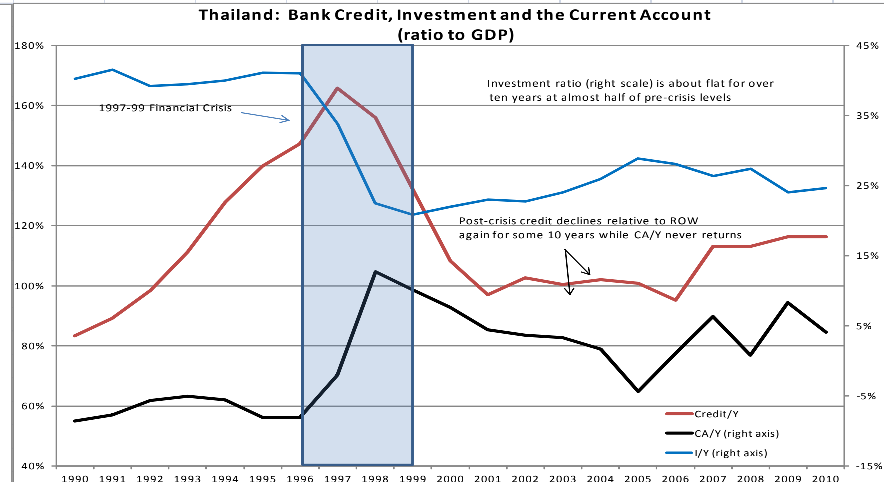
- <u>Maturity transformation</u>: funding in short-term money markets and (mostly) short-term deposit, investing in longer-term loans involving costly monitoring and default risk.

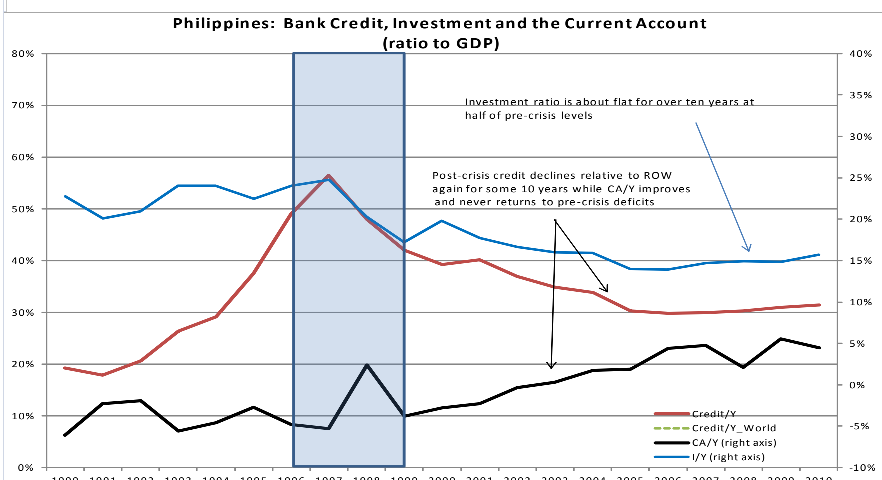
- Both features are key to the models we will review.

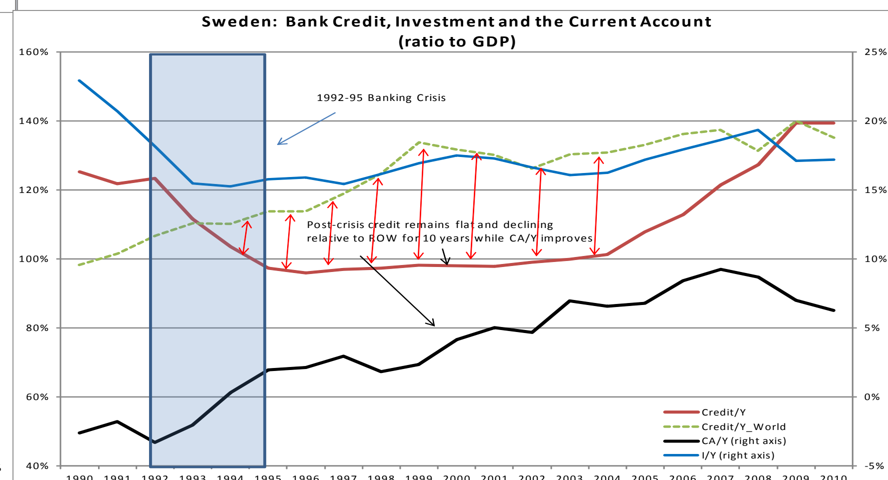
The Credit Channel

Bank Credit, Investment and Current Account in Financial Crises of the 1990s









The Credit Channel

- Let's start by focusing on one of the classic effects of "asymmetric information" on credit supply.
- This is the so-called "credit rationing" phenomenon, studied by Stiglitz and Weiss (1981).
- Key result: Credit rationing can occur in a competitive equilibrium if the interest rate charged by the lender affect the riskiness of loans.
- Rationing meaning that between two (seemly) identical borrower, one gets credit the other does not.

The Credit Channel

- Two different credit rationing mechanisms:

- Adverse selection: interest rate charge affect the ***quality*** of borrowers, more specifically the ratio of good to bad borrowers.

- Moral Hazard: the interest rate charged affect the ***action*** of borrowers.

The Stiglitz-Weiss model of Adverse selection

(follows Walsh, 2004, 7.2.1):

- Two types of borrowers:

  G repays with with prob. q_g

  B repays with with prob. q_b

- Under *Symmetric Information* (SI): Two lending rates, $r_{L(g,b)}$

$$(1+r)L_g = q_g(1+r_{L_g})L_g + (1-q_g)0L_g .: r_{L_g} = r / q_g$$

$$r_{L_b} = r / q_b$$

The Credit Channel

where $r_{L_b} > r_{L_g}$

→ No credit rationing occurs!

