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ASSET PRICES AND SELF-FULFILLING MACROECONOMIC PESSIMISM

Andrés Velasco
Harvard Univesity and NBER

Alejandro Neut
Research Department, BBVA

Asset prices and self-fulfilling macroeconomic pessimism*

Alejandro Neut
Research Department, BBVA

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Harvard Univesity and NBER

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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 returns, 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 in emerging markets, 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 returns, 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 an extremely simple 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

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

where K denotes capital, L land and N labor. Without loss of generality, we assume capital depreciates completely in one period. Land L is fixed, and we normalize $L_t = 1$ from now on.

In each one of the two periods cost-minimizing firms choose capital, land and labor according to

$$R_t^K = \alpha \left(\frac{Y_t}{K_t} \right) \tag{2}$$

$$R_t^L = \gamma \left(\frac{Y_t}{L_t} \right) \tag{3}$$

$$W_t = (1 - \alpha - \gamma) \left(\frac{Y_t}{N_t} \right) \tag{4}$$

where R_t^K, R_t^L and W_t are the factor returns to capital, land and labor. The numeraire in this economy is the price of output Y, which is used for consumption and investment in capital for the following period.

2.2 Workers

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

$$C_1 + \frac{C_2}{1+r} = D + W_1 + \frac{W_2}{1+r}, \tag{5}$$

where D is accumulated wealth saved by workers (and consequently borrowed by capitalists in the shape of debt) in the past and r is the market rate of interest for bond transactions between these two groups. Period 1 savings by workers are also channeled to capitalists, who invest in either land or capital.

Using equations 1 and 4, budget constraint 5 can be written as

$$C_1 + \frac{C_2}{1+r} = D + (1 - \alpha - \gamma) K_1^\alpha + \frac{(1 - \alpha - \gamma) K_2^\alpha}{1+r}, \tag{6}$$

where K_2 is obtained through investment in capital in the first period. Capital K_1 and D (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

$$S_1 = f\ \left[r,\, (1 - \alpha - \gamma) K_1^\alpha + B,\, (1 - \alpha - \gamma) K_2^\alpha \right]. \tag{7}$$

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

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

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. They only own land and capital, but the latter depreciates completely once used. Q_t denotes the market value of land in period t (after returns are payed). In this simple two-period model, Q_1 is endogenous and $Q_2 = 0$.

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

$$N_1 \equiv R_1^K K_1 + R_1^L L - D = (\alpha + \gamma) Y_1 - D \tag{8}$$

where the second equality comes from 2 and 3. Although individual capitalists have additional resources in the form of land, the value of land Q_1 does not enter equation (8). The reason is that land is only traded among capitalists, hence there is no additional aggregate net value that can be diverted to acquire capital. Notice that N_1 is exogenous because D is given and so is Y_1: aggregate land and capital are given by history and labor is inelastically supplied.

The capital stock available in the second period is K_2, equal to investment in period 1.[2] Capitalists can invest in additional capital subject to the budget constraint

$$K_2 = N_1 + B_1 \tag{9}$$

where B_1 is the amount borrowed by capitalists in period 1.

A crucial assumption is that, because of limitations in contract enforcement and the like, in case of non-payment lenders can seize at most the value and returns to land net of enforcement costs equal to Λ. Hence, workers will not lend at the initial time an amount generating obligations larger than the value of collateral:[3][4]

$$B_1 \leq \max\{0, Q_1 - \Lambda\}. \tag{10}$$

[2] Recall capital depreciates completely. Introducing a depreciation rate for capital less than one would change nothing, but would make the algebra more cumbersome.

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

[4] A possible objection is that the collateral constraint should depend on period 2 variables –that is to say, on the "stuff" lenders can seize in the event of non-payment. The same results, but with somewhat more cumbersome algebra, would obtain if we adopted that specification. Consider, for instance, the case in which lenders can seize the total returns earned by the capitalist in period 2, minus enforcement costs. The constraint would be $(1 + r) B_1 \leq \max\{0, \ (\alpha + \gamma) Y_2 - \Lambda\}$. See below for details.

