Firms, Bank Loans, and Monetary Policy[1]

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[1] The views expressed in this paper are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

Introduction

- Monetary and banking frictions are important ingredients of Macro models.
- Monetary frictions affect the exchange process.
  - Agents' portfolio decision.
- Banking frictions distort the allocation of capital.
- What is the interplay between these two frictions?
- Are they quantitatively relevant?

Introduction

- Most papers emphasize the monetary frictions faced by consumers.
  - Consumers hold part of their wealth in the form of non-interest-bearing assets.
  - They optimally economize on their holdings of these (usually liquid) assets.
  - Socially inefficient.
- The quantitative importance of this friction is apparently small.
  - Cooley & Hansen (1989).
  - Lucas (2000).

What do we do?

- We emphasize the monetary frictions faced by the firm.
  - Firms hold part of their earnings in the form of non-interest-bearing assets.
    - Opportunity cost of holding these assets.
  - Firms need external finance (subject to CSV friction).
    - Not individually optimal for lenders to fund all firms.
    - Overall investment is suboptimal.
- Channel based on the interplay between these two frictions.
- Investigate the quantitative importance of this channel.

Results

- Monetary & banking frictions matter.
  - Monetary frictions amplify the banking frictions.
  - Our channel is quantitatively important.

Literature

- **Banking:** Diamond (1984); Williamson (1986, 1987a).
- **Money:** Lagos & Wright (2005); Rocheteau & Wright (2005).
- **Banking & Business Cycles:** Bernanke & Gertler (1989); Williamson (1987b).
- **Money & Banking:** Williamson (1987b); Andolfatto & Nosal (2008); He, Huang & Wright (2008); Williamson (2011).

Model: Agents & Commodities

- Discrete time: $t = 0, 1, 2, ...$
- Each period is divided into two subperiods.
- Two *perishable* goods:
  - General good (GG) produced in the first subperiod.
  - Special good (SG) produced in the second subperiod.
- Two types of agents:
  - Households: $[0, 1]$ continuum.
  - Entrepreneurs: continuum with measure $\alpha > 0$.

Model: Technologies

- Households produce GG only.
  - h units of effort $\Rightarrow$ h units of GG.
- Entrepreneur is endowed with one *indivisible* project.
  - 1 unit of GG $\Rightarrow$ $\tilde{y}$ units of SG.
  - $\tilde{y}$ is uniformly distributed over $[0, 1]$.
  - The realization of $\tilde{y}$ is privately observable.
- Households can verify at a cost (effort) the realization of $\tilde{y}$ at date $t+1$.
- Monitoring cost: $\gamma > 0$ is uniformly distributed over $[0, \bar{\gamma}]$.

Model: Preferences

- Households have preferences represented by

$$U_t^h\left(x_t, h_t, q_t\right) = x_t - h_t + u\left(q_t\right)$$

- Entrepreneurs have preferences represented by

$$U_t^e\left(e_{t+1}\right) = e_{t+1}$$

- Household's discount factor $\beta \in (0, 1)$.

Unconstrained Efficient Allocation

- Suppose $\bar{\gamma} = 0$.
- Planner solves:

