Asset prices and self-fulfilling macroeconomic pessimism[*]

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Abstract

We show multiple equilibria can occur in a simple macro model with an imperfection in the capital market that causes borrowing to be collateralized. Since the value of the collateral depends on current asset prices, and asset prices depend on current expenditure and future profits, this opens the door to self-fulfilling expectations. Fiscal or monetary policies, debt rescheduling and financial reform can help rule out the bad equilibrium if one exists. JEL Nos. E0, F0.

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1. Introduction

The tremendous volatility in asset prices (especially stock prices) over the last few years, both in the US and elsewhere, has caused economists to wonder about the effects of movements in these prices on aggregate demand and economic activity. One standard link runs from stock prices to private wealth, and then to consumption demand and income. Feeling suddenly poor after a bear market, consumers can curtail their spending, pushing the economy even further down.

Another possible effect, which is the focus of this paper, runs from asset prices to investment demand. A bear market reduces the value of the collateral held by households and firms, which in turn cuts their ability to borrow and invest, again pushing ouput down.

But that need not be the end of the story. Changes in activity affect future firm profits, which in turn affect current stock prices. Circular causation can occur, which inevitably raises the question whether movements in asset prices and economic activity are based on self-fulfilling beliefs. Can it be the case that any event (a terrorist attack? a political crisis? a poor night's sleep?) causes a bout of depression and a fall in the stock market, which in turn triggers a fall in investment and a recession, which justifies the initial pessimism?

Here's a toy model that delivers such a result.

2. The Model

The model has two periods, one good, and two kinds of people, capitalists and workers. Workers supply labor and consume. Capitalists own the factors of production other than labor, which they rent to firms, and also consume. They finance investment in excess of their own resources by borrowing from workers. The key aspect of the model is that such borrowing is constrained by the need to put up collateral, and the value of this collateral in turn depends on asset prices.

2.1. Domestic Production

Production is carried out by competitive firms. Each firm has access to the Cobb-Douglas technology

$$Y_t = I_t^{\alpha} K_t^{\gamma} L_t^{1-\alpha-\gamma}, \quad 0 < \alpha + \gamma < 1 \tag{2.1}$$

where I denotes inputs, L labor and K capital. Inputs I should be interpreted to include any factor of production, other than labor, whose level can be changed from one period to the next: intermediates, certain technologies, etc. Capital K should also be broadly defined to include land and anything that is bolted to the ground: buildings, certain kinds of equipment, etc. This is a factor of production whose aggregate availability changes only slowly through time —and in this two-period model, not at all.

In each one of the two periods the firm chooses inputs, capital and labor according to

$$Z_t = \alpha \left(\frac{Y_t}{I_t} \right) \tag{2.2}$$

$$R_t = \gamma \left(\frac{Y_t}{K_t} \right) \tag{2.3}$$

$$W_t = (1 - \alpha - \gamma) \left(\frac{Y_t}{L_t} \right) \tag{2.4}$$

where Z, R and W are the factor returns to inputs, capital and labor.

2.2. Workers

Workers consume and they supply one unit of labor inelastically (so that $L = 1$ by assumption from now on) for which they are payed labor's marginal return. As consumers, they maximize a standard two-period utility function subject to the budget constraint

$$C_1 + \frac{C_2}{1+r} = B + W_1 + \frac{W_2}{1+r}; \tag{2.5}$$

where B is accumulated wealth saved by workers (and consequently borrowed by capitalists) in the past. Period 1 savings by workers are also channeled to capitalists, who invest in either capital or inputs.

Using equations 2.1 and 2.4, budget constraint 2.5 can be written as

$$C_1 + \frac{C_2}{1+r} = B + (1 - \alpha - \gamma) I_1^{\alpha} + \frac{(1 - \alpha - \gamma)(I_1 + I_2)^{\alpha}}{1+r}; \tag{2.6}$$

where I_2 is aggregate investment in inputs in the first period, to be used in the second period. Inputs I_1 and old assets B (assets for the workers, debts for the capitalists) are given by history. The solution to the maximization problem faced by workers boils down to the savings function

$$S_1 = f\left[r; (1-\alpha-\gamma)I_1^{\alpha} + B; (1-\alpha-\gamma)(I_1+I_2)^{\alpha}\right]. \tag{2.7}$$

From now on, assume the "normal" case in which f is increasing in r.[1]

2.3. Capitalists

Capitalists are the key players in the model: they finance spending partly with loans, and borrowing is subject to frictions. They consume in the closing period only. Their objective is to maximize the utility from such consumption, which boils down to maximizing the amount consumed.