2.4 Market Clearing

Capitalists can only borrow from workers, so that

$$B_1 = S_1. \tag{11}$$

Equations (7),(9) and (11) together yield

$$K_2 - (\alpha+\gamma)K_1^{\alpha} + D = f\ \left[r,\, (1-\alpha-\gamma)K_1^{\alpha} + D,\, (1-\alpha-\gamma)(K_1+K_2)^{\alpha}\right]. \tag{12}$$

This is an implicit expression for r as a function of K_2 and a pair of exogenous variables:

$$r = \phi\,(K_2,\, K_1,\, D) \tag{13}$$

It is easy to show that, under the assumptions made on f, ϕ is increasing in K_2 and D. The partial relationship between the interest rate and K_1 is ambiguous.

2.5 Equilibria

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

- LK schedule:

  Equating the marginal returns of land and capital implies

  $$\frac{R_2^L}{Q_1} = R_2^K. \tag{14}$$

  Using (2) and (3) in (14) one obtains

  $$Q_1 = \left(\frac{\gamma}{\alpha}\right) K_2. \tag{15}$$

  This schedule, which we term LK (for no arbitrage between land and capital), gives the equilibrium price of land today as a function of investment in capital today. As K_2 rises, tomorrow's capital-land ratio goes up, increasing the marginal product of land 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 capital investment such that

  $$R_2^K = 1 + r. \tag{16}$$

  Using (2) and (13), this equation implies

  $$K_2 \left[1 + \phi\,(K_1, K_2, D)\right]^{\frac{1}{1-\alpha}} = \alpha^{\frac{1}{1-\alpha}}. \tag{17}$$

where the LHS is unambiguously increasing in K_2. We denote this schedule KB because it corresponds to no-arbitrage between capital and bonds. Let K_2^* be the level of capital that solves (17). We assume $K_2^* > N_1$, so that capitalists will indeed want to borrow.

But financial constraints may not let capitalists borrow the resources to invest as much capital as they want, in which case capital-bonds arbitrage does not obtain. In those constrained situations the amount of investment is bounded from above as follows:

$$K_2 \left[1 + \phi\left(K_1, K_2, D\right)\right]^{\frac{1}{1-\alpha}} \leq \alpha^{\frac{1}{1-\alpha}}. \tag{18}$$

- FC schedule:

  The fact that borrowing is constrained can lead investment to be constrained. Combining (10) and (9) one has

$$K_2 \leq \max\left\{N_1, Q_1 - \Lambda + N_1\right\}. \tag{19}$$

  Rearrange (19) to read

$$Q_1 \geq K_2 + \Lambda - N_1 \quad \text{if } K_2 \geq N_1 \tag{20}$$

  This inequality shows that for every level of planned investment K_2, the price of land Q_1 must be sufficiently high for that investment to be feasible. We term this the FC (financial constraint) schedule.[5]

3 Outcomes with and without crises

The model can be solved quite simply using a diagrammatic representation in Q_1, K_2 space.

Notice that LK always holds because there are no rigidities or constraints in arbitraging between land and capital. Therefore, to solve for K_2 and Q_1 one needs one additional equation. There are two candidate inequalities, depicted by schedules KB and FC. At least one of these inequalities must hold with equality. The reason is straightforward. If KB is not binding, the return to capital 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:

[5] If instead we had assumed the constraint $(1+r)B_1 \leq \max\{0,\ (\alpha+\gamma)Y_2 - \Lambda\}$, the FC schedule would be $Q_1 \geq \upsilon\left[(K_2 - N_1)(1 + \phi(K_2, K_1, B)) + \Lambda\right]^{\frac{1}{\alpha}}$ if $K_2 > N_1$, where υ is a positive constant and the RHS of the inequality is unambiguously increasing in K_2. The only difference would be that the FC is no longer linear in K_2.

- Case where KB is binding:

  This is a situation where LK and KB together yield the level of investment K_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:

  In this case firms do not have enough collateral to obtain any additional credit. Schedules LK 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 and 3.

Figures 1 and 3 involve a unique equilibrium, at point A in each case. Figure 2 involves multiple equilibria, at points A and B. The bad equilibrium implies no borrowing (i.e. $K_2 = N_1$) and lower asset prices than does the good equilibrium. 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.

