Liquidity and Inefficient Investment

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- The Great Recession and the ensuing policy debate have spurred a renewed interest in some basic questions:
- Does a market economy provide the right amount of liquidity ? If not, does it provide too little or too much ?
- 2. What inefficiency does fiscal policy address?
- 3. Is there any value to committing to a fiscal policy rule?

- These questions have been analyzed in a number of recent contributions. See particularly Holmstrom-Tirole (2011) and Lorenzoni (2008).
- These works focus on firms' liquidity needs in the face of an aggregate shock when
 - firms' cash flow is not fully pledgeable
 - consumers cannot pledge future endowments.

- In contrast our paper emphasizes <u>consumers'</u> <u>liquidity problems</u> when they cannot pledge their human capital.
- During the Great recession firms had plenty of liquidity while consumers were severely constrained (Kahle and Stulz (forthcoming) and Mian and Sufi (2012)).
- This seems to be true also in general
 - 37% of families are financially constrained (2004 Survey of Consumer Finances)
 - only 15% of small firms (2003 Survey of Small Businesses Finances).

Preview of the Results

- We study consumer liquidity in a complete markets model where the <u>only friction is the non-</u> <u>pledgeability of human capital</u>. We show that
- 1. the competitive equilibrium is constrained inefficient: too little risky investment.
- 2. Fiscal policy following a large negative shock can increase ex ante welfare.
- 3. If the government cannot commit to the promised level of fiscal intervention, the ex post optimal fiscal policy will be <u>too small</u> from an ex ante perspective.

The Framework

• We consider an economy that lasts 4 periods:

1 ------4

- There are two types of agents in equal numbers: doctors and builders.
- <u>In the paper</u>: fully symmetric
- <u>In the presentation</u>: the doctors go first.
- Doctors want to consume building services in period 2 and builders want to consume doctor services in period 3.
- In period 1 both doctors and builders have an endowment of wheat equal to e >1.
- Agents can consume wheat in period 4.
- No discounting.

• We write agents' utilities as:

Doctors:
$$U_d = w_d + b_d - \frac{1}{2}{l_d}^2$$

Builders:
$$U_b = w_b + d_b - \frac{1}{2}{l_b}^2$$

w_i = wheat consumed by ind. *i=d,b;*

 b_d = quantity of building services consumed by doctors; l_d = labor supplied by the doctors; d_b = quantity of doctor services consumed by builders; l_b = labor supplied by builders.

- Constant returns to scale:
 - 1 unit of builder labor yields 1 unit of building services
 - 1 unit of doctor labor yields 1 unit of doctor services.
- There are many doctors and many builders, and so the prices for both services are determined <u>competitively.</u>
- There is <u>no simultaneous double coincidence of wants</u>: the builder a doctor buys from cannot buy from this doctor at the same time or requires the doctor services of another doctor.
- We normalize to 1 the price of wheat in period 4.
- Agents are risk neutral.

Investment Technologies

- In period 1 wheat can be invested in two technologies:
 - a riskless technology (storage): one unit of wheat is transformed into one unit of period-4 wheat
 - a risky technology: 1 unit of wheat is transformed into R^H >1 units of period-4 wheat with probability
 - π and $R^L < 1$ units with probability 1π , where $0 < \pi < 1$
 - and $\overline{R} = \pi R^{H} + (1 \pi)R^{L} > 1$.
 - -The returns of the various risky projects are perfectly correlated.

-Agents learn about the aggregate state of the world—H or L-- between periods 1 and 2.

Supplies (in state H or L)

• <u>Doctors</u> solve max $p_d l_d - \frac{1}{2} {l_d}^2$

=>
$$l_d = p_d$$
 if $p_d < 1$. Net utility = $\frac{1}{2} p_d^2$

• <u>Builders</u> solve max $\frac{p_b}{p_d} l_b - \frac{1}{2} l_b^2$

=>
$$l_b = \frac{p_b}{p_d}$$
 if $p_b < 1$. Net utility $= \frac{1}{2} \left(\frac{p_b}{p_d} \right)^2$

• If doctors <u>can pledge their future labor</u> income to pay the builders, then

$$p_b = p_d = 1$$
 $d_b = b_d = 1$ $U_b = U_d = e\overline{R} + 1/2$

Equilibrium

- All wheat invested in risky technology.
- This is the first best (and also Arrow-Debreu equilibrium).

$$q^{H} = \pi / \overline{R}, \qquad q^{L} = (1 - \pi) / \overline{R}$$

• No role for insurance (before an agent learns his type)

Nonpledgeable human capital

- The state of the world H or L is verifiable.
- Two Arrow securities exist:
 - paying 1 unit of wheat in H (price q^H)
 - paying 1 unit of wheat in L (price q^L)
- These Arrow securities are supplied by firms investing in projects.
- They will be collateralized by the project returns in each state and so there will be no default in equilibrium (asset returns cannot be stolen by firms' managers).
- Normalize price of wheat in period 0 to be 1.