- Under *Asymmetric Information* (AI): Lender cannot observe (or only imperfectly) good vs. bad borrower.
- Then pricing becomes a signal: e.g. increases in the lending rate may attract worse borrowers ("Lemons").
- As the share of credit that goes bad increases, this may actually lower lender's expected return (as in Arkelof, 1970).

The Credit Channel

Then,

$$g q_g r_L + (1-g) q_b r_L = r$$

$$\therefore r_L = \frac{r}{g q_g + (1-g) q_b}$$

So $r_{L_b} > r_L > r_{L_g}$.

Hence, the bad borrower is being "subsidized" and will want to borrow more (or more bad borrowers will knock at the door of the bank); and mutatis mutandis for the good borrower.

Thus, this cannot be a stable equilibrium: g will have to adjust!

The Credit Channel

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The Credit Channel

Let's now put more structure into the model.

The cost of loans is not just interest rate. Also loan amount (L), collateral requirements (C), maturity. We hold maturity cte.

Consider an investment project requiring loan L and that has an actual return R.

It is advantageous for the borrower to pay if:

$$\tilde{R} \geq L(1 + r_L) - C$$

The Credit Channel

Let:

$$\tilde{R}\begin{cases} = E(\tilde{R}) + x, \text{ with p=0.5} \\ = E(\tilde{R}) - x, \text{ with 1-p=0.5} \end{cases}$$

So that $\mathrm{var}(\tilde{R}) = x^2$. Call $\bar{R} = E(\tilde{R})$

Now assume that x is sufficiently large so that

$$\bar{R} - x < L(1 + r_L) - C$$

Then, it is optimal for the borrower to default.

The Credit Channel

In this case the borrowers ends up with –C. If the shock (x) is good, then the borrower receives $\bar{R} + x - L(1 + r_L)$.

So, the expected return to the borrower is:

$$E(\pi^B) = \frac{1}{2}[\bar{R} + x - L(1 + r_L)] - \frac{1}{2}C \qquad (4.1)$$

It is always useful to solve these models to define a threshold x* where expected return=0, i.e., the shock is zero.

$$x^*(r_L, L, C) = L(1 + r_L) + C - \bar{R} \qquad (4.2)$$

The Credit Channel

So, x* is increasing in r_L.

When x-x*>0 the borrower's profit is positive → so, expected return is rising on the riskiness of the project.

The analogous expression for the lender is:

$$E(\pi^L) = \frac{1}{2}[L(1+r_L)] + \frac{1}{2}\left[C + \bar{R} - x\right] - (1+r)L \qquad (4.3)$$

The Credit Channel

So, the lender's expected profit is decreasing on the project's risk.

Suppose two types of borrowers, one with xg and the other with xl, where xl>xg>x*. Then, assuming their proportion is equally likely, there will be lending to both:

$$E(\pi^L) = \frac{1}{2}[L(1+r_L) + C + \bar{R}] - \frac{1}{4}\left[x_g + x_b\right] - (1+r)L \qquad (4.4)$$

But if r_L rise so $x^*>x_g$, then only the bad borrows enter:

$$E(\pi^L) = \frac{1}{2}[L(1+r_L) + C + \bar{R}] - \frac{1}{2}x_b - (1+r)L \qquad (4.5)$$

The Credit Channel

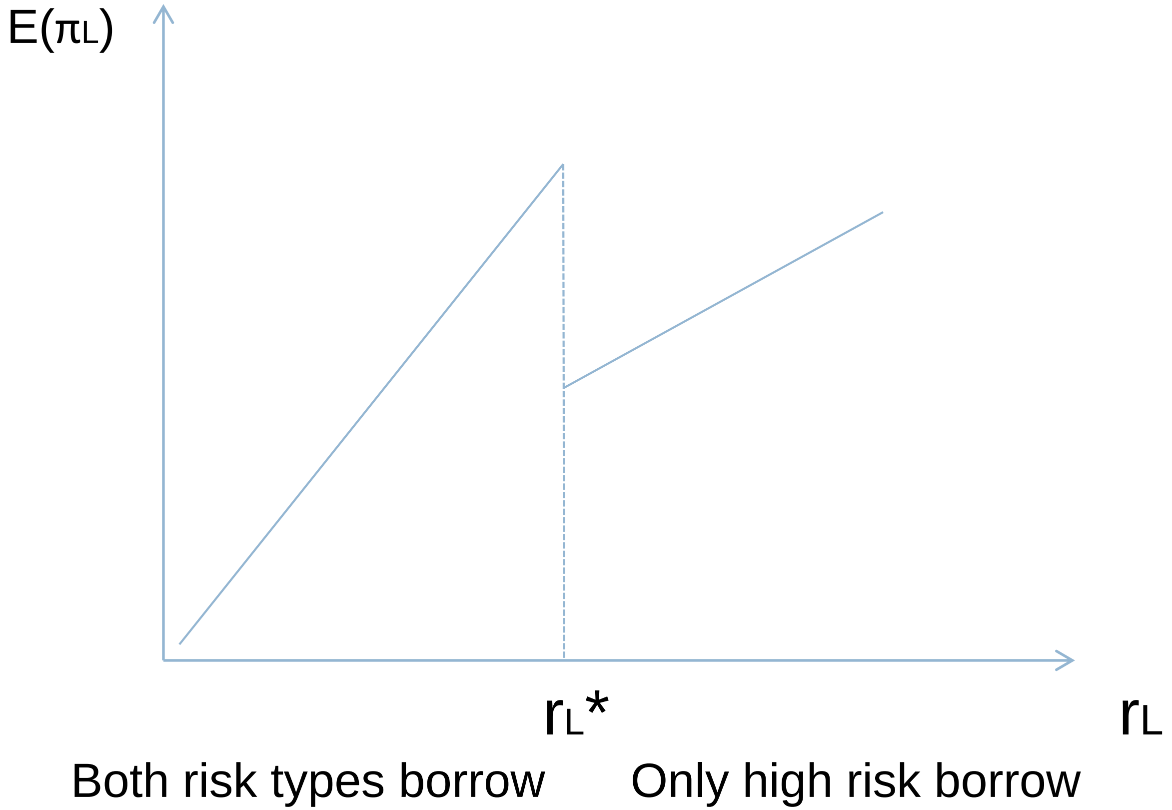
- So, there is a discontinuity in the function: while r_L is such that $x^* <= x_g$, lender's expected profit rises with r_L. But once r_L rises so that $x^* > x_g$, then the supply curve jumps from (4.4) to (4.5).