A necessary and sufficient condition for a bad equilibrium with no borrowing to exist (whether unique, as in figure 3 or non-unique, as in figure 2) is that the FC schedule be above the LK schedule at $K_2 = N_1$. That is to say,

$$\Lambda \geq \left(\frac{\gamma}{\alpha}\right) N_1. \tag{21}$$

Hence, if enforcement costs Λ are sufficiently small, the "no borrowing" bad equilibrium disappears. Notice this condition need not be too restrictive, since given the definition of net worth ($N_1 \equiv (\alpha + \gamma) Y_1 - D$), it could be near zero or even negative if inherited debts are large.

The intuition for multiple equilibria is simple: there is feedback between asset prices and aggregate demand. A higher price of land allows the capitalists to borrow and invest more in capital. But at the same time, higher capital investment raises the marginal product of land and therefore its price. For some parameter values, this circularity opens the door for multiplicity and self-fulfilling beliefs.

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 the vertical portion of the FC schedule to the right until condition (21) no longer holds.[6] A sufficiently large expansion will cause the FC curve to be below the LK schedule at $K_2 = N_1$, eliminating the bad equilibrium. Now the only equilibrium is at A. The intuition is that with larger current output the capitalists' gross resources available for investment rise relative to debt due, so they can afford to invest more for every price of land. 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 D (debt could be written down, paid by the government, or involuntarily reprogrammed to period 2) also increases N_1, moving the vertical portion of the FC schedule to the right while leaving LK unchanged. A sufficiently large cut in the current debt burden would rule out the bad equilibrium by causing FC to be below LK at $K_2 = N_1$. This case also corresponds to figure 4, with a unique equilibrium at point A. 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 Λ brings about a downward movement in FC, as in figure 5. For Λ 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*. To the extent such a policy lowers the value of $r = \phi(K_1, K_2, D)$ for any level of K_2, it shifts the KB curve (see figure 6). But 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 (21), 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.

[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.

[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 profits, this opens the door to self-fulfilling expectations. But in certain conditions, policies can rule out the bad outcome, if one exists.

The mechanism in the paper is quite specific. But the result that small deviations from the perfect financial 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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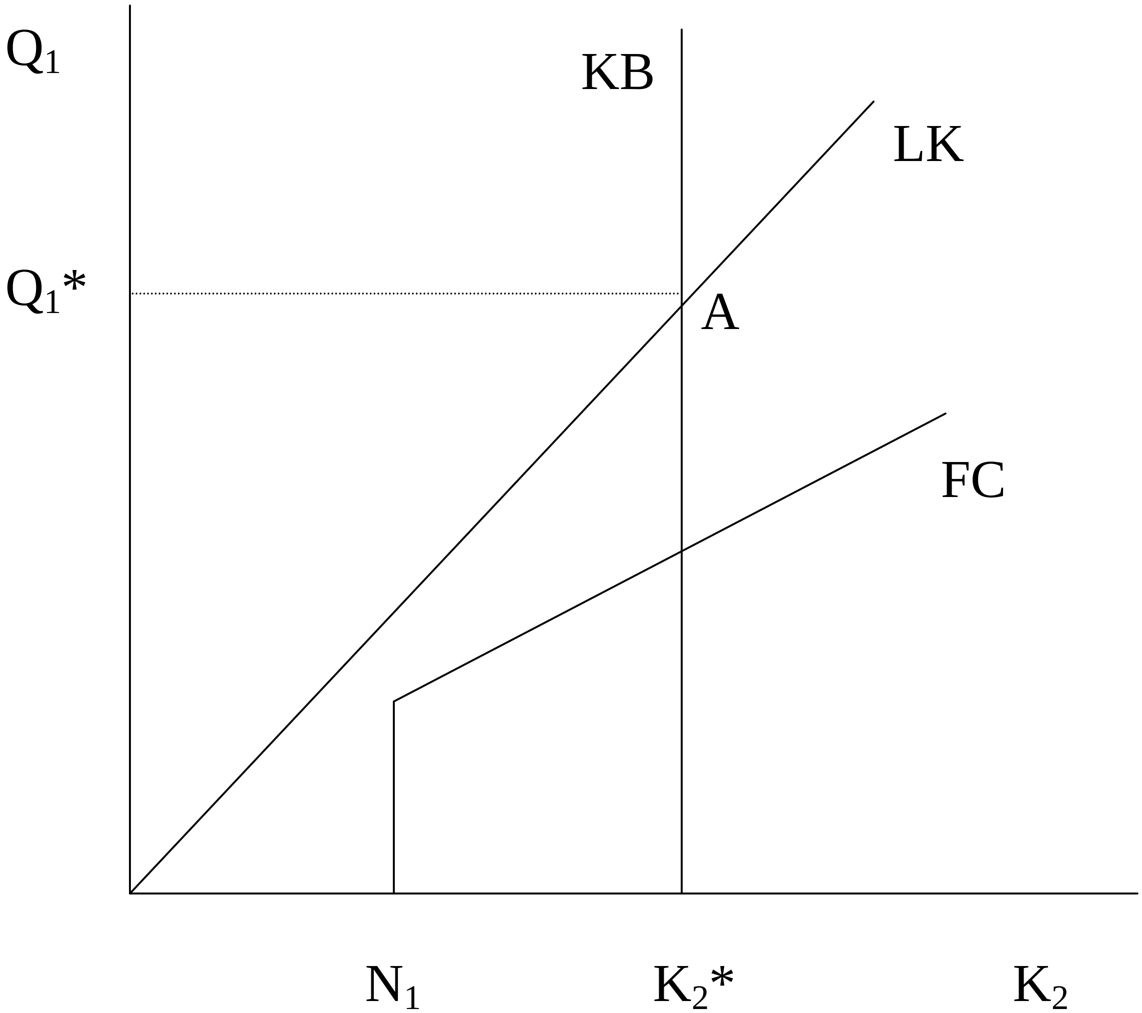

