NBER WORKING PAPER SERIES

CREDIT RATIONING AND EFFECTIVE SUPPLY FAILURES

Alan S. Blinder

Working Paper No. 1619

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 1985

The research reported here has been supported by the National Science Foundation, and was done in part while I was a visiting fellow at the Institute for International Economic Studies, Stockholm, Sweden. I am grateful for comments received at seminar presentations at the Institute, Princeton, Harvard, Columbia, Brown, the Center of Planning and Research in Athens, and the National Bureau of Economic Research; and for discussions of these topics with Rudiger Dornbusch, Stanley Fischer, Benjamin Friedman, Michael Horgan, Leonard Nakamura, John Seater, Dennis Snower, Robert Solow, Joseph Stiglitz and Lawrence Summers. Finally, it was a remark made at a seminar some years ago by Robert Mundell which first got me scratching my head about the concept of "effective supply." The research reported here is part of the NBER's research program in Economic Fluctuations. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper #1619
May 1985

Credit Rationing and Effective Supply Failures

ABSTRACT

This paper presents two macro models in which central bank policy has real effects on the supply side of the economy due to credit rationing. In each model, there are two possible regimes, depending on whether credit is or is not rationed. Starting from an unrationed equilibrium, either a large enough contraction of bank reserves or a large enough rise in aggregate demand can lead to rationing. Monetary (fiscal) policy is shown to be more (less) powerful when there is rationing than when there is not.

In the first model, credit rationing reduces working capital. There is a "failure of effective supply" in that credit-starved firms must reduce production below national supply. The resulting excess demand in the goods market may in turn drive prices up and reduce the real supply of credit further, leading to further reductions in supply and a stagflationary spiral.

In the second model, credit rationing reduces investment, which cuts into both aggregate demand and supply. Despite the effect on demand, stagflationary instability is still possible. A rise in government spending crowds out investment in the rationed regime but crowds in investment in the unrationed regime.

Alan S. Blinder
Department of Economics
Princeton University
Princeton, NJ 08544
609-452-4010

CREDIT RATIONING AND EFFECTIVE SUPPLY FAILURES

1. MOTIVATION AND BASIC IDEAS

The topic of this paper is among the oldest and most fundamental in monetary theory: how and why does monetary policy affect real economic activity? Traditional answers hold that the central bank can raise (shrink) aggregate demand by engineering an expansion (contraction) of the medium of exchange.

In its monetarist variant, this story posits a direct link between something called M and aggregate spending. In its Keynesian variant, the story holds that adjustments in asset prices brought about by a change in M lead to more spending, especially on capital goods. In either case, short-run stickiness of prices is needed to translate some of the changes in demand into movements of real output.

In recent years, these conventional stories have become increasingly implausible, as Stiglitz and I (1983) have argued elsewhere. With more and more assets apparently serving as media of exchange, it has become increasingly difficult to define M, much less to believe that the central bank can cause a recession by contriving an artificial shortage of whatever it calls M. Put differently, the point seems both simple and compelling: if there are ready substitutes for money, control of money will not give the authorities much leverage over the real economy.

This paper develops a very different explanation for how central bank policy affects real economic activity: one based on credit rationing. In order to make the credit-rationing mechanism stand out in bold relief, most other channels of monetary policy (such as interest elasticities and expectational errors) are banished from the model. The reader should understand that this is merely an expositional device. I would not wish to deny that the interest-elasticity and expectational-error mechanisms have some validity. But the spirit of this paper is that those mechanisms do not seem important enough to explain the deep recessions that are apparently caused by central bank policy. There must be something else.

The idea that credit availability impinges on economic activity is, of course, hardly new. But it does seem to have gone out of style in recent years under the pressure of the classical revival. Stiglitz and I (1983) recently suggested that this fashion change may have been a mistake; and this paper is an attempt to give analytical substance to the ideas we sketched there.

The basic principle is simple. Firms may have a desired or "notional" supply based on relative prices, expectations, and other variables. But they may need credit to produce the goods. If the required credit is unavailable, there may be a "failure of effective supply" in which firms fail to produce as much as they can sell. The idea of a supply failure contains a hint of what is to come: if recessions are initiated by declines in supply, rather than by declines in demand, then prices may rise, not fall, as economic activity contracts.

Where, then, does money enter the story? The banking system both connects credit to money and creates what I call the "credit multiplier." Suppose demand rises. Firms, seeing higher expected marginal value products, borrow more and expand production. As economic activity expands, higher transactions balances are required; so bank deposits rise. As funds flow into the banking system, the supply of bank credit is expanded further. This credit expansion fuels both the increase in demand and the increase in supply by easing credit constraints, and so the expansion is amplified. This "credit multiplier"--whereby more credit leads to more hiring of factors, more production, more bank deposits, and then to more credit--operates alongside the standard Keynesian income-expenditure multiplier because demand expands as firms pay out more factor income. The interaction of the Keynesian and credit multipliers is at the heart of this paper.[1]

The paper is organized as follows. Section 2 outlines the essential elements of the model, including heuristic microfoundations for some of the assumptions. Sections 3 and 4, the bulk of the paper, present and analyse two simple models in which credit rationing impinges on the behavior of firms. In the first (Section 3), credit rationing restricts the use of working capital and thus reduces aggregate supply. While this mechanism is the focus of the paper, credit rationing in the real world also has important effects on aggregate <u>demand</u>. Therefore, in the second model (Section 4), credit rationing restricts investment spending, which naturally cuts into both aggregate demand and aggregate supply. In both models, I show that credit rationing enhances the power of monetary policy but reduces the power of fiscal policy. Section 5 is a brief summary.

2. ELEMENTS OF THE MODELS

While the two models considered in this paper differ in some important ways, they share the following seven common elements:

(1) Firms need credit for working capital (and for other purposes). They must pay their factors of production *before* they receive revenues from sales, and must borrow in order to do so. The role of this assumption--which is, of course, overly strong--is to make credit an essential ingredient in the production process. Firms that cannot get credit must cut back their hiring, which is what I mean by an *effective supply failure*. Naturally, there are other ways to introduce demand for credit, such as for financing inventories (which will appear in Section 3) or for fixed investment (which will appear in Section 4).

(2) There is no auction market for credit, that is, no commercial paper market. So firms wishing to borrow must borrow from banks. The role of this assumption is to give banks primacy in the credit market, albeit in a very stark way. As explained in Blinder and Stiglitz (1983), this assumption may adequately characterize the availability of credit to small firms whose

banks have certain informational advantages over other lenders.[2] But it certainly is not realistic for large firms. A better model would recognize the existence of two kinds of firms: large firms that can borrow either at the bank or in the auction market, and small firms that can borrow only at the bank. In such a world, when bank credit is restricted, small firms may borrow in the form of trade credit from large firms who can, in turn, go to the open market and are rationed only by price.[3] The best way to think of this paper is as a stepping stone that includes only the small firms.[4] Subsequent models should include the big ones as well.