- So, from r* expected profits may drop despite rising r_L rising.

- Whether, however, they drop or not will depend on the demand curve for borrowing, however. If too inelastic to r_L, then banks can still be able to shore-up profits.

- Still, the general point stands that loan supply may not be monotonic in R_L.

The Credit Channel



The Credit Channel

Moral Hazard

- Now let the project return being endogenous: the borrower can choose between projects of different risks.
- Given AI, lender cannot monitor this choice.
- Then, higher interest rates imply that riskier projects get selected.
- Since the lender's expected return is decreasing on the variance of project returns, expected profits will fall.

The Credit Channel

Illustration:

Let $\left\{\begin{array}{l} p_a > p_b \\ p_a R_a > p_b R_b \end{array}\right\}$, same collateral C for both.

→ $E(\pi_a) > E(\pi_b)$ if $\dfrac{p_a R_a - p_b R_b}{p_a - p_b} > (1 + r_l)L - C$

So, as r_L rises, project b becomes more preferred. Let r_L^* be

$$\frac{p_a R_a - p_b R_b}{p_a - p_b} = (1 + r_l^*)L - C \qquad (4.6)$$

The Credit Channel

Expected payments to the lender:

$$\begin{cases} p_a(1+r_l)L-(1-p_a)C, \text{ if } \mathrm{r}_l < r_l^* \\ p_b(1+r_l)L-(1-p_b)C, \text{ if } \mathrm{r}_l > r_l^* \end{cases}$$

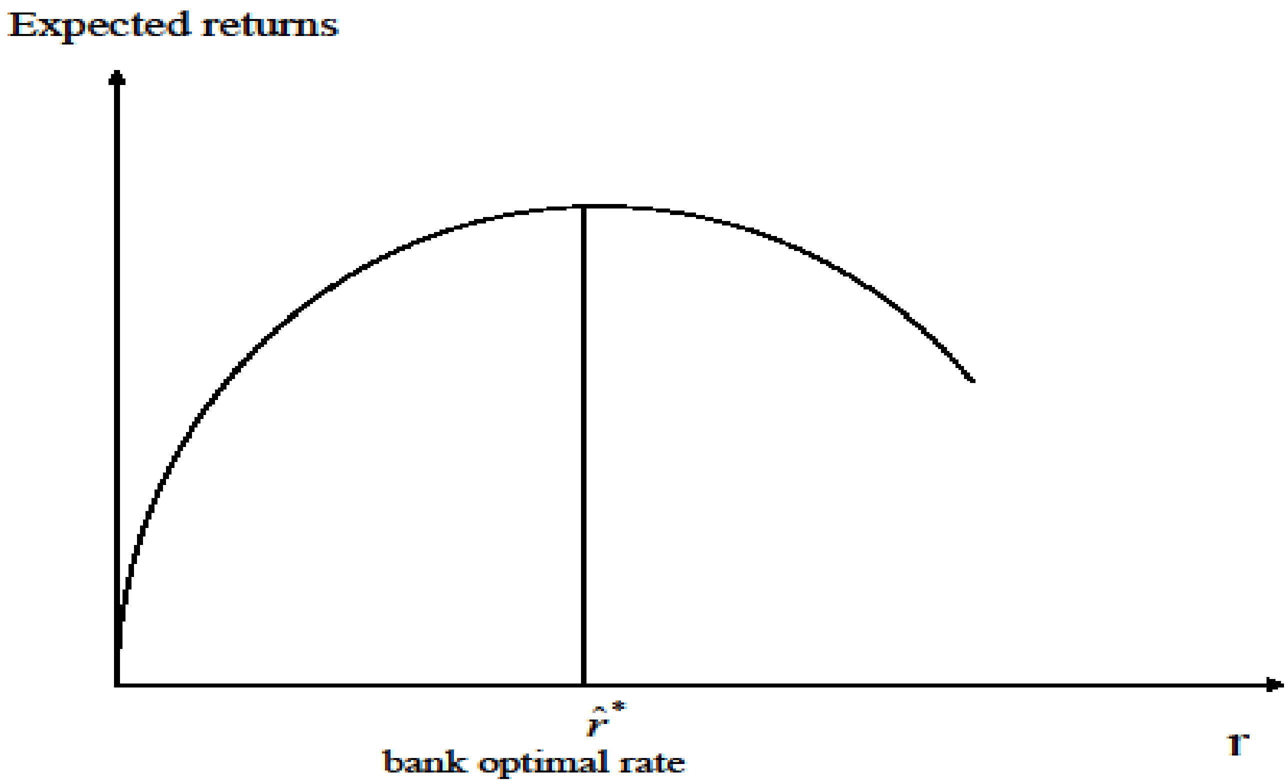
Since the upper term is higher than the lower term, lender's profits are not monotonic on the loan rate. In particular:

$$p_a(1+r_l^* l)L-(1-p_a)C > p_b(1+r_l^*)L-(1-p_b)C$$

Hence, expected returns fall for r>r*. This opens the possibility of credit rationing once r>r*.