At the beginning of each period, capitalists collect the income from inputs and capital and repay debt (to workers). In the first period, their net resources available for investment are

$$N_1 \equiv Z_1 I_1 + R_1 K - B = (\alpha+\gamma)Y_1 - B \tag{2.8}$$

where the second equality comes from 2.2 and 2.3.[2] The stock K of capital is fixed and does not depreciate. We also normalize it to one from now on. Notice that N_1 is exogenous because B is given, and so is Y_1: aggregate capital and inputs are inherited, and labor is inelastically supplied.

Inputs can be accumulated and do not depreciate, and the stock available in the second period is $I_1 + I_2$.[3] Capitalists can invest in additional inputs subject to the budget constraint

$$I_2 = N_1 + B_1 \tag{2.9}$$

where B_1 is the amount borrowed in period 1.

In the closing period capitalists receive total income $(\alpha+\gamma)Y_2$. A crucial assumption is that, because of limitations in contract enforcement and the like,

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[1] That is, assume the substitution and wealth effects of movements in interest rates are greater than the income effect.

[2] Although individual capitalists have additional resources in the form of capital ownership, the value of capital Q_1 does not enter equation (2.8). The reason is that capital is only traded among capitalists, hence there is no additional aggregate net value that can be diverted to acquire inputs.

[3] A note on language: we refer to the accumulation of inputs as investment, because the capital stock (the other asset in which capitalists can tradidionally invest) is fixed. Note that introducing a depreciation rate for inputs would change nothing.

lenders can seize at most this return, net of enforcement costs equal to Λ, in case of non-payment. Hence, workers will not lend at the initial time an amount generating obligations larger than the resulting collateral:[4]

$$(1+r)B_1 \leq \max\{0; (\alpha+\gamma)Y_2 - \Lambda\}: \qquad (2.10)$$

2.4. Market Clearing

Capitalists can only borrow from workers, so that

$$B_1 = S_1: \qquad (2.11)$$

Equations (2.7),(2.9) and (2.11) together yield

$$I_2 - (\alpha+\gamma)I_1^{\alpha} + B = f\left[r; (1-\alpha-\gamma)I_1^{\alpha} + B; (1-\alpha-\gamma)(I_1+I_2)^{\alpha}\right]: \qquad (2.12)$$

This is an implicit expression for r as a function of I_2 and a pair of exogenous variables:

$$r = \phi(I_2; I_1; B) \qquad (2.13)$$

It is easy to show that, under the assumptions made on f, ϕ is increasing in I_2 and B.[5] The partial relationship between the interest rate and I_1 is ambiguous.

2.5. Equilibria

Next we define three schedules that jointly determine the possible equilibria of the model.

- KI schedule:

  Equating the marginal returns of capital and inputs implies

$$\frac{R_2}{Q_1} = Z_2: \qquad (2.14)$$

  Using (2.2) and (2.3) in (2.14) one obtains

$$Q_1 = \frac{\gamma}{\alpha}(I_1+I_2): \qquad (2.15)$$

[4] This is as in Kiyotaki and Moore (1997), Krugman (1999) and Aghion, Bachetta and Banerjee (2001), among many others.

[5] To show that ϕ is increasing in B, use the fact that the marginal propensity to save from one extra unit of income is less than one.

This schedule, which we term KI (for no arbitrage between capital and inputs), gives the equilibrium price of capital today as a function of investment in inputs today. The right hand side of (2.15) is increasing in I_2: as I_2 rises, tomorrow's inputs-capital ratio goes up, increasing the marginal product of capital and hence raising Q_1.

- KB schedule:

If capitalists are not financially constrained and can borrow as much as they want, they maximize their next-period consumption by choosing an amount of investment such that

$$\frac{R_2}{Q_1} = 1 + r. \qquad (2.16)$$

Using (2.3) and (2.13), this equation implies

$$Q_1 = \frac{\gamma (I_1 + I_2)^{\gamma - 1}}{1 + \phi(I_1, I_2, B)}. \qquad (2.17)$$

As I_2 increases, two distinct forces affect this condition in the same direction:

– The return on bonds r must increase to attract the needed increase in savings. With cheaper bonds, the price of capital must go down in order to keep no-arbitrage between the two assets.

– Tomorrow's marginal productivity of capital increases as the capital-inputs ratio goes up. In order to keep no-arbitrage between capital and bonds, the price of capital needs to go up.