Demand for Arrow securities

Doctors choose x_d^L and x_d^H to maximize

$$\pi \left[\frac{x_d^H}{p_b^H} + \frac{1}{2} \left(p_d^H \right)^2 \right] + (1 - \pi) \left[\frac{x_d^L}{p_b^L} + \frac{1}{2} \left(p_d^L \right)^2 \right]$$

s.t.

$$q^H x_d^H + q^L x_d^L \le e$$

• Similarly, builders maximize

$$\pi \left[\frac{x_{b}^{H}}{p_{d}^{H}} + \frac{1}{2} \left(\frac{p_{b}^{H}}{p_{d}^{H}} \right)^{2} \right] + (1 - \pi) \left[\frac{x_{b}^{L}}{p_{d}^{L}} + \frac{1}{2} \left(\frac{p_{b}^{L}}{p_{d}^{L}} \right)^{2} \right]$$

s.t.

 $q^H x_b^H + q^L x_b^L \le e$

Supply of Arrow securities

- Profit maximization + constant returns to scale => zero profit: the value of the return stream of each technology cannot exceed the cost of investing in that technology (i.e., 1).
- If the inequality is strict the technology will not be used.
- $q^{H} + q^{L} \le 1$ where $y^{s} = 0$ if inequality strict
- $q^{H}R^{H} + q^{L}R^{L} \le 1$ where $y^{r} = 0$ if inequality strict

Market clearing conditions

- Arrow securities: $x_d^H + x_b^H = y^s + y^r R^H$ $x_d^L + x_b^L = y^s + y^r R^L$
- Wheat: $y^{s} + y^{r} = 2e$

- Market clearing conditions in each state (i= H, L):
 - <u>builder</u> market in period 2

$$p_b^i \le 1$$
. If $p_b^i < 1$, then $\frac{x_d^i}{p_b^i} = \frac{p_b^i}{p_d^i}$. If $p_b^i = 1$, then $x_d^i \ge \frac{1}{p_d^i}$

<u>doctor</u> market in period 3

$$p_d^i \le 1$$
. If $p_d^i < 1$, then $\frac{x_b^i + ((p_b^i)^2 / p_d^i)}{p_d^i} = p_d^i$.
If $p_d^i = 1$ then $x_b^i + (p_b^i)^2 \ge 1$.

Proposition 2: Prices of both goods equal 1 in H state

If $2eR^{L} \ge 1$, then a competitive equilibrium delivers the first best.

If $1 > 2eR^{L} \ge \left(\frac{1-\pi}{\pi}\frac{1-R^{L}}{R^{H}-1}\right)^{\frac{4}{3}}$ then a competitive equilibrium is such that investment is efficient (only the risky technology is used), but trading in doctor and building services is inefficiently low.

If
$$2eR^{L} < \left(\frac{1-\pi}{\pi}\frac{1-R^{L}}{R^{H}-1}\right)^{\frac{4}{3}}a$$
 competitive equilibrium is such that

investments and trading in labor services are both inefficient: the riskless technology is operated at a positive scale and trade is inefficiently low.

Intuition

- In the first best, economy operates at full capacity and all wheat is invested in risky project
- The key variable that determines whether the economy is at the F.B. is the total amount of pledgeable wealth in the bad state: $2eR^{L}$.
- The smaller is the endowment and/or the smaller is the gross return in the bad state, the less likely it is that the economy is at the F.B.

• If $R^L = 0$, the economy will never be at the F. B.

- No role for insurance
- Turn now to second-best optimality..

- We focus on the case $2eR^L < \left(\frac{1-\pi}{\pi}\frac{1-R^L}{R^H-1}\right)^{\frac{1}{3}}$
- There is a one-to-one relationship between
 y^r and x^L_d: decreases in the former correspond to increases in the latter.
- Suppose the planner can intervene by regulating x_d^L , what happens?
- The market clearing conditions yield $p_d^L = (x^{CP})^{\frac{1}{2}} \quad p_b^L = (x^{CP})^{\frac{3}{4}}$
- The doctors' utility becomes $\pi \left[\frac{e q^L x^{CP}}{q^H} + \frac{1}{2} \right] + (1 \pi) \left[\left(x^{CP} \right)^{\frac{1}{4}} + \frac{1}{2} x^{CP} \right]$
- The builders' one: $\pi \left[\frac{e}{q^H} + \frac{1}{2} \right] + (1 \pi) \left[\frac{1}{2} \left(x^{CP} \right)^{\frac{1}{2}} \right]$