(3) <u>Credit expands as economic activity expands</u>. This is the idea behind the "credit multiplier" sketched above. A rough justification is as follows.[5] When banks receive deposit inflows, they set aside some reserves, invest some of the proceeds in government bonds, and lend the rest to customers. As the economy expands, business loans become less risky. So banks hold smaller excess reserves (thereby raising the deposit multiplier) and also shift their optimal portfolio proportions away from riskless government bonds toward risky (but higher yielding) business loans.[6] Specifically, suppose that banks hold real excess reserves, E/P, that are a decreasing function of real income:

(1a) $E_t = \beta_1(\overline{y} - y_t)P_t$

where β_1 and $\overline{y}$ are constants. If M is bank deposits, the reserve identity is:

$$(1b)\quad R_t = rM_t + E_t ,$$

where R_t is bank reserves and r is the required reserve ratio. The banks' balance sheet identity (ignoring net worth) is:

$$(1c)\quad R_t + C_t + B_t = M_t ,$$

where B is the banks' holdings of government bonds. As just mentioned, I assume that desired portfolios shift toward customer loans as economic activity expands:

$$(1d)\quad C_t = h(1-r)M_t + \beta_2(y_t - \overline{y})P_t \qquad \beta_2 > 0$$

$$\hat{B}_t = (1-h)(1-r)M_t - (\beta_2-\beta_1)(y_t - \overline{y})P_t ,$$

where $\hat{B}_t$ is the banks' notional demand for government bonds.[7] Substituting from (1a) and (1b) into (1d) yields:

$$C_t = \frac{h(1-r)}{r}R_t + (\beta_2 + \frac{\beta_1 h(1-r)}{r})\ (y_t - \overline{y})P_t ,$$

which can be written compactly as:

$$(1)\quad \frac{C_t}{P_t} = \frac{L_t}{P_t} + \alpha y_t$$

where L_t/P_t is a linear function of real bank reserves, R_t/P_t. For convenience, I hereafter treat L_t, not R_t, as the central bank's policy instrument.

(4) As mentioned already, all interest elasticities are banned from the model, as are other responses to relative prices such as input substitutions among labor, materials, and capital in response to changes in relative factor prices.[8]

(5) A simple Keynesian income-expenditure multiplier augmented by a real balance effect comprises the entire demand side of the model. There are no explicit investment goods in the model of Section 3. Investment appears in Section 4, but does not depend on interest rates. These assumptions are strictly expositional--to close off the standard Keynesian channel for monetary policy.

The real balance effect on consumption is included only as a way to make the price level determinate when there is no credit rationing; in several places I assume that it is "small."

(6) Money plays no essential role in the models. Firms hold money to facilitate production. But money adjusts passively to income, as in King and Plosser (1984), not the other way around.[9]

(7) In those places in which expectations enter the models, I assume perfect foresight. So expectational errors also play no role in the analysis.

3. CREDIT RATIONING AND WORKING CAPITAL

This section embeds in an otherwise conventional macro model the idea that credit rationing might create a shortage of working capital, and thereby force firms to cut back on production. I begin with a preliminary "finger exercise" version of the model which, while incomplete, aids our understanding by making the linkages from credit rationing to working capital to output completely transparent. There will be time for subtlety later.

3.1 A Preliminary Model

Firms hire factors of production at constant relative prices that are normalized to unity. Thus the quantity of factors hired and real factor payments are represented by the same symbol, F_t, which should be thought of as an amalgam of labor, materials, and capital. Since relative prices do not change, neither should factor proportions. It is important to note that, unlike many other models of monetary policy, the expansions and contractions of real output in this model do not stem from any policy-induced change in the real wage.

Factors hired at time t are paid immediately and go to work. One period later they produce output. Assuming constant returns to scale and fixed factor proportions, the production function is:

(2) $y_t = vF_{t-1}$

where v is a measure of productivity ($v > 1$).

Aggregate demand comes from a simple linear consumption function with a real balance effect:

(3) $x_t = a + by_t + s\frac{L_t}{P_t} \quad 0 < b < 1, \quad s > 0,$

where x_t is real final sales. Here "a" is Keynesian "autonomous expenditure," "b" is the marginal propensity to consume, and "s" indicates the wealth effect of outside money. I presume s to be small.

Credit rationing is the critical element of the model. Under the assumption that firms expectations are correct, firms today expect to sell x_{t+1} next period. To produce this much output, they must hire x_{t+1}/v factors today. Hence, if unconstrained, their hiring today would be x_{t+1}/v, which constitutes the <u>notional</u> demand for credit:

(4a) $\frac{C^d_t}{P_t} = \frac{x_{t+1}}{v}$,

where P_t is the price level and C_t is nominal credit.[10] However, as explained in Stiglitz and Weiss (1981), banks normally ration credit to a maximum volume C_t. Hence actual credit is:

(4b) $C^a_t = \min(C^d_t, C_t)$.

Since factor hiring and borrowing are taken to be equal ($F_t = C^a_t/P_t$), we have, in real terms:

(4) $F_t = \min[\frac{x_{t+1}}{v}, \frac{C_t}{P_t}]$

Finally, the price level adjusts according to the "law of supply and demand":

$$(5)\quad P_{t+1} - P_t = \lambda(x_t - y_t), \qquad \lambda > 0 .$$

Consider the credit-rationed regime. If the credit constraint is binding, then (1), (2), and (4) imply the following difference equation for factor payments:

$$(6)\quad F_t = (L/P)_t + uF_{t-1} ,$$

where $u = \alpha v$. Subtracting F_{t-1} from both sides gives a dynamic equation for real factor payments:

$$(7)\quad F_t - F_{t-1} = \frac{L_t}{P_t} - (1-u)F_{t-1} .$$

Substituting (2) and (3) into (5) gives the other dynamic equation, for the price level:

$$(8)\quad P_{t+1} - P_t = \lambda(a + s\,\frac{L_t}{P_t} - v(1-b)F_{t-1}).$$

By setting both equations equal to zero, we obtain the stationaries $\Delta P = 0$ and $\Delta K = 0$ in Figure 1. (It is convenient to put L/P rather than P on the vertical axis.) The $\Delta P = 0$ locus is steeper so long as:

$$(9)\quad v(1-b) > s(1-u),$$

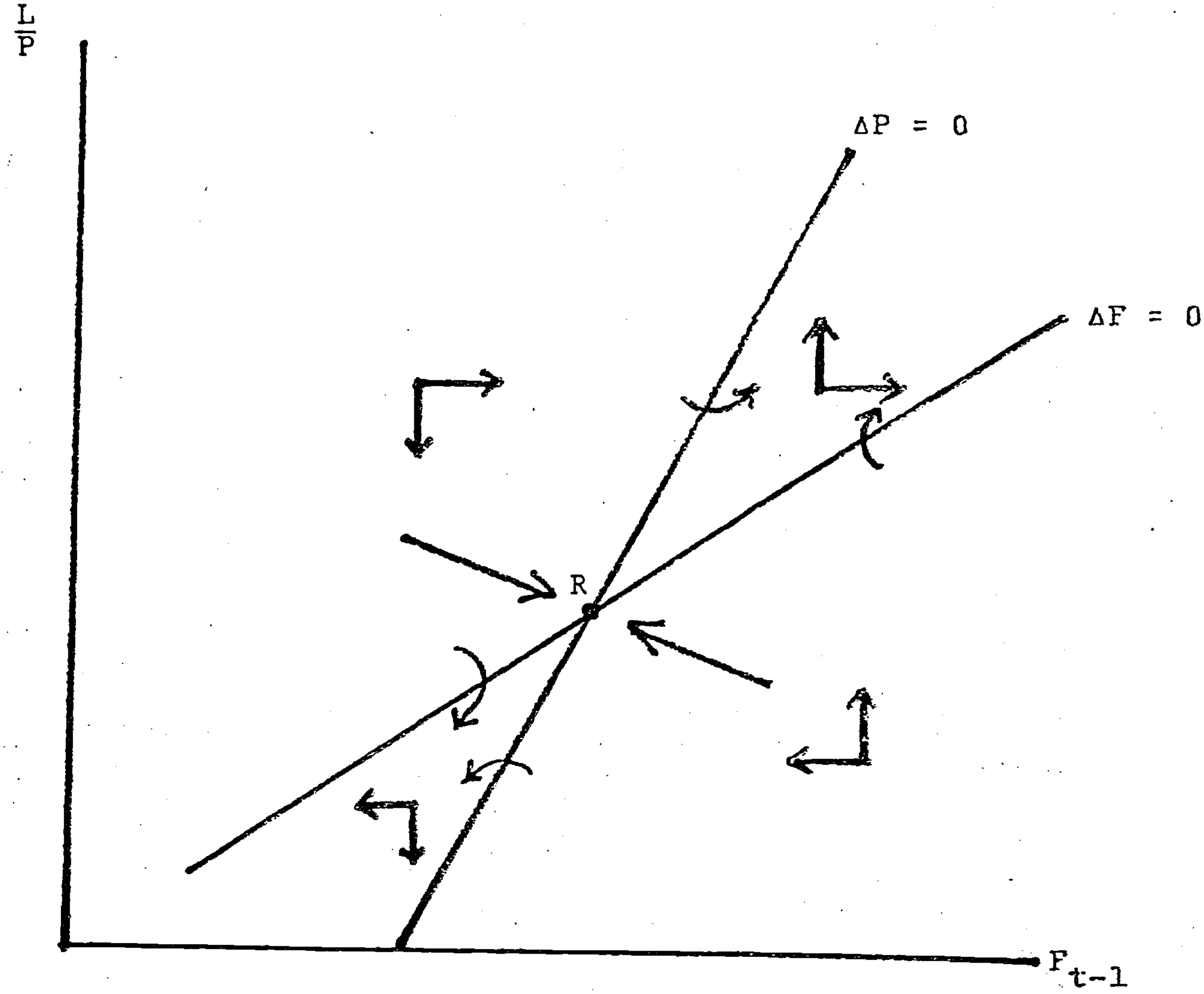


Figure 1

which is assumed.[11]

As can be seen by inspection, the credit-rationed equilibrium, point R, is a saddle point. If L/P starts at just the right level (given F_{t-1}), the system will converge to point R along the stable arm indicated in the diagram. Otherwise, the system will explode. In sharp contrast to many modern models with rational expectations, however, there is no optimizing agent to set L/P at just the right level to put the economy on the convergent path. Hence the convergent path is a knife-edge solution, obtained only by coincidence; instability is the more likely, and therefore the more interesting, outcome.

There are two possibilities. Explosion in the northeasterly direction means that output is rising while the price level is falling (L/P is rising) -- a deflationary boom! With the supply of real credit rising, you might expect that the credit constraint would soon cease to be binding. When the model is fleshed out, this will be shown to be the case.

Explosion in the southwesterly direction is stagflationary -- output falls as prices rise (L/P falls). The dynamic mechanism in this case is interesting and important enough to merit some attention. Why is the model unstable?

Ignore the financial parameters s and u for the moment (that is, set $s = u = 0$), and suppose that, starting from equilibrium, credit is reduced by one unit. Demand next period will fall by bv, but supply next period will fall by v, which is bigger. Hence the restriction of credit causes excess demand as long as $b < 1$.[12]

Excess demand drives prices higher, according to (5). But with L fixed <u>in nominal terms</u>, rising prices lead to further reductions in real credit, and the whole cycle repeats: less credit leads to excess demand which leads to higher prices which leads to less credit . . . This chain of events, which may lead to dynamic instability under credit rationing, is the basic message of this paper.

Is this mechanism realistic? I think it is. Credit restrictions do reduce effective supply in the real world (e.g., through investment). And if these effects are bigger than the effects of tight credit on demand, inflationary pressures will result. Section 4 will consider a model in which credit rationing impinges on fixed investment. The rest of this section elaborates the "finger exercise" model based on working capital. This elaboration is necessary because Figure 1 raises more questions than it answers. What happens in the case of upward explosion into the "unrationed" region? What factors determine whether credit is rationed or not? Is the model still unstable under alternative price-adjustment mechanisms?

We can answer the last question right away. Suppose we replace the law of supply and demand by a Phillips-curve equation with a natural rate at F*, viz.:

(10) $P_{t+1} - P_t = \gamma(F_t - F^*)$.

Using (6), it can be seen that the $\Delta P = 0$ locus is now:

$$\frac{L_t}{P_t} + uF_{t-1} = F^*,$$

which is the downward-sloping line shown in Figure 2. Evidently, the credit-rationed equilibrium is now stable. What has changed? Notice that the demand parameters b and s from (3) are now irrelevant because demand no longer enters the picture. If inflation is determined by (10), a reduction in credit reduces factor hiring, which is deflationary. (By contrast, under (5) a reduction in supply is inflationary.) The price level falls, thereby raising the real supply of credit back toward its original level. The equilibrium is stable. (See Figure 2.)

In the remainder of this section, as we elaborate and complicate the model, the relative importance of price adjustment according to (5) versus (10) will turn out to be critical to the nature of the credit-rationed equilibrium (if one exists). Figures 1 and 2 show, in the simplest possible terms, why this is so.

3.2 Elaborating the Model

In the model just sketched, demand (sales) and supply (production) can differ. If they do, then inventories must be changing. In order to add inventories to the model while keeping the dynamics to second-order (so as to permit graphical analysis), I switch to continuous time, thereby eliminating the lags present in the preliminary model.[13] Hence, equations