Equations (2.15) and (2.17) imply

$$Q_1 = \frac{\gamma}{\alpha} \left(\frac{1 + \phi(I_2, I_1, B)}{\gamma} \right)^{\frac{1}{\alpha - 1}}. \qquad (2.18)$$

where the right hand side is decreasing in I_2. We denote this schedule KB because it corresponds to no-arbitrage between capital and bonds.

Notice that financial constraints may not let capitalists have the resources to invest as much as they want. In constrained situations the price of capital is bounded from above as follows:

$$Q_1 \leq \frac{\gamma}{\alpha} \left(\frac{1 + \phi(I_2, I_1, B)}{\gamma} \right)^{\frac{1}{\alpha - 1}}. \qquad (2.19)$$

- FC schedule:

  Using (2.15) one can rewrite financial constraint (2.10) as

$$B \leq \max\left\{0; \frac{\alpha+\gamma}{1+r}\left(\frac{\alpha}{\gamma}\right)^{\alpha} Q_1^{\alpha} - \frac{\Lambda}{1+r}\right\}: \tag{2.20}$$

  The fact that borrowing is constrained can lead investment to be constrained. Combining (2.13) , (2.9) and (2.20) one has

$$I_2 \leq \max\left\{N_1; N_1 - \frac{\Lambda}{1+\phi(I_2; I_1; B)} + \frac{\alpha+\gamma}{1+\phi(I_2; I_1; B)}\left(\frac{\alpha}{\gamma}\right)^{\alpha} Q_1^{\alpha}\right\}: \tag{2.21}$$

  Rearrange (2.21) to read

$$Q_1^{\alpha} \geq \nu\left[(I_2 - N_1)(1+\phi(I_2; I_1; B)) + \Lambda\right] \quad \text{if } I_2 \geq N_1 \tag{2.22}$$

  where $\nu \equiv \frac{\gamma^{\alpha}}{\alpha^{\alpha}(\alpha+\gamma)}$. This inequality shows that for every level of planned investment I_2, the price of capital Q_1 must be sufficiently high for that investment to be feasible. We term this the FC (financial constraint) schedule.

3. Outcomes with and without crises

The model can be solved quite simply using a diagrammatic representation in $Q_1; I_2$ space.

Notice that KI always holds because there are no rigidities or constraints in arbitraging between capital and inputs. Therefore, to solve for I_2 and Q_1 one needs one more equation. There are two inequalities, depicted by schedule KB and schedule FC. At least one of these inequalities must hold with equality. The reason is straightforward. If KB is not binding, the return to inputs is greater than r. For this to be the case, capitalists must be financially constrained (i.e., the FC schedule is binding). On the other hand, if FC is not binding, this means that capitalists are financially unconstrained, and therefore KB holds with equality.

We therefore have the following possible cases:

- Case where KB is binding:

  This is the case where KI and KB together give the level of investment I_2 that capitalists would like to undertake if unconstrained (i.e. as long as the inequality in schedule FC still holds). We show this case in figures 1 and 2.

- Case where FC is binding:

  Assume I_2 is sufficiently large so that schedule FC is binding. In this case firms do not have enough collateral to obtain any additional credit. Schedules KI and FC determine an equilibrium as long as capitalists are willing to invest more under those circumstances (i.e. as long as the inequality in KB holds). We show this case in figures 2, 3 and 4.

Figures 2 and 4 involve multiple equilibria. A key exogenous variable is N_1. The lower N_1, the farther to the left is FC, possibly taking the economy from the one-equilibrium case in figure 1 to the two-equilibria case in figure 2. The bad equilibrium implies no borrowing (i.e. $I_2 = N_1$).

A necessary and sufficient condition for a bad equilibrium with no borrowing to exist (as in figures 2 and 3) is that the FC schedule be above the KI schedule at $I_2 = N_1$. That is to say

$$\Delta \geq (\alpha + \gamma)(I_1 + N_1)^{\alpha}. \tag{3.1}$$

Hence, if enforcement costs Δ are sufficiently small, the "no borrowing" bad equilibrium disappears.

As stated in the introduction, multiple equilibria exist because of the feedback between asset prices and aggregate demand. A higher price of capital allows the capitalists to borrow and invest more on inputs. But at the same time, higher inputs raise the marginal product of capital and therefore its price.

4. Policy Alternatives

This model is too simple to say much about policy, but a few points are suggestive. Focus on the case of multiple equilibria only, and look for ways to eliminate the bad outcome.