Figure 1

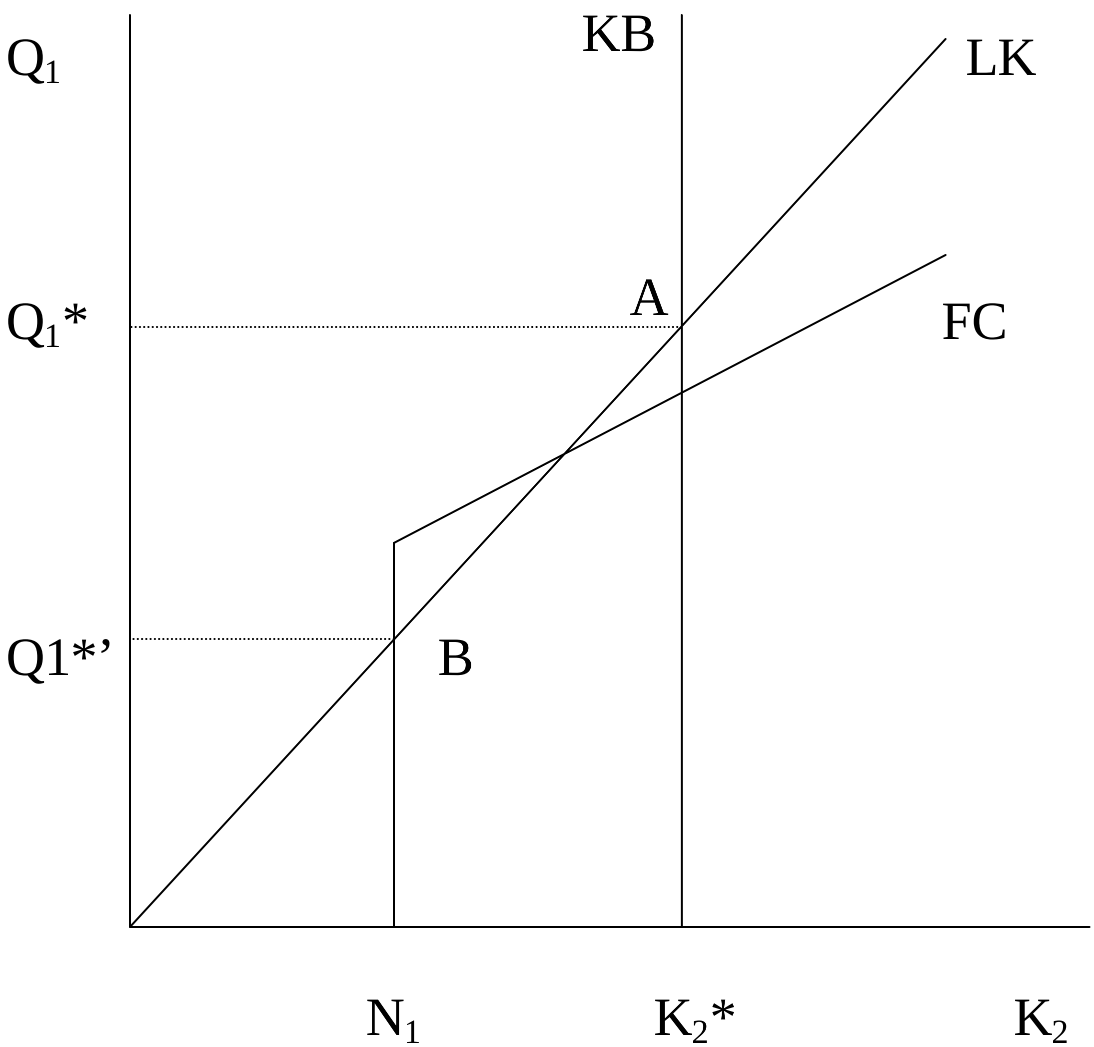