$$\max_{(x,e,,h,i,q)\in\mathbb{R}^5_+} \left[x - h + u\left(q\right)\right]$$

$$h = x + \alpha e + i;$$

$$q = \frac{i}{2};$$

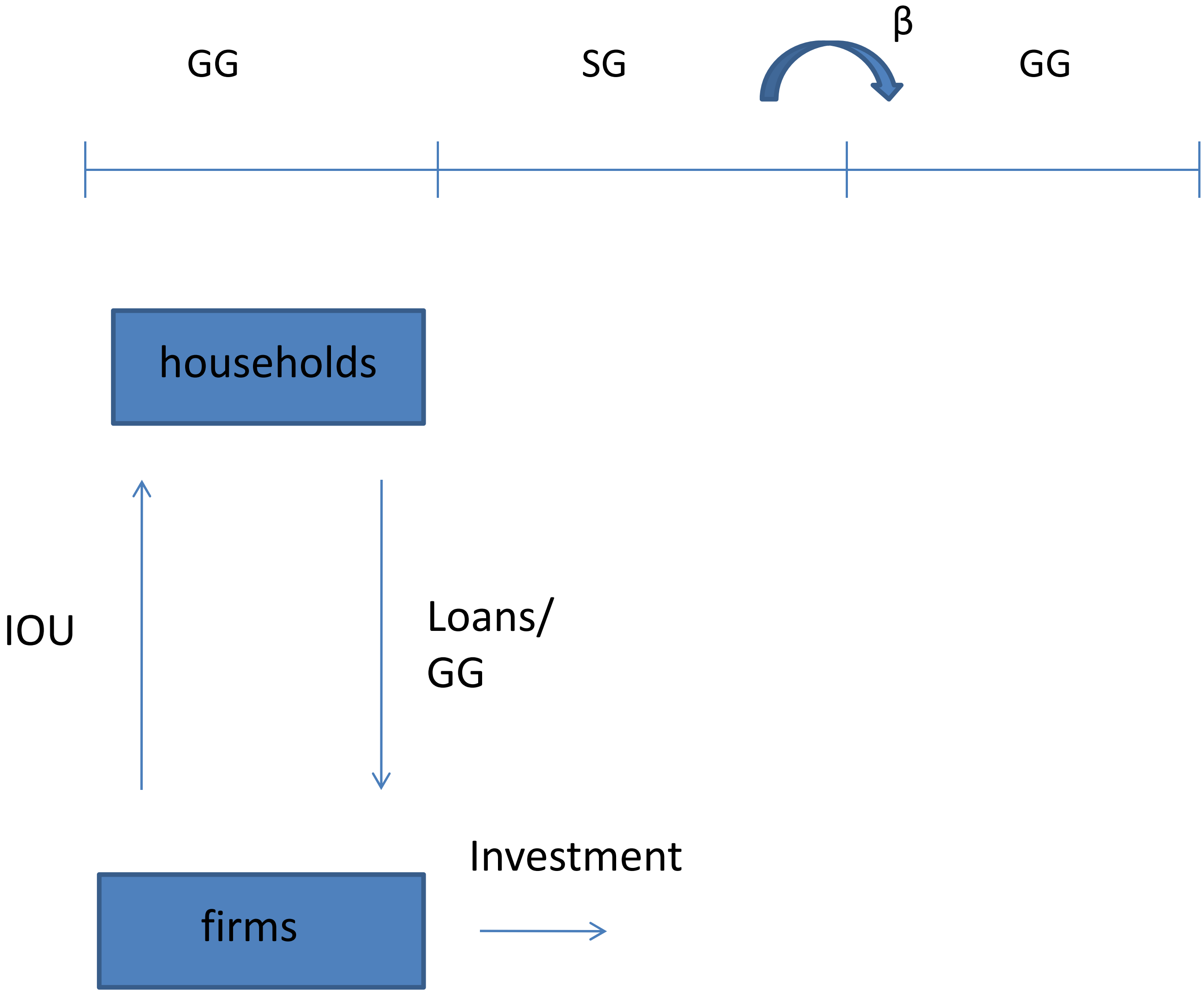
$$0 \leq i \leq \alpha;$$

$$e \geq \bar{U}^e$$

- Solution: $i = 2q^*$, where $u'\left(q^*\right) = 2$.
- Assume $\alpha = 2q^*$.

Pure Credit Economy

- First subperiod (GG): Market for Loanable Funds
  - Entrepreneurs post the terms of the contract.
- Second subperiod (SG): Goods Market.
  - Perfectly competitive.
- Perfect recordkeeping & perfect enforcement of private liabilities.