The Credit Channel

Non-monotonicity of lender's supply under moral hazard



The Credit Channel

The Bank-Lending Channel

(based on Blinder-Bernanke, 1988)

- Imperfect substitutability between bonds and bank loans
- This will change the IS-LM curve in traditional Keynesian models
- The result will be that the effect of changes in money supply on output are *amplified*.

The Credit Channel

Banks' Balance Sheet

ASSETS	LIABILITIES
Reserves (R)	Deposits (D)
E	Other Funding (here=0 by assumption)
σD	
Bonds (B)	Equity (here=0 by assumption)
Loans (L)	

where $R = \sigma D + E$. σ is set by the regulator ("required reserves") and E is excess reserves.

The Credit Channel

- Equilibrium portfolio shares:

- $$\begin{aligned} L &= l^s(i_L, i_b)(1-\sigma)D \\ B &= b^d(i_L, i_b)(1-\sigma)D \\ E &= \varepsilon^s(i_b)(1-\sigma)D \end{aligned} \qquad (4.7)$$

- In this model, money(i.e., M1) = D and high-powered money is reserves, R. R is supplied by CB so R=Rs. M1 is:

$$M1 = R * m(i_b, i_L) = R^s / [\varepsilon(i_b) * (1-\sigma) + \sigma] = D(\underset{-}{i_b}, \underset{+}{y}) \qquad (4.8)$$

The Credit Channel

This defines equilibrium in the money market (LM curve)

Equilibrium in the loan market is pinned-down by loan demand:

$$L^d = l(i_L, y)D(1-\sigma) \qquad (4.9)$$

- Now equalize L^d and L^s and substitute out D in the latter:

$$L^d(i_L, y) = l_s(i_b, i_L)m(i_b)[1-\sigma]R^s \qquad (4.10)$$

where $m(i_b) = 1/\sigma$ if there is “reserve saturation”, i.e. E=0.

The Credit Channel

The model closes with the equilibrium condition in the goods market:

$$y = Y(\underset{-}{i_L}, \underset{-}{i_b}) \tag{4.11}$$

But i_L can be substituted out from the loan market equilibrium condition, i.e.:

$$i_L = \phi(\underset{+}{i_b}, \underset{+}{y}, \underset{-}{R^s}, \underset{+}{\sigma}) \tag{4.12}$$

If substitution effect predominates

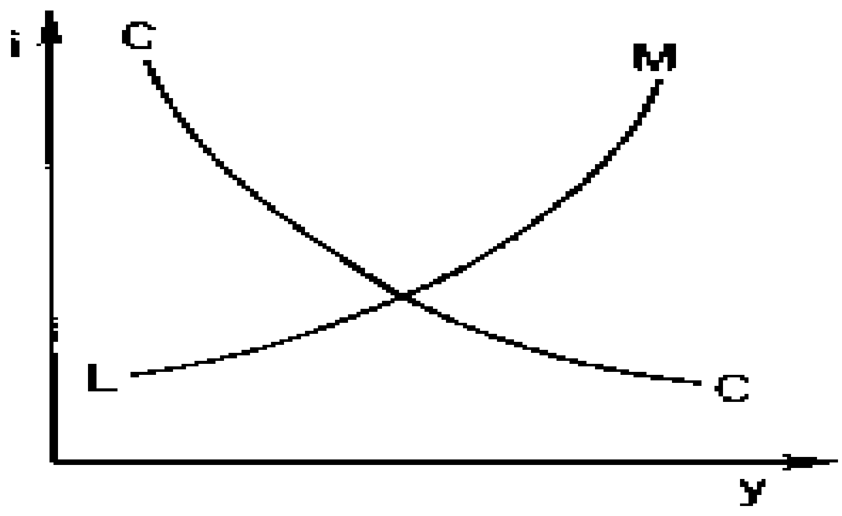
The Credit Channel

Thus the new IS curve obtains:

$$y = Y[i_b, \phi(i_b, y, R^s, \sigma)] = Y'(\underset{-}{i_b}, \underset{+}{R^s}, \underset{-}{\sigma}) \qquad (4.13)$$

New (amplification factor)

Bernanke and Blinder call it CC curve (commodities and credit market equilibrium)