Expansionary fiscal and monetary policies: To the extent they can raise current income Y_1 and consequently raise N_1, these policies can move FC to the right until condition (3.1) no longer holds.[6] A sufficiently large expansion will cause the FC curve to be below the KI schedule at $I_2 = N_1$, eliminating the bad equilibrium in figure 5. The intuition is that with larger current output the capitalists' gross

[6] Of course, extending the model to allow for such Keynesian effects would require a) labor supply to be endogenous and b) prices to be sticky. Both can be added without much complication.

resources available for investment rise relative to debt due, so they can afford to invest more for every price of capital. In addition, higher Y_1 raises asset prices for any level of investment. The combination can rule out self-fulfilling pessimistic animal spirits.

Debt forgiveness or rescheduling: A reduction in B (debt could be written down, paid by the government, or involuntarily reprogrammed to period 2) also increases N_1, while leaving KI unchanged. A sufficiently large cut in the current debt burden would rule out the bad equilibrium by causing FC to be below KI at $I_2 = N_1$, again as in figure 5. The intuition is the same as in the previous case: with improved cash flow, the capitalists can afford to invest even if asset prices are low.

Financial and legal reform: A reduction in ¤ brings about a downward movement in FC, as in figure 6. For ¤ sufficiently small, the bad equilibrium disappears. The single equilibrium can be either unconstrained (as drawn) or constrained. In the new single equilibrium, capitalists can borrow and invest as much as they would like.

There are other policies that may have advantages even though they cannot eliminate a bad equilibrium when one exists. Consider, for instance, subsidies to savings and/or opening of capital markets to the rest of the world. To the extent such a policy lowers the value of $r = Á(I_1; I_2; B)$ for any level of I_2, it relaxes the financial constraint (i.e. the non-vertical portion of FC shifts down, as in figure 7). But the vertical portion of FC is unchanged, so there is no interest rate that can free the economy from the possibility of a bad equilibrium. An alternative way to see this is to note that r does not enter condition (3.1), so changes in interest rates alone cannot affect the number of feasible equilibria. The intuition is that a bad equilibrium is the consequence of asset prices that are so low that capitalists end up financially constrained when they do not borrow anything. In that situation, the present value of their collateral is negative.[7] Therefore, no matter how low interest rates go, the present value of that collateral remains negative and the bad equilibrium does not disappear.

This is not to say that opening capital markets or stimulating savings has no benefits in this situation. In figure 7, the policy improves the "good" constrained equilibrium, in that allows for an investment I_2 that is higher and closer to the unconstrained level.

[7] This is the case for any "bad" equilibrium, for instance, the equilibrium in figure 3.

5. Conclusions

The model in this paper involves perfect competition and well functioning markets in all respects but one: there is an imperfection in the capital market that causes borrowing to be collateralized. Since the value of the collateral depends on current asset prices, and asset prices depend on current expenditure and future pro…ts, this opens the door to self-ful…lling expectations. But in certain conditions, policies can rule out the bad outcome, if one exists.

The mechanism in the paper is quite speci…c. But the result that small deviations from the perfect …nancial markets paradigm can generate more than one equilibrium is not. Other asset prices –for instance, the exchange rate in an open economy– can play the same role. For an example see Velasco (2001).

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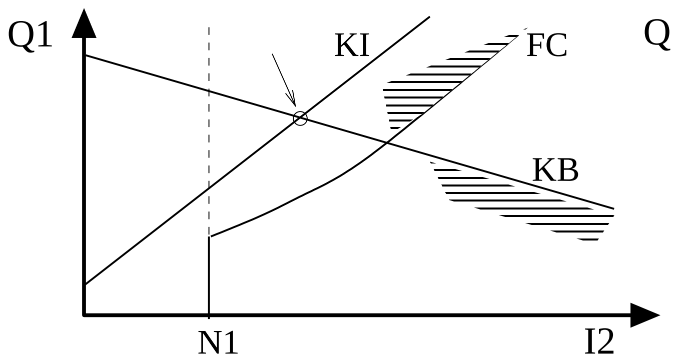

Figure 1.

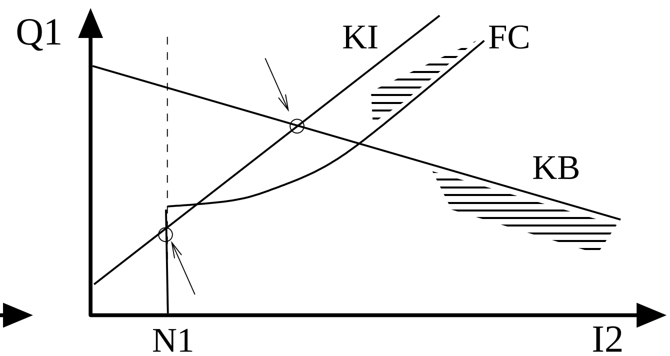

Figure 2.