Figure 2

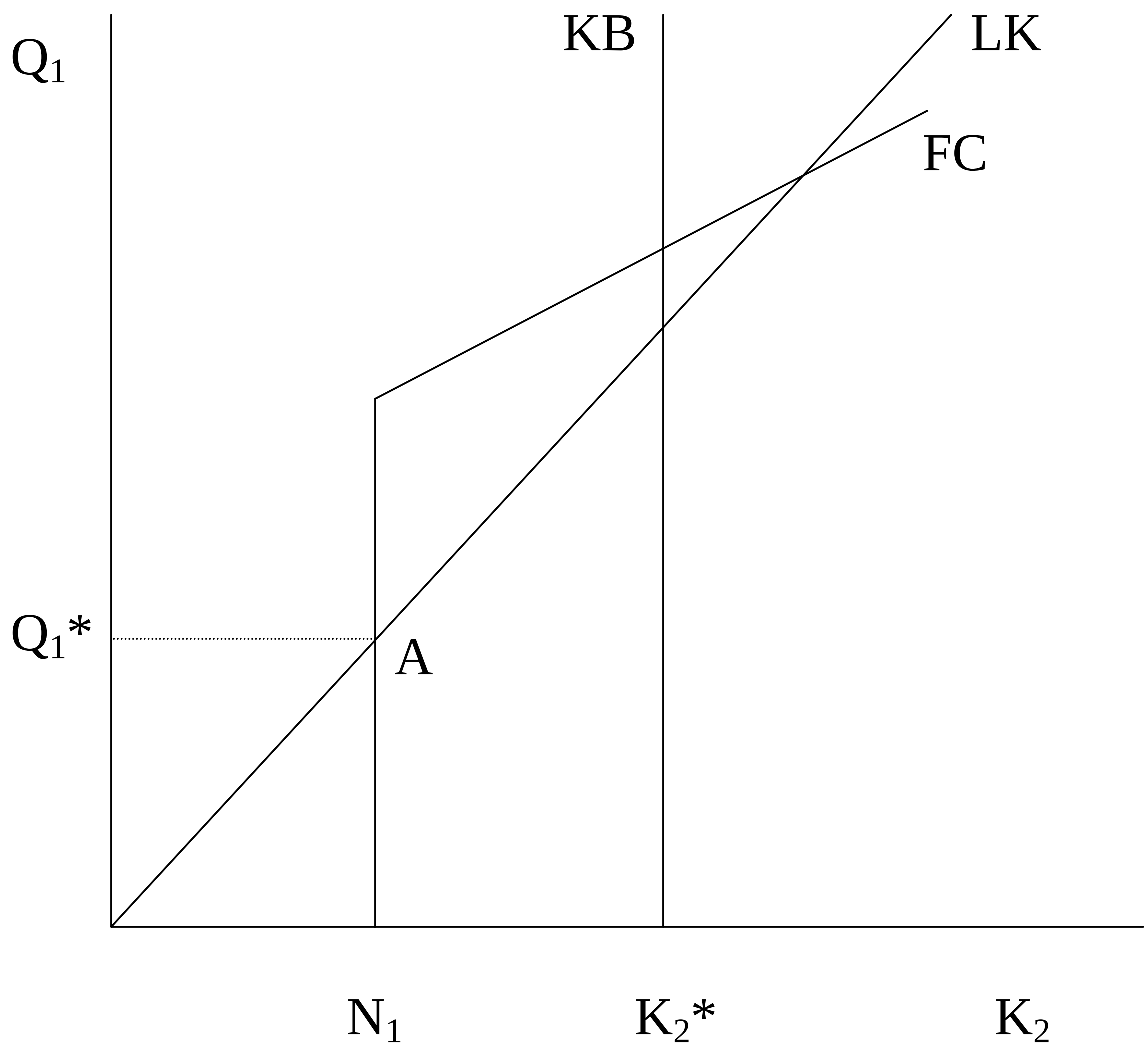