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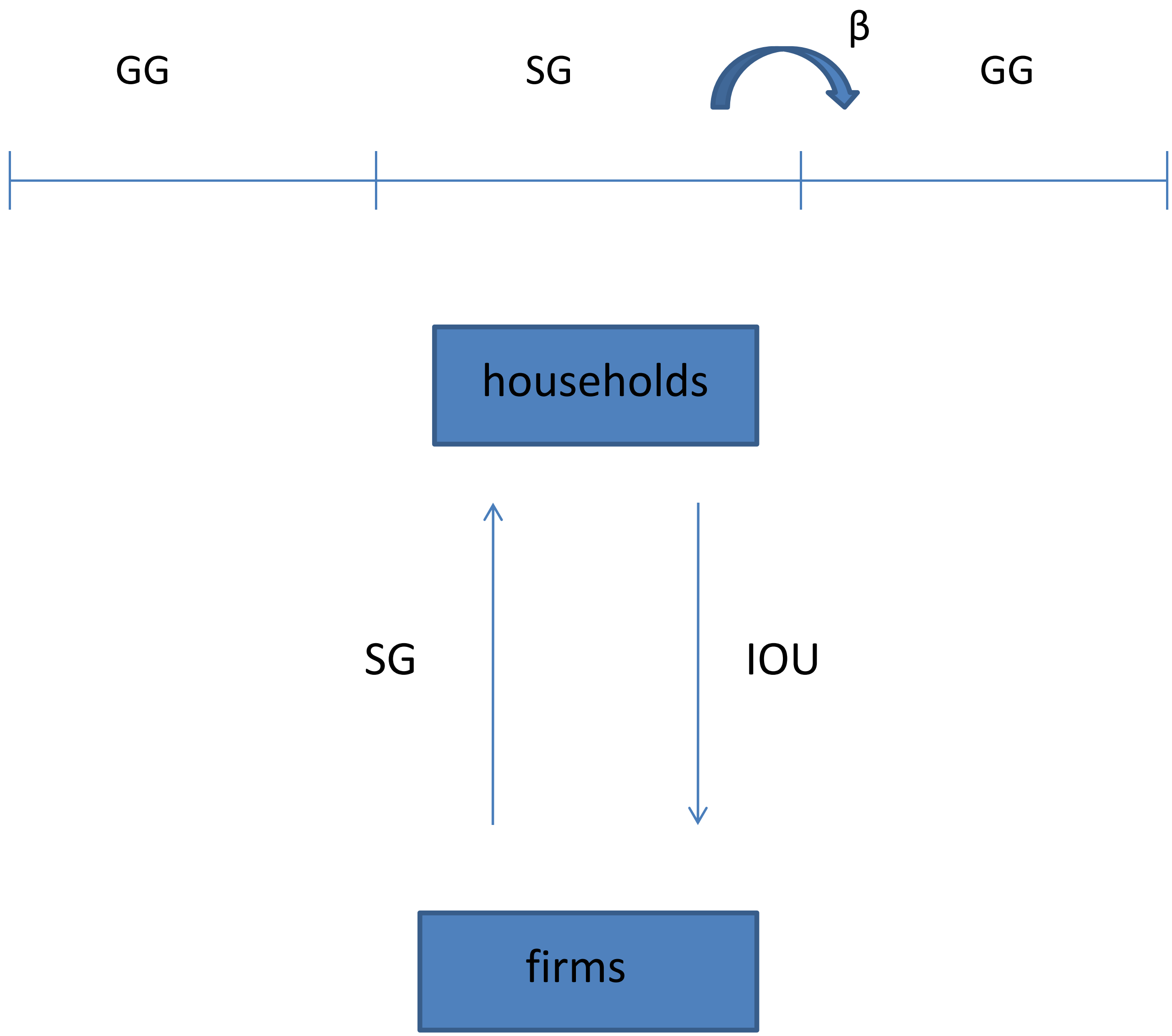
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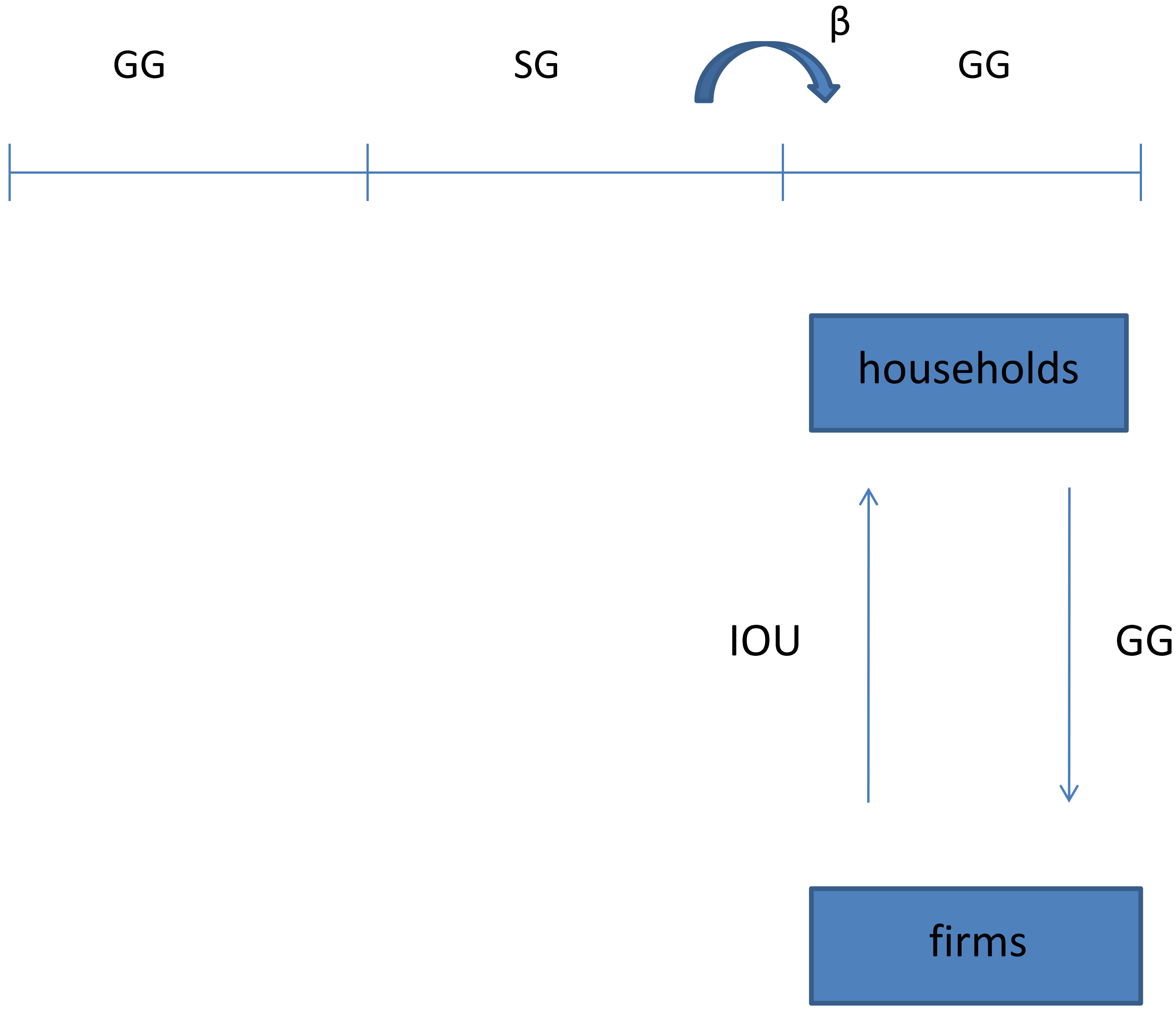
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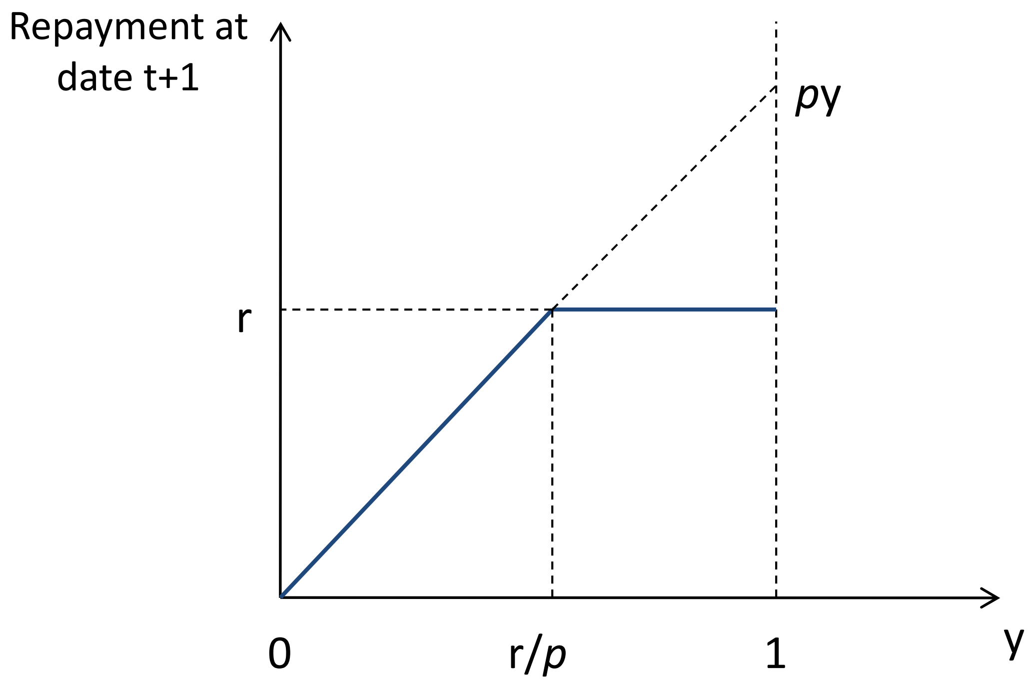
Figure 1 - Optimal Contract