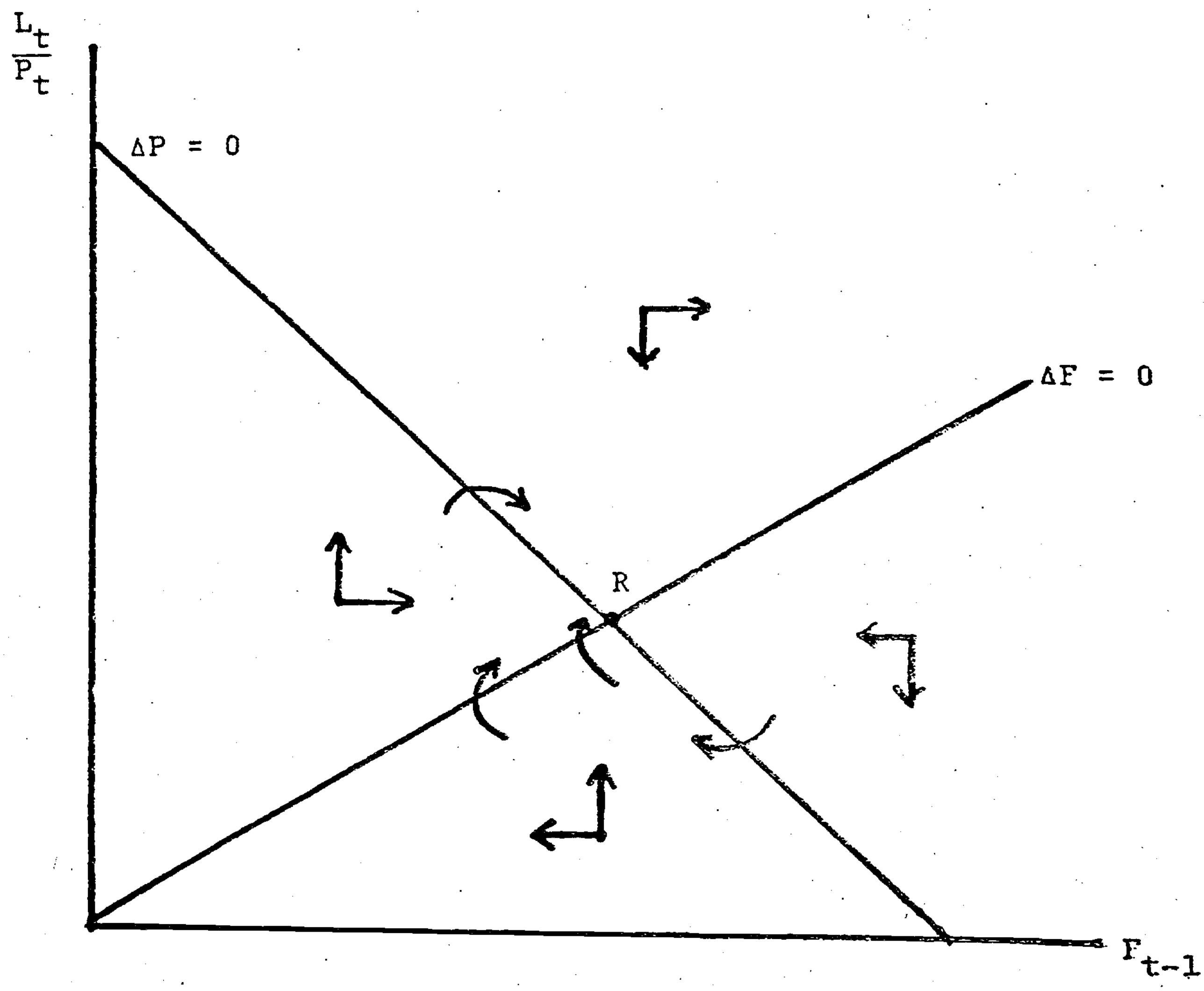


Figure 2

(1)-(4) become:

$$(11)\quad \frac{C_t}{P_t} = \frac{L_t}{P_t} + uF_t$$

$$(12)\quad y_t = vF_t$$

$$(13)\quad x_t = a + by_t + s(\frac{L}{P})_t$$

$$(14)\quad F_t = \min\left[\frac{x_t + \theta(\overline{H} - H_t)}{v}, \frac{C_t}{P_t} - (H_t - \overline{H})\right],$$

where H is the stock of inventories and $\overline{H}$ is the (constant) desired stock.

Compared to equations (1) and (2), equations (11) and (12) eliminate the lag of production behind factor payments, effectively removing the previous short-period dynamics of F_t. The dynamics now come exclusively from inventory change and gradual price adjustment. Owing to the elimination of the one-period production lag, the need for working capital now becomes entirely allegorical. Those obsessed with a need for precision should think of factor payments as being paid "just before" output is produced, so that credit is only for a fleeting instant. Those not so obsessed should think of the one-period lag as still being present in spirit, but suppressed to allow a convenient graphical exposition of the ideas.

Equation (14) requires explanation. As before, x_t is assumed equal to expected sales. Now, however, a firm whose initial inventories (H_t) differ from its desired inventory stock

($\bar{H}$) will not wish to produce what it expects to sell. Instead, as indicated in Blinder and Fischer (1981) and in Blinder (1982), it will produce expected sales plus some fraction, θ, of its inventory shortfall. This explains the first term in (14), which applies when credit is not rationed.

The second term recognizes that financing inventories is a second use of credit, in addition to providing working capital. The assumption is that the firm's equity is sufficient to finance its steady-state inventory stock, $\bar{H}$, but that bank credit is needed to finance any inventories in excess of this norm. Symmetrically, if inventory stocks are below normal, some of the equity is freed to finance working capital, thereby easing borrowing requirements. The available credit is still C_t/P_t, but now $(C_t/P_t) - (H_t - \bar{H})$ is available to finance working capital, and hence is the second term of (14).

Two further amendments to the model are needed. First, we need the identity that inventory change is the difference between production and sales:

$$(15) \quad \dot{H} = y - x .$$

The price adjustment specification combines the "law of supply and demand" (5) and the "Phillips curve" (10):

$$(16) \quad \dot{P} = \lambda(x - y) + \gamma(y - y^*),$$

where y* is the (exogenous) natural rate of output. Obviously, the special cases $\lambda = 0$ and $\gamma = 0$ merit special attention, for the preliminary model suggests that they could lead to quite different dynamics under credit rationing.

I proceed by analyzing the model separately in the two regimes defined by (14), and then putting the two regimes together.

3.3 The Keynesian Regime

I call the regime in which the credit constraint is not binding "Keynesian" because it yields a familiar Keynesian solution. From (15) and (16), it is clear that steady state equilibrium requires that $x = y = y^*$. By (14) and (12), then, H=H. Hence the Keynesian equilibrium is defined by the pair of equalities:

$$(17)\quad y = \frac{a+s\frac{L}{P}}{1-b} = y^*$$

The first equality is the simple Keynesian multiplier formula. The second pins down the price level. (As mentioned earlier, this is the only role of the real balance effect.) Obviously, one requirement for a Keynesian equilibrium to exist is that:

$$(18)\quad y^* > a/(1-b).$$

I assume throughout the paper that this condition holds; but notice that it will be false if a is large enough relative to y^*.