Figure 3

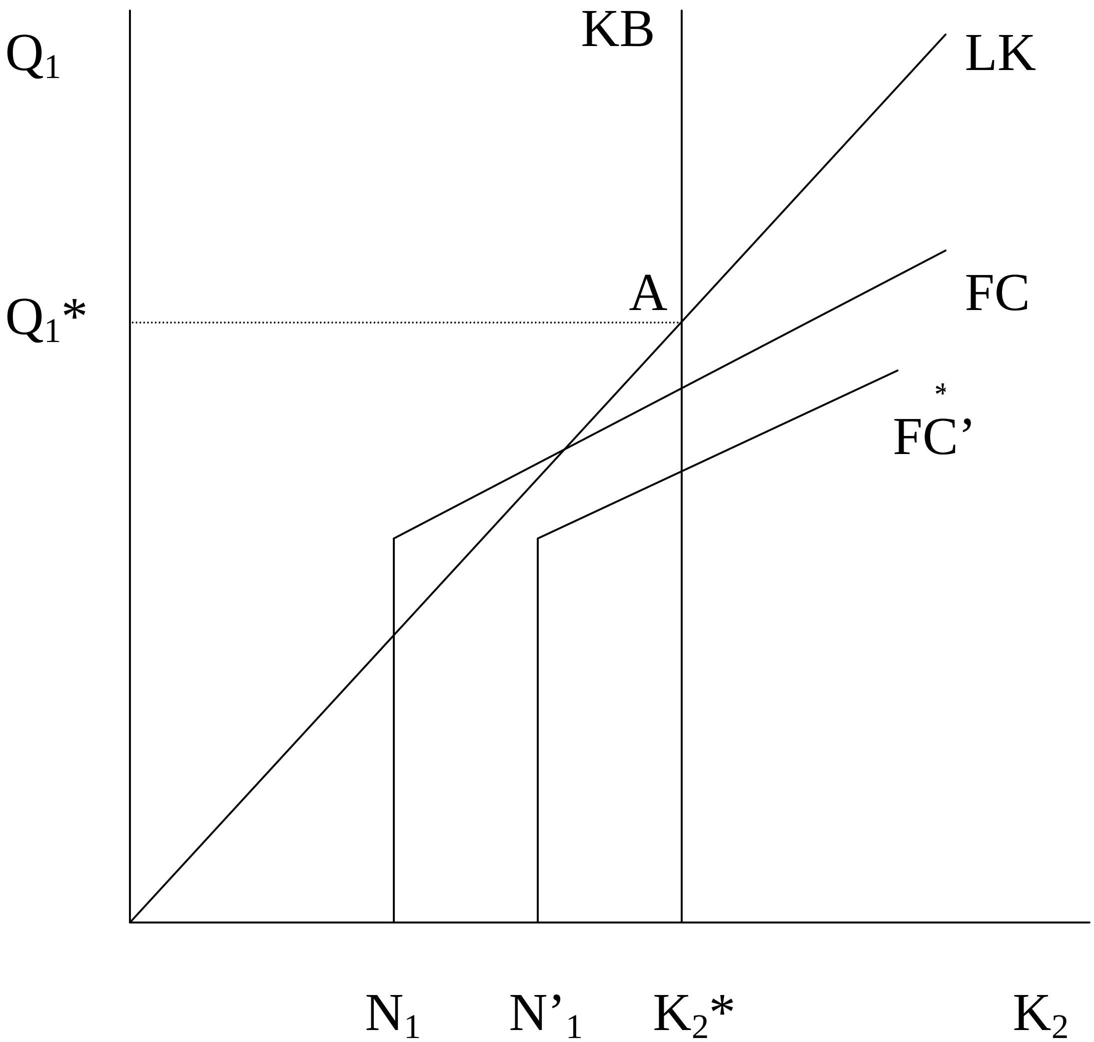