p is the price of one unit of SG in terms of GG.

Figure 2 – Loans to Entrepreneurs

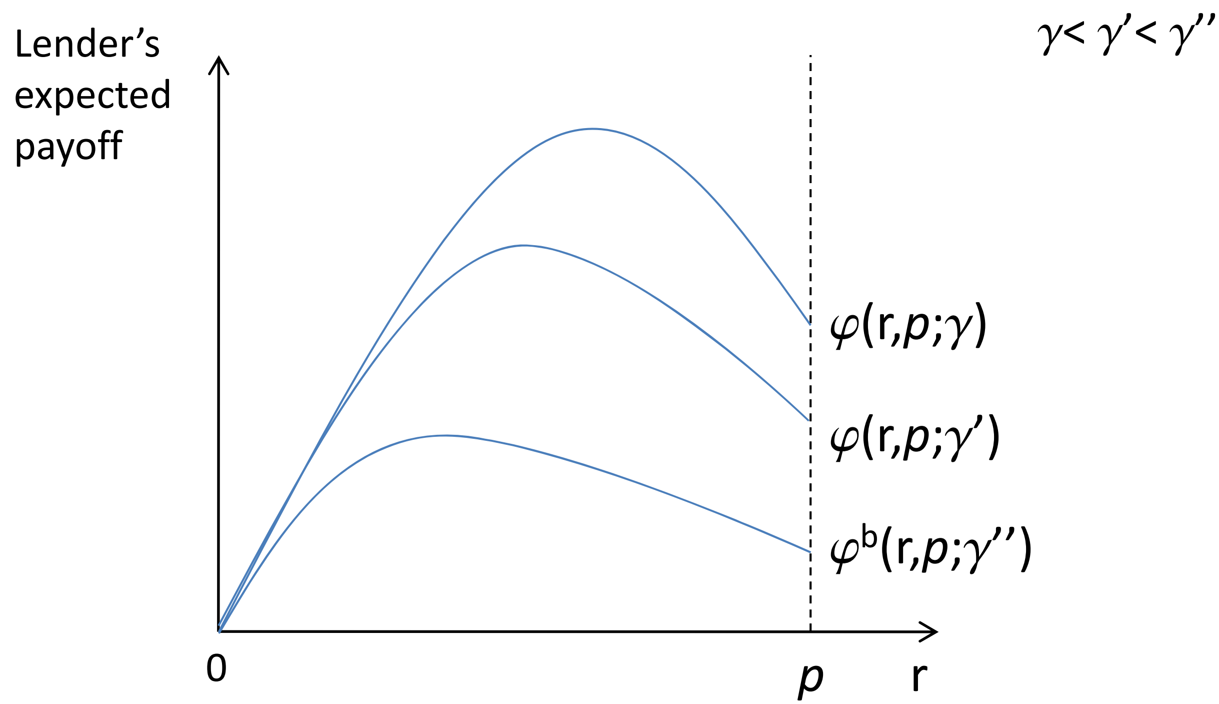
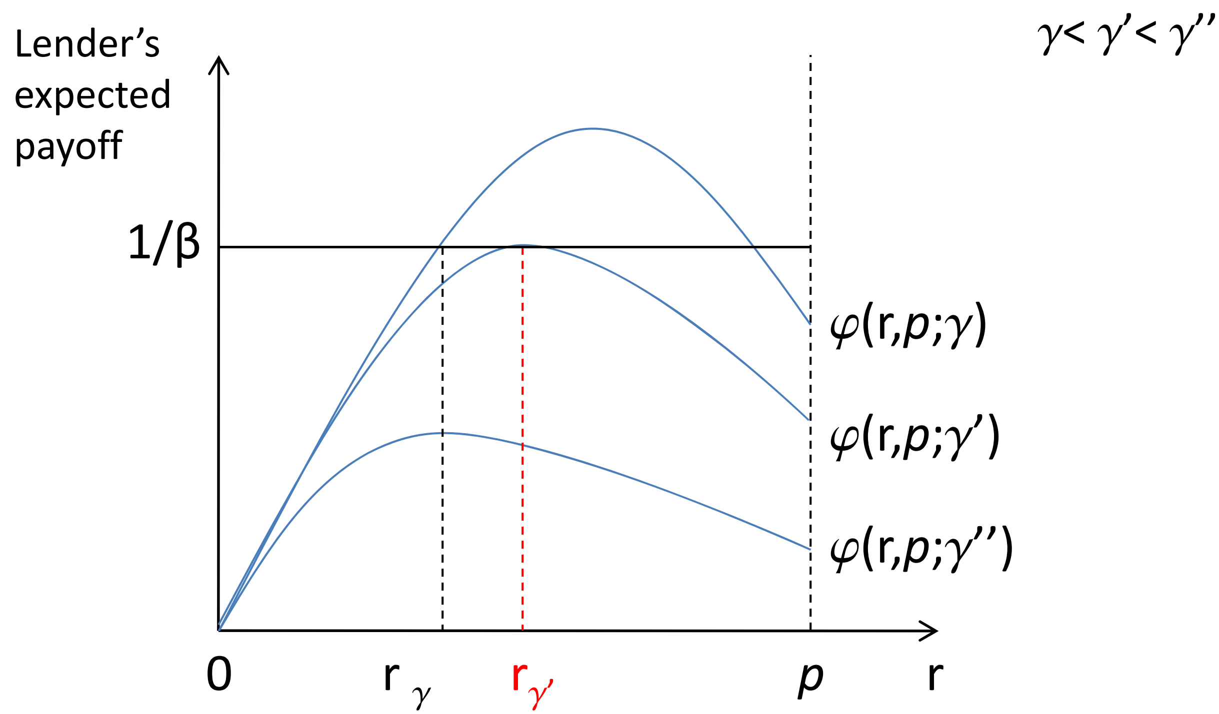