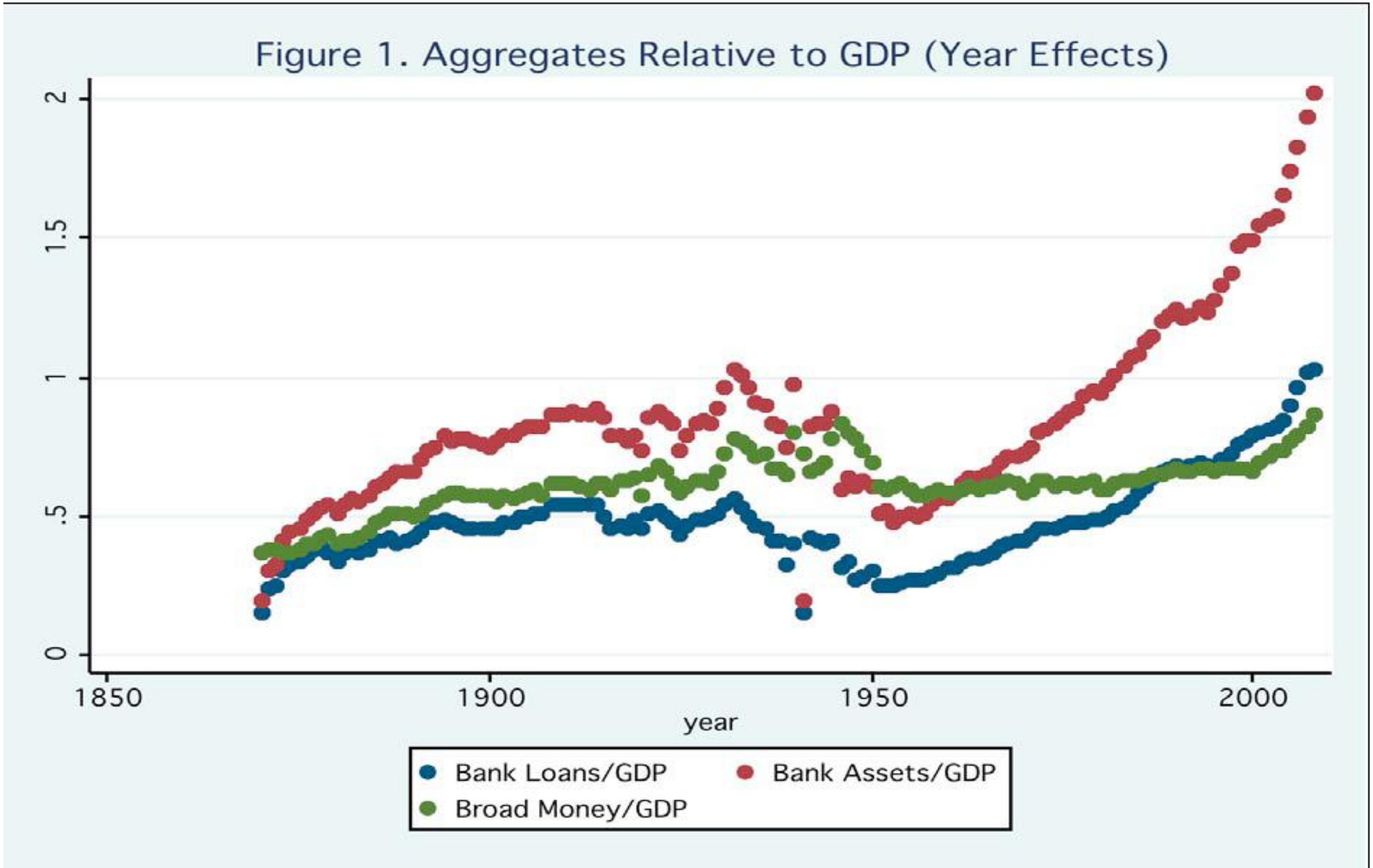
The Credit Channel

Comparative Statics

- What happens if Rs goes up?
- What would happen if the perceived riskness of loans increases (as typical in financial crises)?
- What would happen if production becomes more credit intensive?
- What would happen if there is monetary tightening through increased reserve requirement ratio, σ?

The Credit Channel

From Schularick and Taylor, AER, 2012



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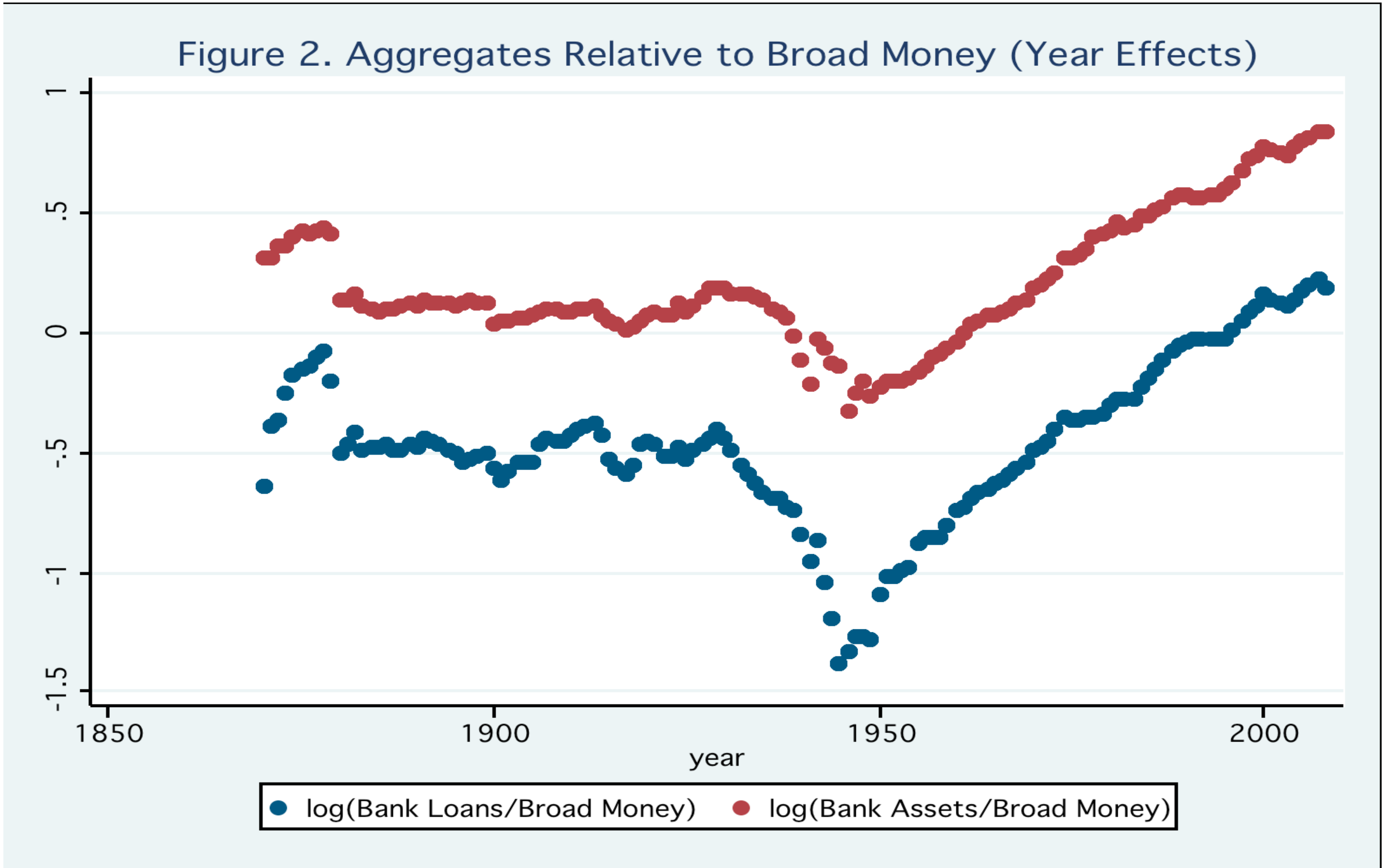