Figure 4

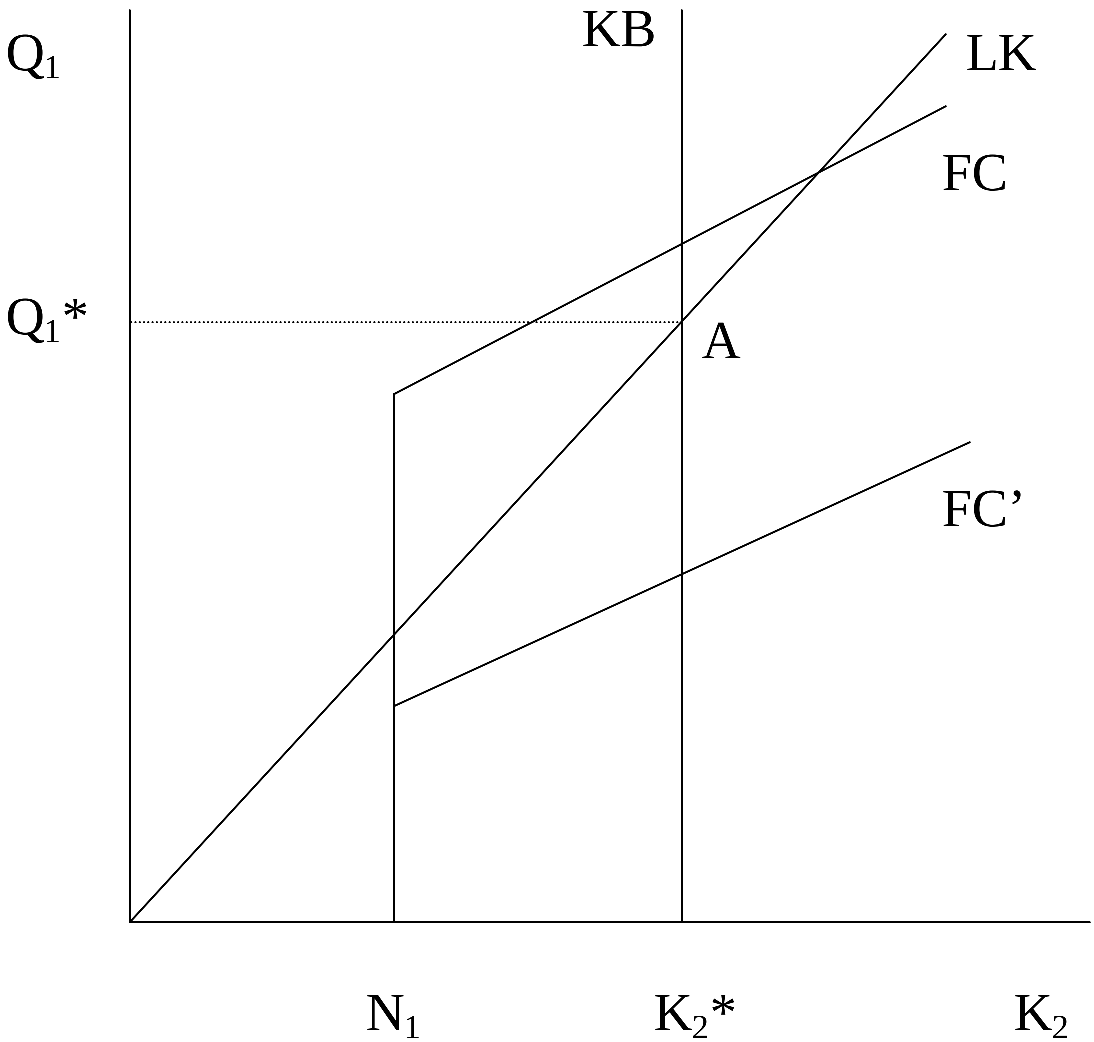

Figure 5