- The planner maximizes $U^d + U^b$. (Why?)
- Differentiating the welfare function with respect to x^{CP} yields

$$-\pi \frac{q^{L}}{q^{H}} + (1-\pi) \left[\frac{1}{4} \left(x^{CP}\right)^{-\frac{3}{4}} + \frac{1}{2}\right] + (1-\pi) \frac{1}{4} \left(x^{CP}\right)^{-\frac{1}{2}}$$

• Computed at $x^{CP} = \left(\frac{1-\pi}{\pi} \frac{1-R^{L}}{R^{H}-1}\right)^{\frac{3}{3}}$ it yields

$$-\pi \frac{q^{L}}{q^{H}} + (1-\pi) \left[\frac{1}{4} \left(\frac{1-\pi}{\pi} \frac{q^{H}}{q^{L}}\right)^{-1} + \frac{1}{2}\right] + (1-\pi) \frac{1}{4} \left(\frac{1-\pi}{\pi} \frac{q^{H}}{q^{L}_{4}}\right)^{-\frac{2}{3}} < 0$$

Proposition 3: When $2eR^L < \left(\frac{1-\pi}{\pi}\frac{1-R^L}{R^H-1}\right)^{\overline{3}}$, the

economy overinvests in safe assets.

Intuition

- Non-pledgeability of labor income creates an additional demand for relatively safe assets.
- Doctors buy a lot of the bad-state securities because they are liquidity constrained in that state.
- In doing so they ignore the effect that this buying has on the prices and hence on the utility of <u>other</u> doctors.
- The negative pecuniary externality on other doctors is not second order, because the doctors are liquidity constrained.

Fiscal Policy

- So far ignored the role of the government in providing liquidity.
- Following Woodford (1990) and Holmstrom and Tirole (1998, 2011), we assume the government can exploit the power to tax.
- It can issue notes to consumers, which are backed by future tax receipts.
- Since the intervention does not affect the wealth of each consumer, but only the temporal distribution of this wealth, we label it *fiscal policy*.

Flour Technology

- Assume that each agent can obtain λ units of flour at the cost of $\frac{1}{2}c\lambda^2$ units of wheat.
- **Doctors:** $U_d = w_d + b_d \frac{1}{2}l_d^2 + (1-t)\lambda_d \frac{1}{2}c\lambda_d^2$
- Builders: $U_b = w_b + d_b \frac{1}{2}l_b^2 + (1-t)\lambda_b \frac{1}{2}c\lambda_b^2$ — where *t* is the tax rate on flour
- If agents are not at a corner solution(large endowment of wheat in period 4), λ_d , λ_b satisfy FOC 1-t

$$\lambda_d = \lambda_b = \frac{1-t}{c}$$

Budget balance implies

$$T = \frac{2t(1-t)}{c}$$

Ex post intervention

- When the state is low, if the government intervenes with an (unexpected) hand-out m to doctors in period 2, it will boost the level of output by more than m (fiscal multiplier).
- Assume that x^L_d and x^L_b are fixed at their competitive equilibrium levels, which are less than 1.
- The new equilibrium is

$$\frac{x_d^L + m}{p_b^L} = \frac{p_b^L}{p_d^L}$$
$$\frac{x_d^L + m}{p_d^L} = p_d^L$$

which implies $p_b^L = (x_d^L + m)^{\frac{3}{4}}$ $p_d^L = (x_d^L + m)^{\frac{1}{2}}$. Since $l_d^L = p_d^L$ and $l_b^L = \frac{p_b^L}{p_d^L}$, the fiscal policy increases output (which we measure $p_d^L l_d^L + p_b^L l_b^L$ as $= (p_d^L)^2 + \frac{(p_b^L)^2}{p_d^L}$ from $2x_d^L$ to $2(x_d^L + m)$

- Thus, the fiscal multiplier is 2.
- Not only does a fiscal policy following a big negative shock increase output more than one-to-one, but it also increases ex ante welfare.