Away from the steady state, output is given by:

$$(19)\quad y = \frac{a + s\,\frac{L}{P} - \theta(H-\bar{H})}{1-b},$$

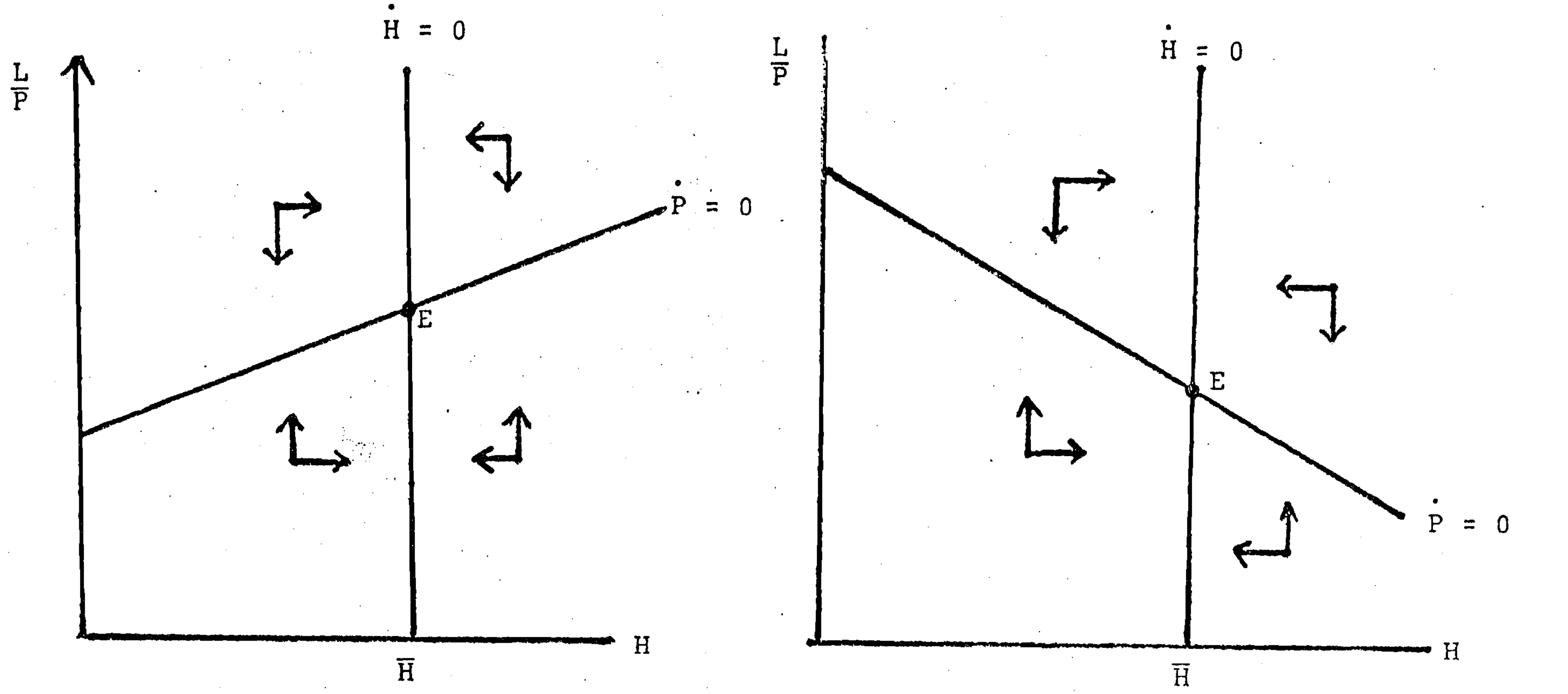
which follows from (13) and (14). Output is higher the higher is autonomous expenditure, the higher are real bank reserves, and the lower are inventories. Since, by (13) and (19), the difference $x - y$ is $\theta(H - \bar{H})$, it follows from (15) that the $\dot{H} = 0$ locus is the vertical line at $\bar{H}$ in Figure 3. Similarly, Appendix A shows that the $\dot{P} = 0$ locus is a straight line which crosses $H = \bar{H}$ at a positive value of L/P so long as a Keynesian equilibrium exists (i.e., if (18) holds), and whose slope has the sign of:

$$(20)\quad \rho \equiv \gamma - \lambda(1-b) .$$

(See the two panels of Figure 3.)

The sign of ρ depends on the relative sizes of λ and γ. If $\gamma = 0$ (pure law of supply and demand), ρ is negative; if $\lambda = 0$ (pure Phillips curve), ρ is positive. The parameter ρ has the following meaning. If higher inventories reduce prices, then ρ is positive; if higher inventories raise prices, then ρ is negative. In what follows, I will assume that $\rho > 0$ is the normal case, but will allow for the possibility that $\rho < 0$ as well. Figure 3 shows that the Keynesian equilibrium is stable regardless of the sign of ρ.

3.4 The Credit-Rationed Regime



(a) $\rho > 0$

(b) $\rho < 0$

Figure 3

Under credit rationing, (11), (12), and (14) imply that output is given by:

$$(21) \quad y = \frac{v}{1-u}[\frac{L}{P} - (H - \overline{H})] .$$

Notice the differences between (21) and the Keynesian multiplier formula (19). When credit is rationed, autonomous expenditure has no effect on output, but bank reserves have a larger effect (assuming that (9) holds). In terms of the issues that motivated this paper, we see that monetary policy is more powerful, and fiscal policy (a rise in "a" might represent a balanced-budget rise in government purchases) is less powerful in the credit-rationed regime than in the Keynesian regime. In fact, if the real balance effect is absent (s = 0), monetary policy has no real effects in the Keynesian regime while fiscal policy has no real effects in the credit- rationed regime![14]

Equations (15) and (16) continue to require that $x = y = y^*$ in steady state equilibrium, but H need not be equal to $\overline{H}$ when credit is rationed. Specifically, with some algebraic effort (see Appendix A) it can be shown that an equilibrium with credit rationing exists only when $H < \overline{H}$ and:

$$y^* < \frac{a}{1-b - \frac{s}{v}(1-u)} .$$

Since (18) continues to be the requirement for a finite price level, there can be an equilibrium with credit rationing only if:

(22) $\frac{a}{1-b} < y^* < \frac{a}{1-b - \frac{s}{v}(1-u)}$.

Appendix A shows that the $\dot{H} = 0$ locus in the credit-rationed regime has a positive slope that exceeds unity (see Figure 4), while the $\dot{P} = 0$ locus is a straight line with slope:

(23) $\frac{\rho v}{\rho v+\lambda s(1-u)} = v \left[\frac{\gamma-\lambda(1-b)}{\gamma v - \lambda q}\right]$,