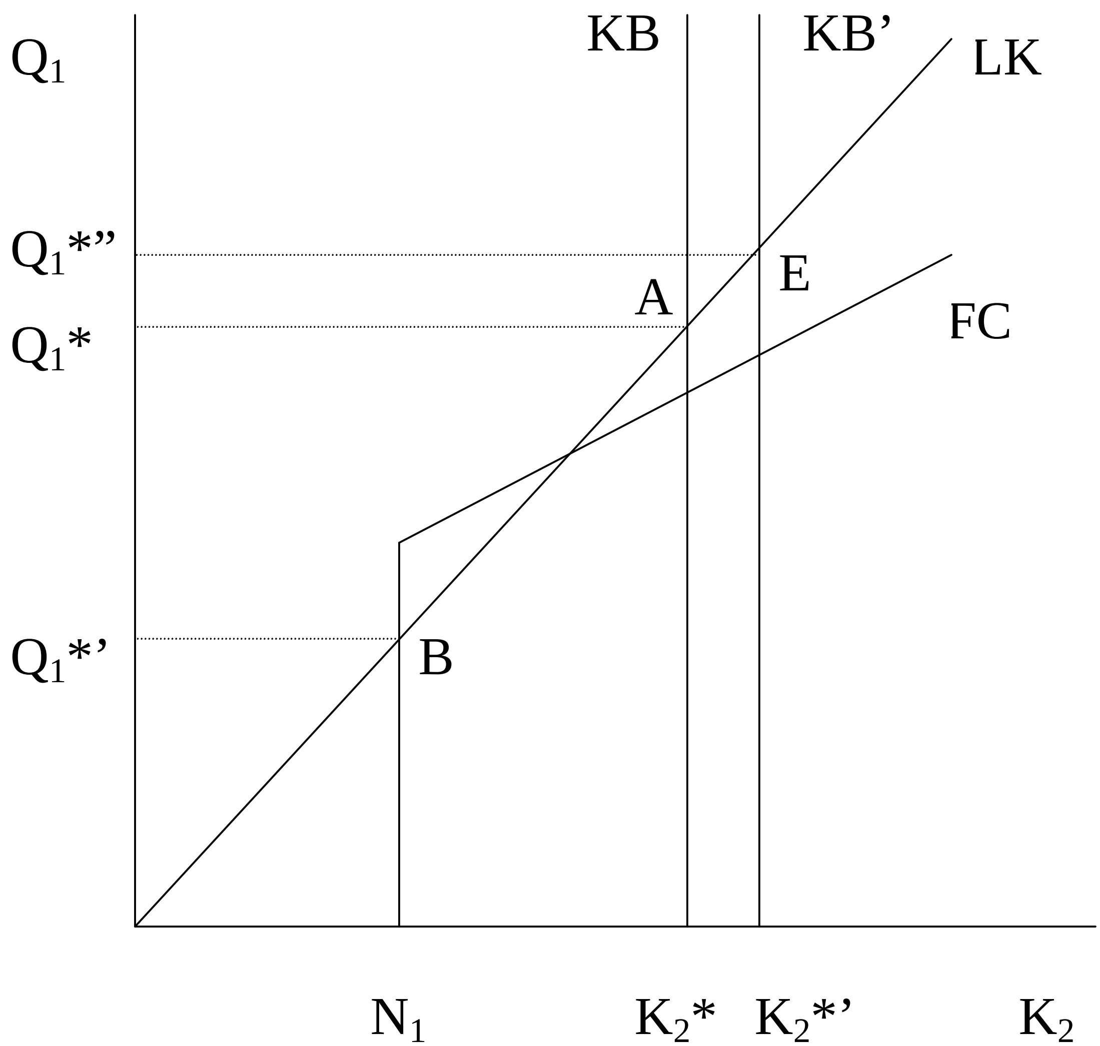

Figure 6