Ex ante intervention (anticipated) – Commitment case

• In period 1 a doctor chooses x_d^H and x_d^L to solve: Max $\pi \left[\frac{x_d^H}{p_b^H} + \frac{1}{2} \left(p_d^H \right)^2 + \frac{1}{2c} \right] + (1 - \pi) \left[\frac{x_d^L + m}{p_b^L} + \frac{1}{2} \left(p_d^L \right)^2 + \frac{1}{2c} (1 - t)^2 \right]$

subject to $q^H x_d^H + q^L x_d^L \leq e$

- Similarly for the builders
- If $p_b^L < 1$, then $\frac{x_d^L + m}{p_b^L} = \frac{p_b^L}{p_d^L}$

• If
$$p_d^L < 1$$
, then $\frac{x_b^L + m + x_d^L}{p_d^L} = p_d^L$

 The government chooses in period 0 to maximize the expected utility of an agent who does not know whether he will buy or sell first

$$W = \pi \left[\frac{x_d^H}{p_b^H} + \frac{1}{2} \left(p_d^H \right)^2 + \frac{1}{2c} + \frac{x_b^H}{p_d^H} + \frac{1}{2} \left(\frac{p_b^H}{p_d^H} \right)^2 + \frac{1}{2c} \right] + (1 - \pi) \left[\frac{x_d^L + m}{p_b^L} + \frac{1}{2} \left(p_d^L \right)^2 + \frac{1}{2c} (1 - t)^2 + \frac{x_b^L}{p_d^L} + \frac{1}{2} \left(\frac{p_b^L}{p_d^L} \right)^2 + \frac{1}{2c} (1 - t)^2 \right]$$

• **Proposition 4:** If $2eR^{L} < \left(\frac{1-\pi}{\pi}\frac{1-R^{L}}{R^{H}-1}\right)^{\frac{1}{3}}$ a positive injection of notes in the low state is welfare improving: $\frac{dW}{dm} = \frac{\pi}{(1-\pi)} \left[\frac{R^{H}-1}{1-R^{L}}\right] - \frac{(1-t)}{(1-2t)} > 0$

at t=0

- When the government intervention is expected, the inefficient overinvestment in safe assets is reduced.
- Yet, the level of output in periods 2 and 3 is still inefficient.
- Government liquidity completely crowds out private liquidity.
- The level of trade remains the same as in the original equilibrium
- Nevertheless, when the government does intervene in period 2, the multiplier is bigger than 1 as per the analysis above

The case of non-commitment

• Since x_d^L and $x_b^L = 0$ are fixed, total welfare in the low state is given by

$$W^{L} = \left[\frac{x_{d}^{L} + m}{p_{b}^{L}} + \frac{1}{2}\left(p_{d}^{L}\right)^{2} + \frac{x_{b}^{L}}{p_{d}^{L}} + \frac{1}{2}\left(\frac{p_{b}^{L}}{p_{d}^{L}}\right)^{2} + \frac{1}{c}(1-t)^{2}\right]$$
$$= \left[\left(x_{d}^{L} + m\right)^{\frac{1}{4}} + \frac{1}{2}\left(x_{d}^{L} + m\right) + \frac{1}{2}\left(x_{d}^{L} + m\right)^{\frac{1}{2}} + \frac{1}{c}(1-t)^{2}\right]$$

$$\frac{dW^{L}}{dm} = \left[\frac{1}{4}\frac{\pi}{(1-\pi)}\frac{R^{H}-1}{1-R^{L}} + \frac{1}{2} + \frac{1}{2}\left(\frac{\pi}{(1-\pi)}\frac{R^{H}-1}{1-R^{L}}\right)^{-\frac{2}{3}} - \frac{(1-\pi)}{\pi}\frac{1-R^{L}}{R^{H}-1}\right] < 0$$

 Ex post the government will want to <u>intervene</u> <u>less</u> than it said it would

Intuition

- The promise to give hand-outs in the low state helps address two problems:
 - inefficient investment in period 0 and
 - inefficiently low level of trade in periods 2 and 3.
- If the government can renege on its promise in period 2, it will find that at that time its actions affect only one inefficiency:

- the low level of trade in periods 2 and 3.

 Since the government finds it less beneficial to tax people to deal with one inefficiency rather than two, it will deviate in the direction of intervening less than promised

Conclusions

- We build a simple GE model to analyze the role of fiscal policy in attenuating the impact of aggregate shocks on
 - private investment choices
 - aggregate output.
- We show that the lack of pledgeability of human capital makes the competitive equilibrium constrained inefficient.
- The market will invest too much in producing safe securities and will dedicate too few resources towards risky investments.

- A fiscal policy following a big negative shock can increase
 - ex post output more than one-to-one
 - ex ante welfare.
- But there is a commitment problem
- We have assumed that consumers purchase liquidity directly from firms.
- If we were to drop this assumption and allow financial intermediaries:
- What would be the consequences if these intermediaries got into trouble ?
- This is something we study in HZ (2013)