where

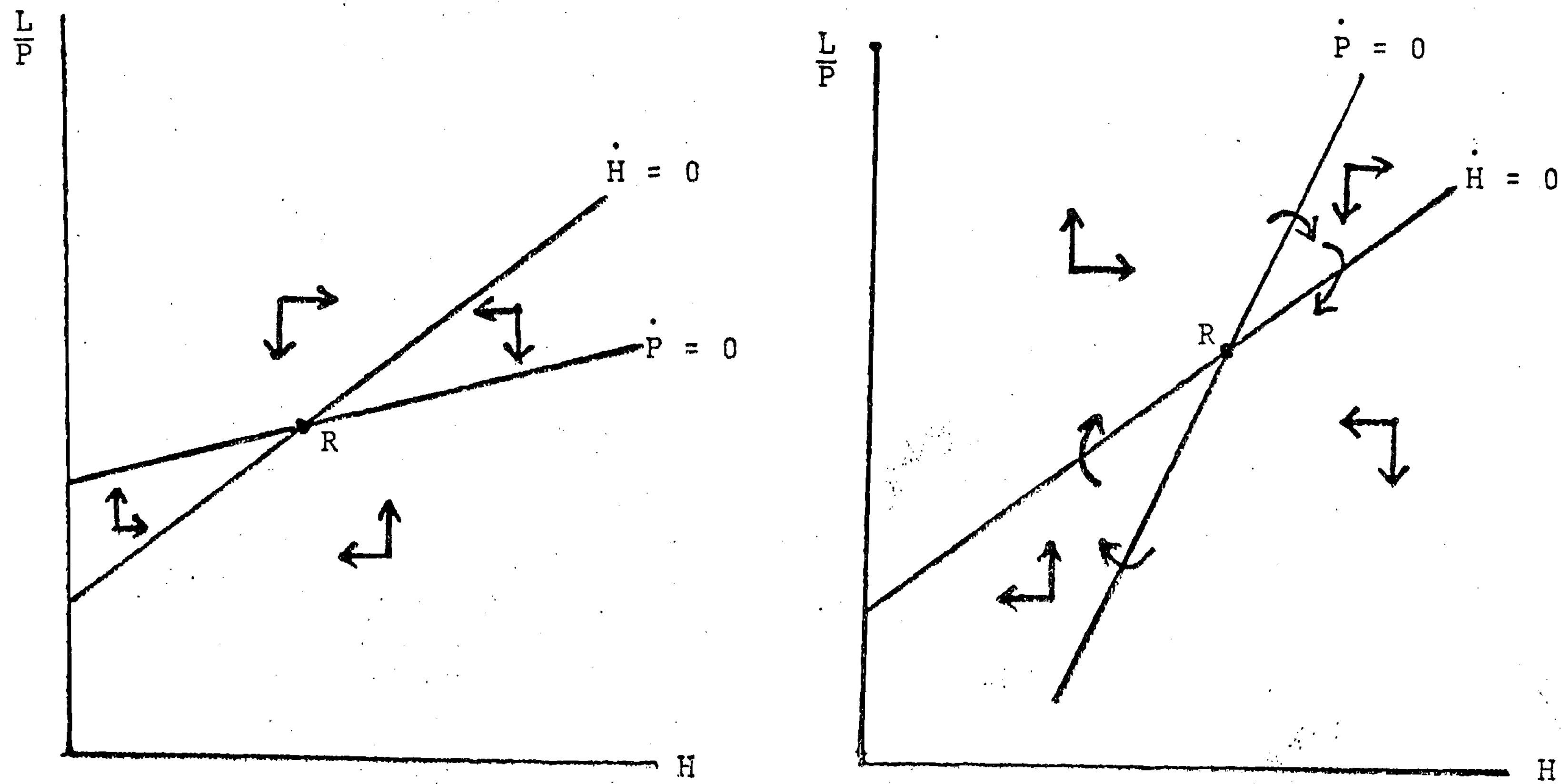
(24) $q \equiv v(1-b) - s(1-u) > 0$.

This is clearly positive if either $\lambda = 0$ (pure Phillips curve) or $\gamma = 0$ (pure law of supply and demand). To avoid a taxanomic treatment, I will hereafter assume that (23) is positive regardless of the sign of ρ .

The two alternative phase diagrams for the credit-rationed regime are shown in Figure 4. They are as follows:

* <u>Panel (a)</u>: If ρ is positive, which must be so if $\lambda = 0$, then Appendix A shows that the slope of the $\dot{H}=0$ locus must exceed that of the $\dot{P}=0$ locus. The credit-rationed equilibrium (if one exists) is stable.

* <u>Panel (b)</u>: If both ρ and $\rho v + \lambda s(1-u)$ are negative (which must occur if $\gamma=0$), the appendix shows that the slope of the $\dot{P}=0$



(a) $\rho > 0$

(b) $\rho < 0$ (but "large")

Figure 4

locus is positive and larger than that of the $\dot{H}=0$ locus. In this case, the credit-rationed equilibrium may be stable or unstable, depending on initial conditions and parameter values. The unstable case here is the analog, in this more complicated model, of Figure 1 above.

3.5 The Borderline between the Regimes

To complete the phase diagram, it only remains to locate the border between the Keynesian and credit-rationed regions. This is easily done. The demand for credit in the Keynesian regime is:

$$\frac{a + s\,\frac{L}{P} - \theta(H - H)}{v(1-b)} \quad .$$

The supply of credit in the rationed regime is:

$$\frac{\frac{L}{P} - (H - \overline{H})}{1-u}$$

These are exactly equal when:

$$(25)\quad \frac{L}{P} = \frac{(1-u)a + [v(1-b)-\theta(1-u)](H-\overline{H})}{q} \quad .$$

which defines the border. Appendix A shows that the border and the $\dot{H} = 0$ locus of the credit-rationed region intersect at $H = \overline{H}$, with the former having the smaller slope. Since the slope of the border can be either positive or negative, and is immaterial to the analysis anyway, I will simply draw the border as horizontal for convenience.

Given the equation for the border, it is straightforward to show (see the appendix) that the Keynesian equilibrium (point E in Figure 3) occurs above the border if:

$$(26)\quad y^* > \frac{a}{1-b - \frac{s}{v}(1-u)} \quad .$$

Similarly, some truly horrendous algebra shows that the credit-rationed equilibrium (point R in Figure 4) lies below the border if and only if (26) is reversed. Hence, we have the following possibilities:

(i) $y^* < a/(1-b)$ ---> no equilibrium

(ii) $a/(1-b) < y^* < \dfrac{a}{(1-b)-\frac{s}{v}(1-u)}$ --> a credit-rationed equilibrium

(iii) $y^* > \dfrac{a}{1-b-\frac{s}{v}(1-u)}$ --> a Keynesian equilibrium

Notice that if s, the real balance effect, is very small, there is little "room" between the two bounds in (ii). This makes the existence of an equilibrium with credit rationing unlikely. So the likely case is that a Keynesian equilibrium, but no credit rationed equilibrium, exists.

3.6 Dynamics when $\rho > 0$

I now put the two regions together and analyze the dynamics of the complete system. Consider first the case $\rho > 0$ which, as already mentioned, seems the more likely case. (It is the only possibility if $\lambda = 0$.)

Combining Figures 3a and 4a gives the phase diagram shown in

Figure 5, which shows a Keynesian equilibrium but no equilibrium with credit rationing. Should a decline in L lead to a period of credit rationing (see point B), a process of deflation would begin, thereby raising L/P. This deflation would continue until the price level rose by enough to restore L/P to its original value (see point E). Hence the model is globally stable, and credit rationing is a self-curing malady.[15]

Let us consider the effects of central bank policy, starting from equilibrium at point E. If L rises, real output will rise (according to (19)), putting the economy in a position like D, where the price level is too low. A period of inflation will ensue, and will continue until L/P is restored to its equilibrium level. During the inflationary adjustment, y will be falling because L/P is falling.[16] But all of this "action" induced by a contraction of bank reserves is presumably minor because the impact multiplier for monetary policy is:

$$\frac{dY}{d(L/P)} = \frac{s}{1-b} ,$$

and s is assumed to be small.