Figure 3 – "Marginal" Entrepreneur



$\gamma_* = \gamma'$

Pure Credit Economy

Market for Loanable Funds

- Household's participation constraint (PC):

$$r\left(1-\frac{\gamma}{\hat{p}}\right)-\frac{r^2}{2\hat{p}}\geq\frac{1}{\beta}$$

- Given $\hat{p}$, entrepreneur γ offers $r(\hat{p};\gamma)$ satisfying PC with equality.
- Only entrepreneurs indexed $\gamma \leq \gamma_*$ can offer r satisfying PC.
- Households create an FI that makes all loans to entrepreneurs.
    - FI maximizes expected utility by taking deposits & making loans.
    - FI holds a fully diversified portfolio.
    - FI is able to promise a certain return β^{-1} to each depositor.

Pure Credit Economy

Household's Problem

- Value function (second subperiod):

$$\hat{V}(a) = \max_{q \in \mathbb{R}_+} \left\{ u(q) + \beta \max_{(x,h,a') \in \mathbb{R}^3_+} \left[x - h + \hat{V}(a') \right] \right\}$$

subject to

$$x + \hat{p}q + a' = h + \beta^{-1} a$$

- Demand for SG as a function of $\hat{p}$:

$$\beta \hat{p} = u'(q)$$

- Aggregate investment:

$$i = \frac{\alpha\gamma_*}{\bar{\gamma}}$$

- Market clearing:

$$q = \frac{\alpha\gamma_*}{2\bar{\gamma}} \;\; \& \;\; a' = i$$

- Relative price:

$$\hat{p} = \gamma_* + \beta^{-1} + \sqrt{\left(\gamma_* + \beta^{-1}\right)^2 - \gamma_*^2}$$

Definition

A credit eq. is a list $(a', i, \gamma_*, q, \hat{p})$ satisfying: **(i)** the Euler equation; **(ii)** the optimal investment choice; and **(iii)** the market-clearing conditions.