A Micro-founded Model: Edwards and Végh (1997)

Households

$$U = \int_0^\infty [\ln(c_t) + \ln(x_t)] \exp(-\beta t) dt$$

$$a_t^h = b_t^h + d_t$$

$$\dot{a}_t^h = r a_t^h + \underbrace{w_t(1 - x_t)}_{\text{Labor supply}} + \Omega_t^f + \Omega_t^b + \tau_t - c_t - (i_t - i_t^d) d_t \tag{4.14}$$

The Credit Channel

- Deposit-in-advance constraint:

$$d_t = \alpha p_t c_t = \alpha c_t \qquad (4.15)$$

- Life-time budget constraint:

$$a_0^h + \int_0^\infty [w_t(1-x_t) + \Omega_t^{Tf} + \Omega_t^{Nf} + \Omega_t^b + \tau_t - c_t(1-\alpha(i_t - i_t^d))]\exp(-rt)dt = 0$$

- Set up the Lagrangean to choose $\{c_t, x_t\}$ st. to above constraint and obtain FOC:

The Credit Channel

F.O.C:

$$\frac{1}{c_t} = \lambda[1+\alpha(i_t - i_t^d)] \tag{4.16}$$

$$x_t = 1 - l_t = \frac{1}{\lambda w} \tag{4.17}$$

where λ is (as usual) the marginal utility of wealth.

The first equation says that the marginal utility of consumption is equal to the price of consumption (=1) times the opportunity cost of purchasing one unit of consumption which is the cost of deposit-in-advance constraint.

The Credit Channel

Firms:

$$y_t = l_t \qquad (4.18)$$

Face a credit-in-`advance constraint:

$$z_t = \gamma w_t l_t \qquad (4.19)$$

Firm's financial wealth:

$$a_t^f = b_t^f - z_t$$

The Credit Channel

Firm's flow constraint:

$$\dot{a}_t^f = ra_t^h + y_t - w_t l_t - (i_t^l - i_t) z_t - \Omega_t^f \qquad (4.20)$$

Integrate forward, impose non-Ponzi and using the production function and credi-in-advance to obtain the present discounted value of dividends:

$$\int_0^\infty \Omega_t^f \exp(-rt)dt = a_0^f + \int_0^\infty \{l_t - w_t l_t [1 - (i_t^l - i_t)\gamma]\} \exp(-rt)dt$$

The Credit Channel

FOC:

$$1 = w_t[1 + \gamma(i_t^l - i_t)] \qquad (4.21)$$

Marginal productivity
of labor

wedge over wage cost
due to credit in advance
“distortion”

Banks:

$$net\ \text{assets}{=}a_t^b = b_t + h_t + z_t - d_t$$

loan

Bank Reserves (high powered money)
Called R in BB paper

In order to "produce" loans and deposits, the bank incurs cost q given by the following cost technology:

$$q_t = \eta(z_t, d_t) \tag{4.22}$$

where $\eta_z(.) > 0, \eta_d(.) > 0, \eta_{zz}(.) > 0, \eta_{dd}(.) > 0, \eta_{zd}(.) < 0$

The Credit Channel

More on the banking cost function

Edwards and Végh mention (footnote 14) the following function:

$$\eta(z_t, d_t) = \sqrt{z_t^2 + d_t^2} \tag{4.23}$$

It can then be readily shown: $\eta_z(z_t, d_t) = \dfrac{z_t}{\sqrt{z_t^2 + d_t^2}} = \dfrac{z_t}{\eta(z_t, d_t)} > 0$

$$\eta_{zz}(z_t, d_t) = \frac{\sqrt{z_t^2 + d_t^2} - z(1/2)\left(\sqrt{z_t^2 + d_t^2}\right)^{-1/2} 2z}{z_t^2 + d_t^2} =$$

$$= \frac{1}{\sqrt{z_t^2 + d_t^2}} - \frac{z^2}{\sqrt{z_t^2 + d_t^2} * (z_t^2 + d_t^2)} = \frac{1}{\eta}\left[1 - \frac{1}{1 + d_t^2 / z_t^2}\right] > 0$$

The Credit Channel

- So, this cost function is convex in z.
- Homework: show that it is also convex in d and that the cross derivative $\eta_{zd} < 0$.
- Given the above, we can write $\eta(z_t, d_t) = \eta(z_t / d_t, 1) = \eta(z_t / d)$
- Now, back to the rest of the model