The effects of a decline in L are symmetric <u>unless</u> the decline is large enough to push the economy into the credit-rationed region. In the rationed region, the impact multiplier for monetary policy is much larger, according to (21). Specifically, it is:

$$\frac{dY}{d(L/P)} = \frac{v}{1-u} .$$

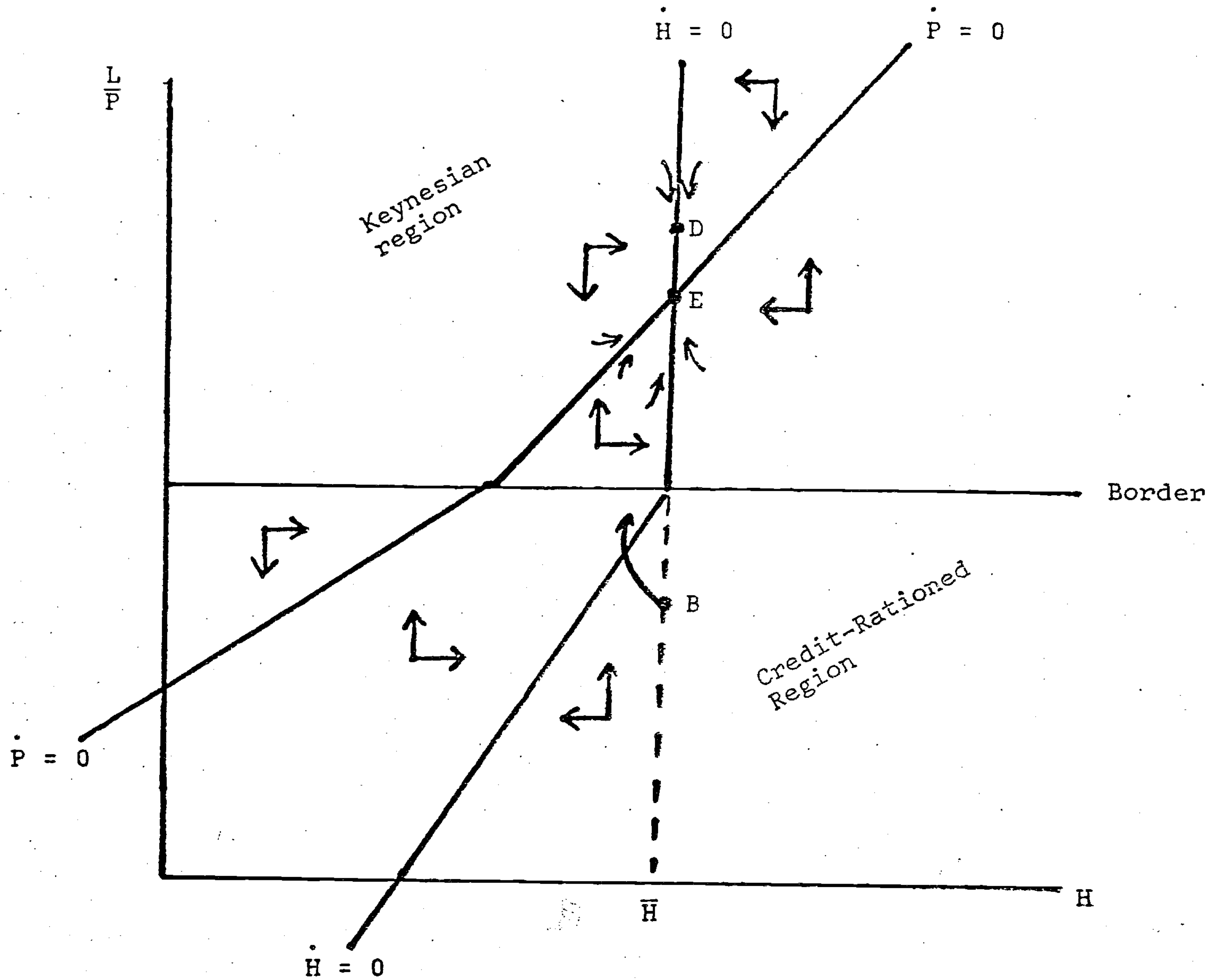

$\dot{H} = 0$
$\dot{P} = 0$
$\frac{L}{P}$
Keynesian region
D
E
Border
B
Credit-Rationed Region
$\dot{P} = 0$
H
$\bar{H}$
$\dot{H} = 0$

Figure 5

If L is reduced starting from a point like B, prices and output start to fall. Since output declines by more than sales, inventories start to fall. Falling inventory stocks tend to push output back up toward equilibrium. Eventually, inventories reach a minimum and begin to be replenished. But deflation continues until L/P is restored to its original level.

So we conclude that the effects of monetary policy, while qualitatively similar in the two regimes, may be rather weak in the Keynesian regime and rather strong in the credit-rationed regime. Translated into real-world terms, a tightening of monetary policy may have strong effects on the real sector when money is already tight, but weak effects when credit is initially plentiful.

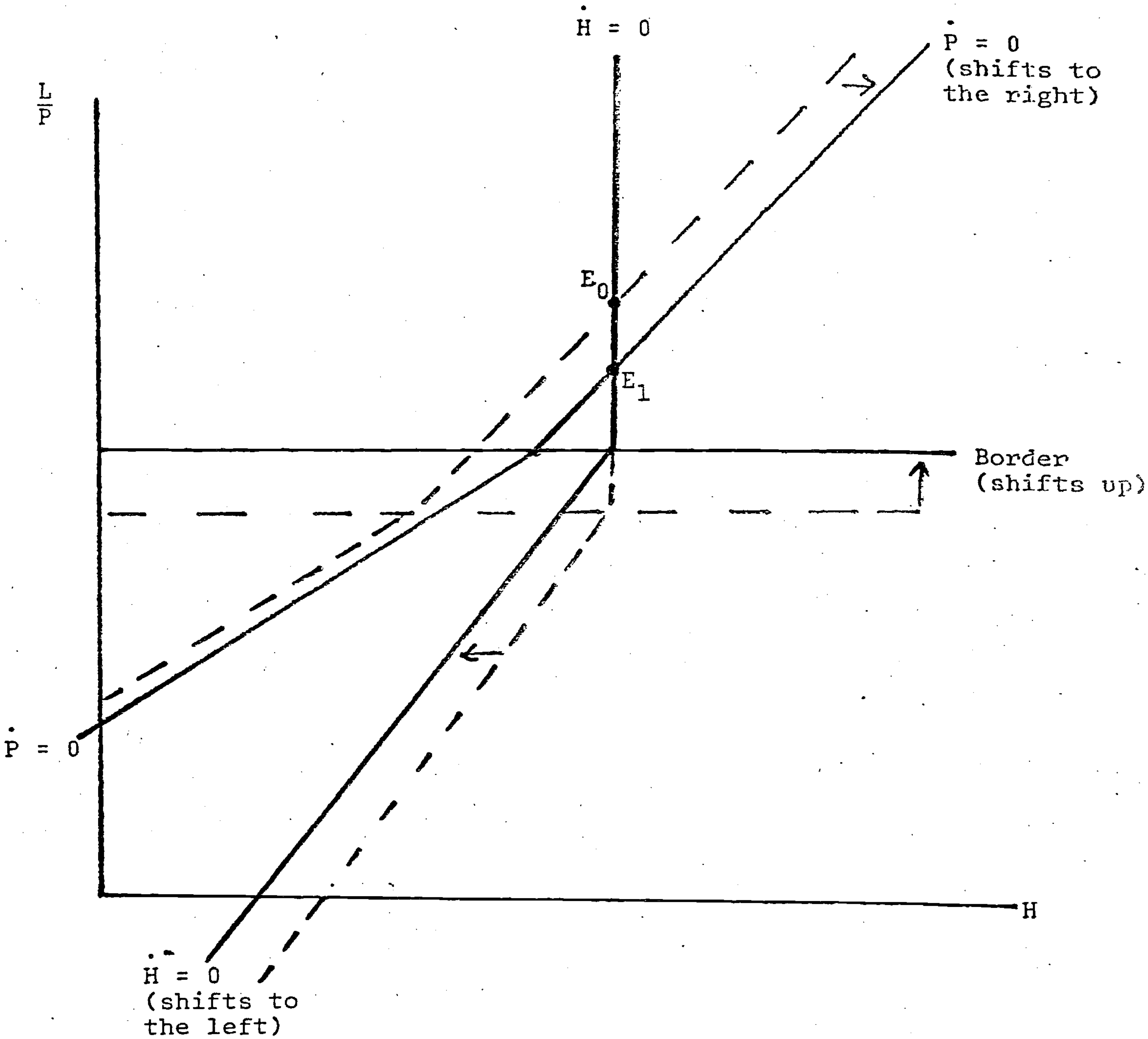
What happens if autonomous expenditure, a, rises? The multiplier formula shows that y rises strongly if the economy is in the Keynesian regime. Inspection of the equations that underlie Figure 5 shows that (see Figure 6):