Pure Credit Economy

- $\omega \equiv \gamma_* / \bar{\gamma}$.
- Social welfare is given by

$$W^c = -2\omega q^* + u\left(q^* \omega\right)$$

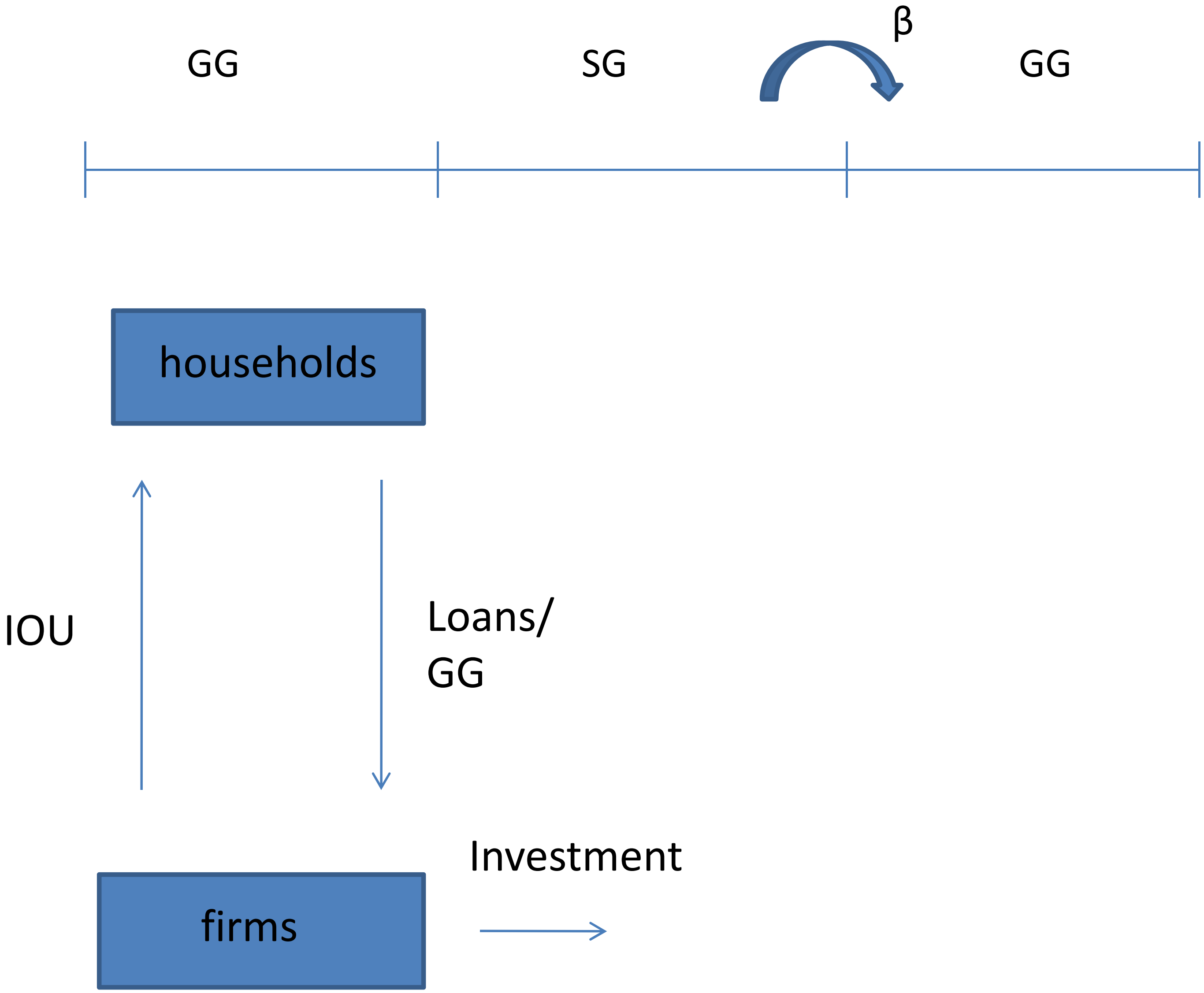
- $\partial\omega / \partial\bar{\gamma} < 0$.
- Small $\bar{\gamma}$ means CSV friction is small: credit economy is arbitrarily close to UE allocation.
- Large $\bar{\gamma}$ means CSV friction is large: credit economy is far away from UE allocation.

Monetary Economy

- Lack of recordkeeping & limited enforcement.
  - A medium of exchange is required to settle transactions on the second market.
- Walrasian market in the first subperiod: Agents trade GG for fiat money.
- Government's budget constraint:

$$\bar{M}_t - \bar{M}_{t-1} = T_t$$

- $\bar{M}_t = \mu \bar{M}_{t-1}$ for all $t \geq 1$.
- ϕ_t is the value of money at date t.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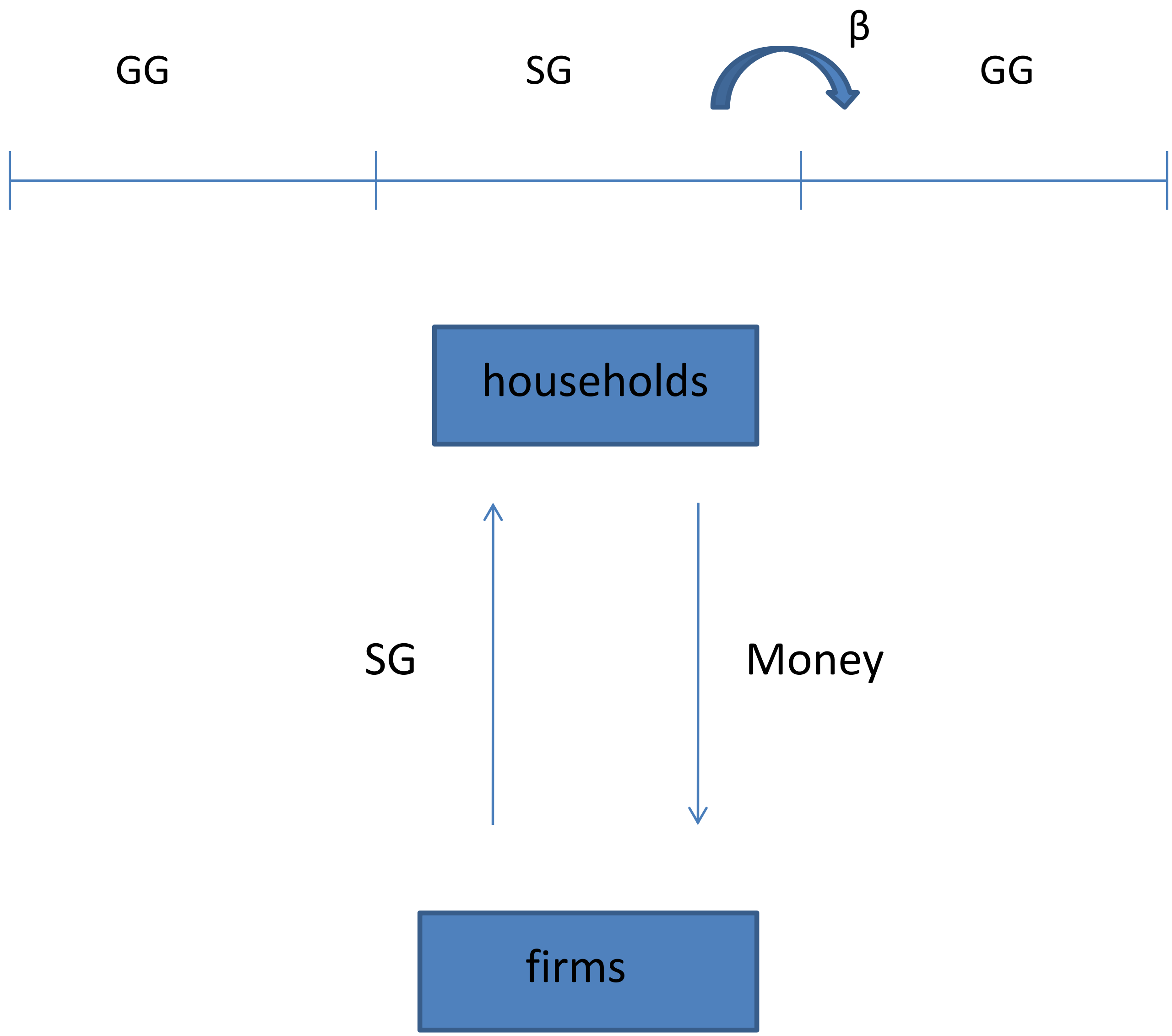
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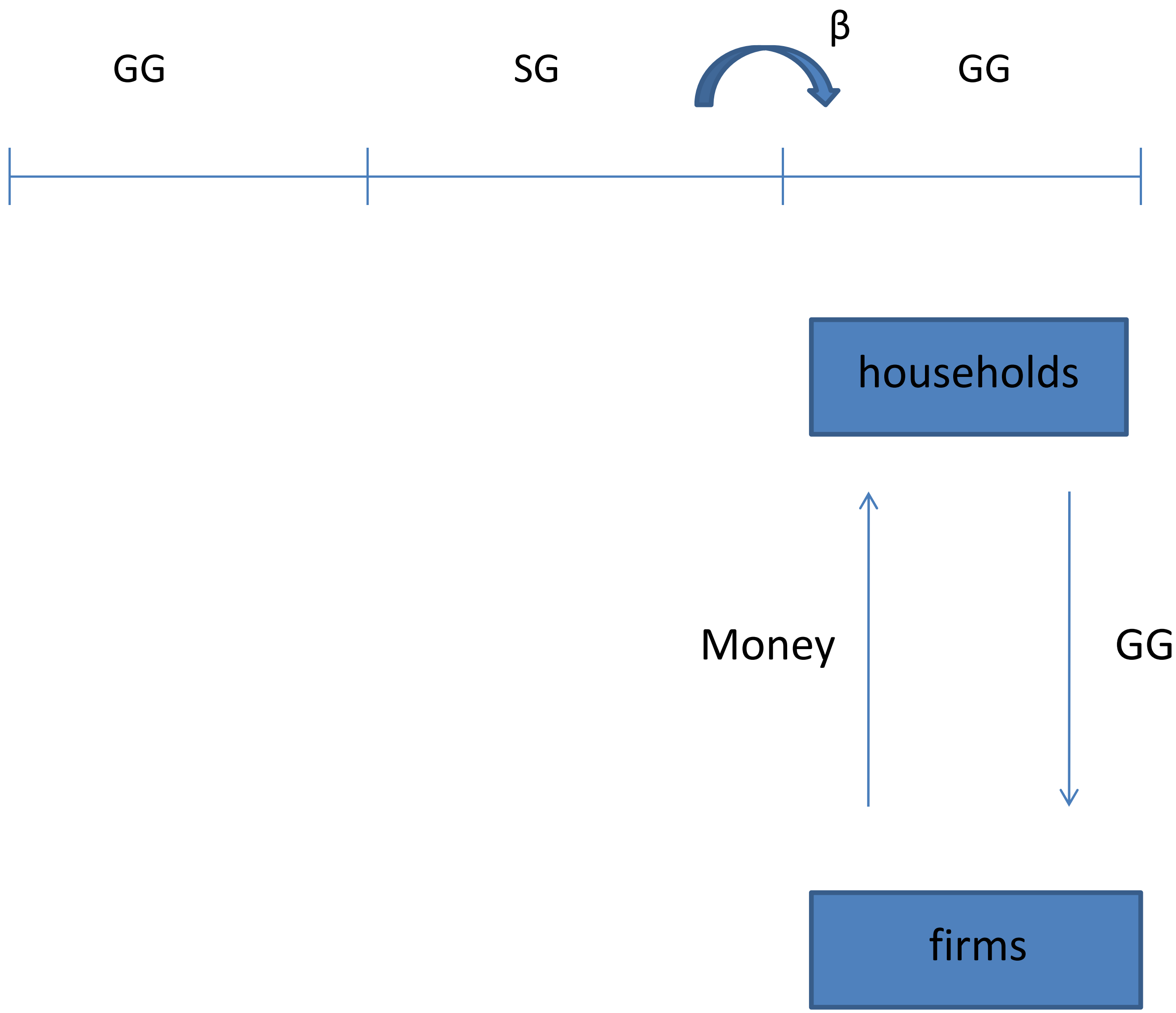
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- Household's participation constraint (PC):