The Credit Channel

As we saw in the Bernanke-Blinder model, the government imposes a binding reserve requirement so:

$$h_t = \delta d_t \qquad (4.23)$$

The flow constraint and NPV of the bank's worth is:

$$\dot{a}_t^b = ra_t^b + (i_t^l - i_t)z_t + (i_t - i_t^d)d_t - i_t(\delta d_t) - \xi_t \eta(z_t, d_t) - \Omega^b \qquad (4.24)$$

$$\int_0^\infty \Omega_t^b \exp(-rt)dt = a_0^b + \int_0^\infty \{(i_t^l - i_t)z_t - (i_t - i_t^d)d_t - i_t(\delta d_t) - \xi_t \eta(z_t, d_t)]\} \exp(-rt)dt$$

Shock to bank costs

The Credit Channel

FOC w.r.t {z,d,h}:

$$i_{lt} = i_t + \eta_z(z_t, d_t, i_t) = i_t + \eta_z(z_t / d_t) \qquad (4.26)$$

$$i_{dt} = (1-\delta)i_t - \eta_d(d_t / z_{tt}) \qquad (4.27)$$

This allows to compute the loan-deposit spread:

$$i_{lt} - i_{d_t} = \delta i_t + \eta_z(z_t / d_t) + \eta_d(z_t / d_t) \qquad (4.28)$$

If bank is costless $\eta(z_t, d_t) = 0$ -> $i_{lt} = i_t$ so back to bond-only model!

Government

Sets δ and (to simplify for a closed economy), it set i_b and π.

It also (for convenience) absorbs the cost of costly banking so its flow and life time constraints are:

$$\dot{b}_t^g = rb_t^g + \dot{h}_t + \pi_t h_t + \xi_t \eta(z_t, d_t, i_t) - \tau \qquad (4.29)$$

$$\int_0^\infty \tau_t \exp(-rt)dt = b_0^g + \int_0^\infty [\dot{h}_t + \pi_t h_t + \eta(z_t, d_t, i_t)]\exp(-rt)dt$$

Perfect Foresight Equilibrium

Labor market: $l_t = 1 - x_t$ (4.30)

Asset markets: $r = i_t^b - \pi$ (4.31)

Goods Markets: $\dot{k}_t = rk_t + y_t - c_t$ (current account) (4.32)

where $k = b^h + b^f + b^b + b^g$

The Credit Channel

Since (for now) we assume that the economy is closed, then:

$$\dot{k}_t = 0 \Longrightarrow c_t = y_t = l_t = 1 - x_t$$

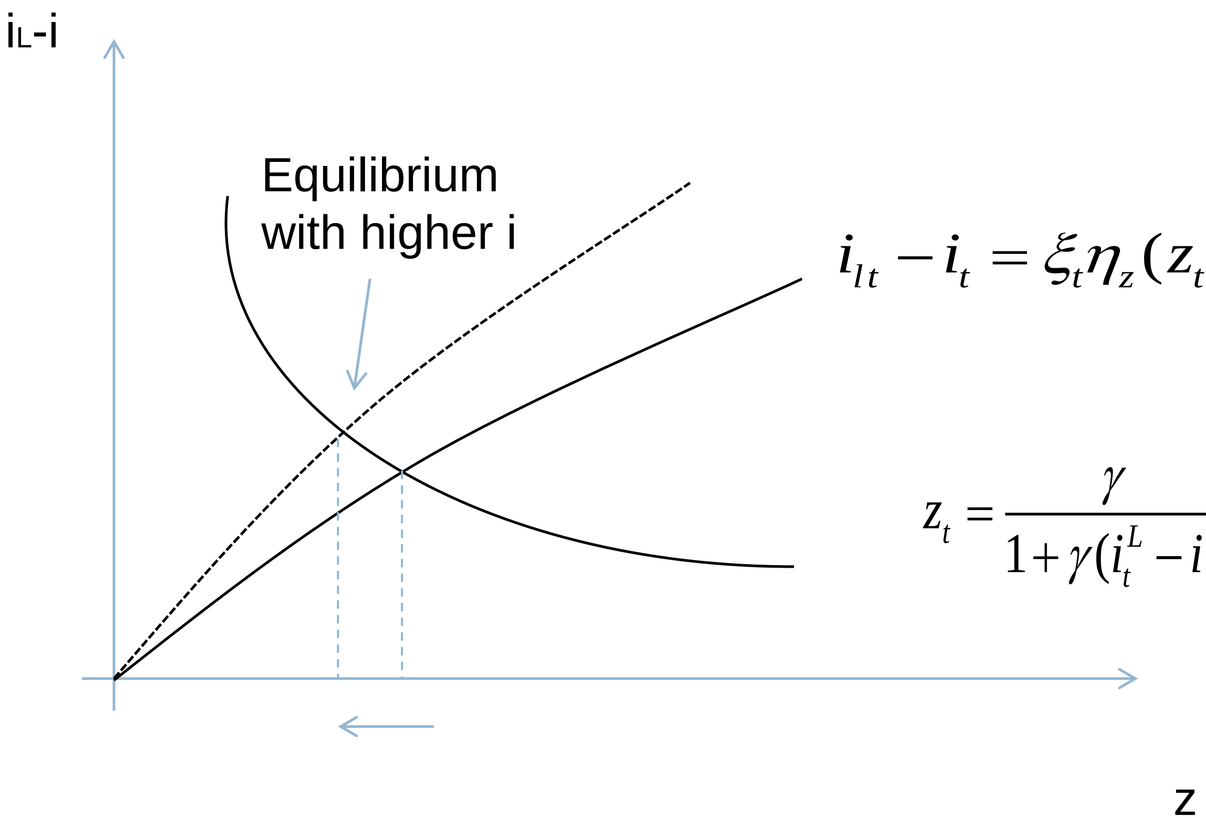
Combine the FOC for household and firms to obtain:

$$\frac{1}{x_t} = \frac{\lambda}{1+\gamma(i_t^l - i_t)} \qquad (4.33)$$

$$\boxed{\frac{x_t}{c_t} = \underbrace{[1+\alpha(i_t - i_t^d)][1+\gamma(i_t^l - i_t))]}_{=1 \text{ at first-best}}} \qquad (4.34)$$