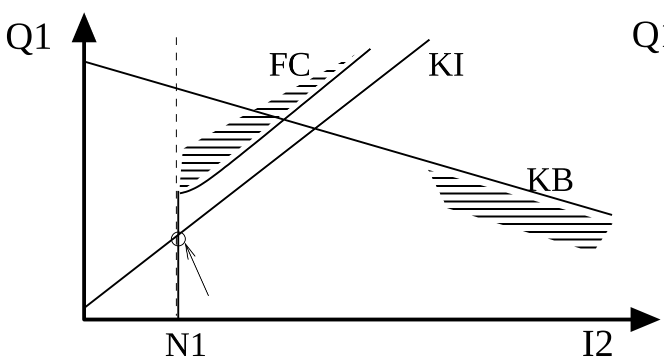

Figure 3.

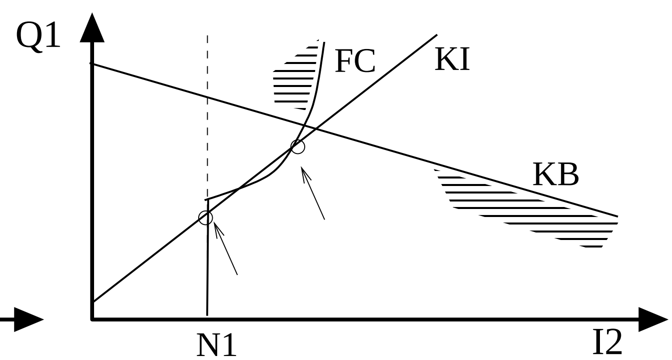

Figure 4.

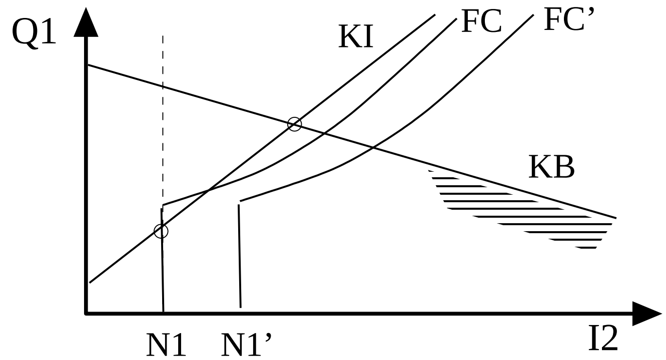

Figure 5.

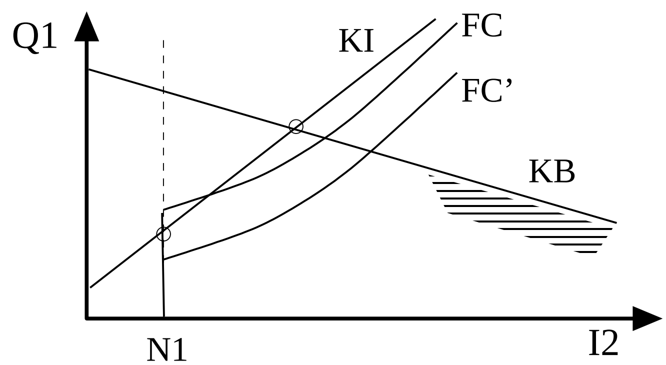

Figure 6.

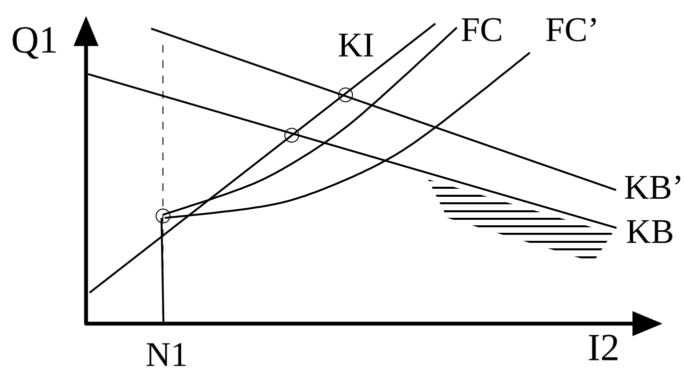

Figure 7.