$$\frac{\mu r^2}{2p} - r + \frac{p}{2\mu} \geq \frac{1}{\beta}$$

- Given p & μ, entrepreneur γ offers $r(p, \mu; \gamma)$ satisfying PC with equality.
- Only entrepreneurs indexed $\gamma \leq \gamma_*$ can offer r satisfying PC.
- Households create an FI that makes all loans to entrepreneurs.
  - FI maximizes expected utility by taking deposits & making loans.
  - FI holds a fully diversified portfolio.
  - FI is able to promise a certain return β^{-1} to each depositor.

- Value function (second subperiod):

$$V(a,m) = \max_{q \in \mathbb{R}_+} \left\{ u(q) + \beta \max_{(x,h,a',m') \in \mathbb{R}^4_+} \left[x - h + V(a',m') \right] \right\}$$

subject to

$$a' + m' + x = h + \beta^{-1} a + \mu^{-1} (m - pq) + \tau;$$

$$pq \leq m$$

- Optimal choice of real balances:

$$1 = \frac{1}{p} u' \left(\frac{m'}{p} \right)$$

- Aggregate investment:

$$i = \frac{\alpha\gamma_*}{\bar{\gamma}}$$

- Market clearing:

$$m' = p\frac{\alpha\gamma_*}{2\bar{\gamma}} \;\; \& \; a' = i$$

- Relative price:

$$p = \mu\left[\gamma_* + \beta^{-1} + \sqrt{\left(\gamma_* + \beta^{-1}\right)^2 - \gamma_*^2}\right]$$

Definition

A monetary eq. is a list (m', a', i, γ_*, p) satisfying: **(i)** the Euler equation; **(ii)** the optimal investment choice; and **(iii)** the market-clearing conditions.

Effects of Monetary Policy

- $\partial\gamma_* / \partial\mu < 0$.
- Higher inflation rate $\Rightarrow$ fewer entrepreneurs are funded (lower aggregate investment).
  - Expected value of each project $p/2\mu$ falls as the inflation rate rises.
  - Only low-cost entrepreneurs are able to obtain external funds.

Optimal Monetary Policy

- Social welfare is given by

$$W(\mu) = -2\omega(\mu) q^* + u(\omega(\mu) q^*)$$

- Friedman rule is optimal: $\mu = \beta$.
    - It implements the same allocation as the credit economy.

Quantitative Analysis

- CRRA utility:

$$\frac{(q+\chi)^{1-\sigma} - \chi^{1-\sigma}}{1-\sigma} \text{ with } \sigma > 0 \;\&\; \chi \in (0,1)$$

- $\beta = 0.96$; $\sigma = 0.5$.
- To calibrate $\bar{\gamma}$, we target the ratio i/m.

$$\frac{i}{m} = 0.67 = \frac{2}{\mu\left[\gamma_* + \beta^{-1} + \sqrt{\left(\gamma_* + \beta^{-1}\right)^2 - \gamma_*^2}\right]}$$

- C&I loans as a proxy for the investment of bank-dependent firms.
- M1 as a measure of the stock of money.

The Welfare Cost of Inflation

- Annual data: 1959-2010.
- Lagos & Wright (2005):

$$-2\omega(\mu) q^* + u(\omega(\mu) q^*) = -2\omega(\beta) q^* + u\left(\omega(\beta) q^* \Delta_\mu\right)$$

- Welfare cost: $1 - \Delta_\mu$
- Cooley & Hansen (1989):

$$-2\omega(\mu) q^* + u\left(\omega(\mu) q^* + \Delta_\mu\right) = -2\omega(\beta) q^* + u\left(\omega(\beta) q^* + \bar{\Delta}_\mu\right)$$

- Welfare cost: $\bar{\Delta}_\mu / \omega(\mu) q^*$

Results

- Benchmark: $i/m = 0.67$ ($\bar{\gamma} = 0.95$)
  - L&W: $1 - \Delta_{1.1} = \mathbf{5.48}\%$
  - C&H: $\bar{\Delta}_{1.1}/\omega(1.1)\, q^* = \mathbf{5.16}\%$
- Fraction $\eta \in (0,1)$ of "credit" firms & fraction $1-\eta$ of "cash" firms.
  - Recalibrate the model (to be done).

Conclusions

- Monetary & banking frictions matter.
  - Monetary frictions amplify the banking frictions.
  - Our channel is quantitatively important.