The Credit Channel

Credit Market Equilibrium



$$i_{lt} - i_t = \xi_t \eta_z (z_t / d_t)$$

$$z_t = \frac{\gamma}{1+\gamma(i_t^L - i)} - \frac{\gamma}{\lambda}$$

Agency Costs and Financial Accelerator

- Lending relationships involve a principal (lender) delegating control decision-making control to an agent (borrower).

- There is a cost to observe what the borrower does and this cost is called “agency cost”.

- This makes the cost of “external” financing higher than if the firm finances itself with internal financing (e.g. retained earnings).

- Key mechanism: a firm’s balance sheet affects the cost of external financing.

Agency Costs and Financial Accelerator

- The state of the firm's balance sheet can be highly cyclical: it tends to deteriorate during recessions.

- If balance sheet positions raise agency costs, then the latter rise during the recessions.

- But precisely during recessions, profits fall, so retained earnings and other sources of internal finance shrink.

- So, overall financing becomes costlier during recessions and this tends to "accelerate" the decline in investment and output when the economy is hit by the bad shock(s) that cause(s) the recession in the first place.

Agency Costs and Financial Accelerator

- Townsend (1979), Bernanke & Gertler (1989) and Bernanke, Gertler and Gilchrist (1999): banks must incur a monitoring cost to observe project outcomes.

- Firms are indexed by $\omega \sim \mathrm{U}[0,1]$. More efficients have lower ω

- Projects require input x(w), yielding k_1 with pr=π_1, and k_2<k1 with 1-pr=1- π_1, so the average project return is:

$$\kappa = \pi_1 \kappa_1 + (1 - \pi_1) \kappa_2$$

- The lender faces a cost c to observe the project's outcome

Agency Costs and Financial Accelerator

Firm's *internal* financing is $S<x(0)$, so all firms need some external financing.

r is the opportunity cost to lenders.

So, firms invest if $w<w^*$ where:

$$\kappa - rx(w^*) = 0$$

They then borrow $B=x(w)-S$.

Under full information: all projects with $w<w^*$ are financed.

Agency Costs and Financial Accelerator

With imperfect information, the firm has an incentive to announce that k_1 occurred and pocket the difference.

So, every time the firm announces k_1, the lender will be tempted to incur the state verification cost c.

The lender will do so with probability p.

Three possible pay-offs for the firm:

P_1^a → when k1 is announced and lenders audit

P_1 → when k1 is announced and no auditing follows

P_2 → payment if k2 is announced

Agency Costs and Financial Accelerator

We can now derive the optimal lending contract:

Borrower chooses

p, P_1^a, P_1, P2 to max:

$$\pi_1 \underbrace{[pP_1^a + (1-p)P_1]}_{\text{Payments made by lender to firm in the event of a bad state}} + \pi_2 P_2 \qquad (4.35)$$

st.

$$\pi_1[\kappa_1 - p(P_1^a - c) - (1-p)P_1] + \pi_2[\kappa_2 - P_2] \geq rB \qquad (4.36)$$

$$P_2 \geq (1-p)(\kappa_2 - \kappa_1 + P_1) \qquad (4.37)$$

$$P_1^a \geq 0 \qquad (4.38)$$

$$P_1 \geq 0 \qquad (4.39)$$

Agency Costs and Financial Accelerator

Once (4.37) holds, the lender breaks even:

$$\pi_1[\kappa_1 - p(P_1^a - c) + (1-p)P_1] + \pi_2[\kappa_2 - P_2] - rB = 0$$

We can the substitute the above in (4.35) so that the original problem consists of maximizing

$$\pi_1(\kappa_1 - pc) + \pi_2\kappa_2 = \kappa - \pi_1 pc$$

But with k fixed, this is equivalent to minimizing the expected auditing costs $\pi_1 pc$.

Agency Costs and Financial Accelerator

Such auditing costs $\pi_1 pc$ are what BG call "*agency costs due to asymmetric information*".

With π_1 and c fixed, we can compute these agency costs by making (4.37)-(4.39) hold with equality, note that B=x(w)-S and substitute in (4.36) to obtain:

$$p = \frac{r[x(\omega) - S] - \kappa_1}{\pi_2(\kappa_2 - \kappa_1) - \pi_1 c} \qquad (4.40)$$

Thus, p varies inversely with the internal funds S and directly with the degree of asymmetric information (monotoring cost) c.

Agency Costs and Financial Accelerator

- As p rises, lending becomes more costly, so the external financing premium $s=r_L-r$ will rise.
- This implies that firms which are less efficient (w higher) will not invest → investment will be lower.
- So, even if r (the risk-free bond rate equivalent) does not rise and technology (x, k1 and k2) does not change, variations in S and or c can reduce the number of projects undertaken.

Agency Costs and Financial Accelerator

- So, how much the firm puts of its own funds will matter!

- This explains why **cash flows** (and indebtness B/S) matter for the determination of investment.

- So, if a recession worsens balance sheets, then the external financing premium or "spread" will rise, exacerbating the recession.

- This gives rise to a supply and demand curve for capital (see BGG, 1999, Figure 1)

Agency Costs and Financial Accelerator