(a) the $\dot{P} = 0$ locus shifts to the right in both regions, so the equilibrium point, E, shifts down vertically (to a higher equilibrium price level);

(b) the border shifts up;

(c) the $\dot{H} = 0$ locus shifts to the left in the credit-rationed region, but does not move in the Keynesian region.

These shifts are depicted in Figure 6, in which the "old" lines are drawn broken and the "new" lines are drawn solid. We see that a rise in "a" leaves the economy at a point qualitatively similar



$\dot{H} = 0$
$\dot{P} = 0$
(shifts to
the right)
$\frac{L}{P}$
E_0
E_1
Border
(shifts up)
$\dot{P} = 0$
H
$\dot{H} = 0$
(shifts to
the left)

Figure 6

to point D in Figure 5. The adjustment process from D to E -- which entails rising P and falling y -- has already been described.

Now consider the possibility that autonomous spending grows so large that the Keynesian equilibrium depicted in Figure 5 ceases to exist, but that s is large enough so that an equilibrium with credit rationing arises. This is shown in Figure 7.

If that happens, the economy initially finds itself at a disequilibrium point like C or, if the border shifts up strongly enough, like B in Figure 7. A substantial inflation ensues -- enough to drive L/P down to the new equilibrium level indicated by point R. As the economy moves from point C down to point D, y is falling (slightly). Once the border is crossed, it is no longer clear whether y is rising or falling because the contractionary effects of declining L/P are counteracted by the expansionary effects of falling H.

3.7 Dynamics when $\rho < 0$

The case in which $\rho < 0$ must arise if $\Upsilon = 0$. As stated earlier, I assume that γ is so small that the $\dot{P} = 0$ locus in the credit-rationed region is positively sloped. Since it must be steeper that the $\dot{H} = 0$ locus (see the appendix), there are again two possibilities, depending on whether the equilibrium is Keynesian or credit rationed.

(a) Figure 8 depicts a Keynesian equilibrium which combines

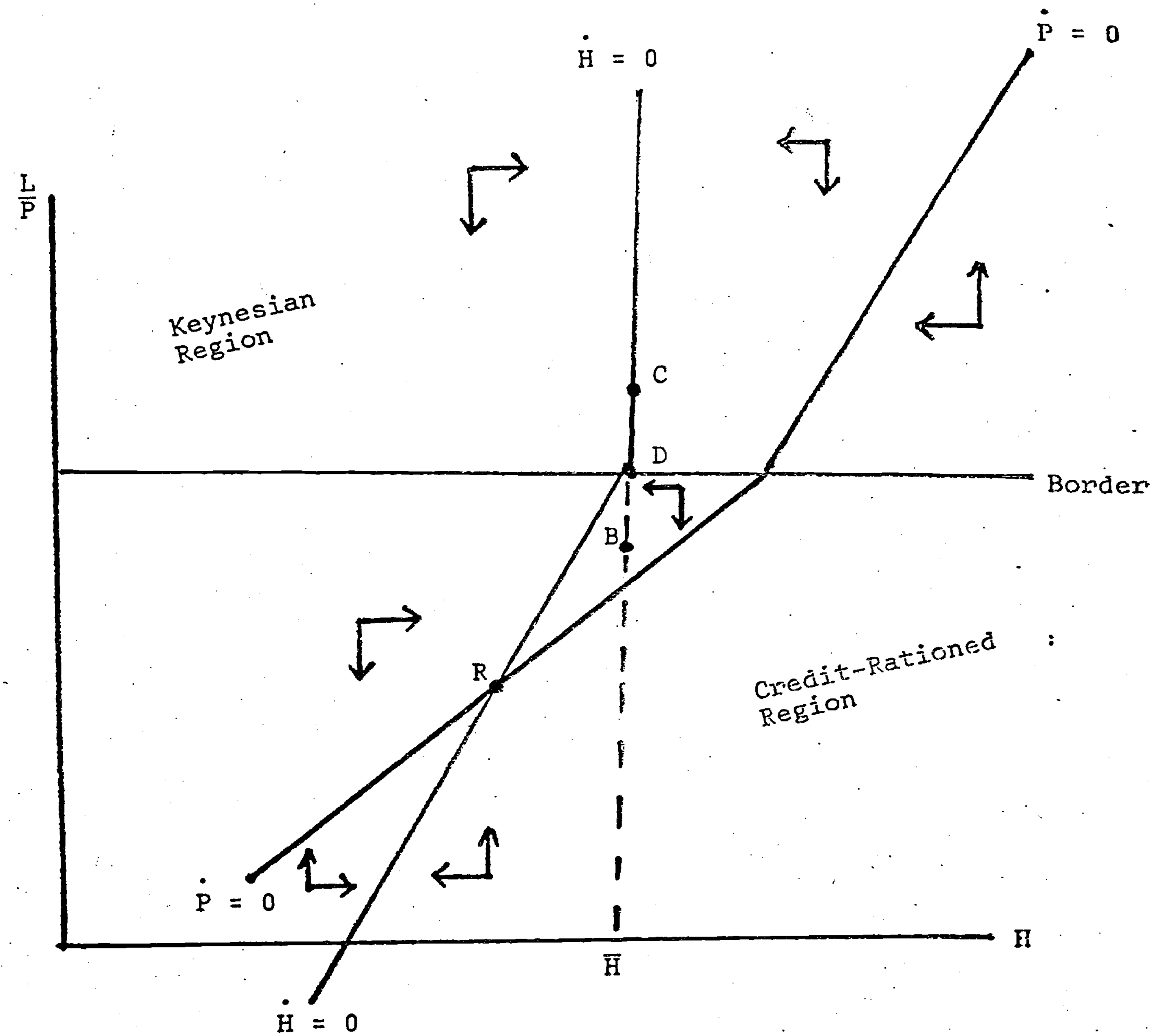

$\dot{P} = 0$
$\dot{H} = 0$
$\frac{L}{P}$
Keynesian Region
C
D
Border
B
R
Credit-Rationed Region
$\dot{P} = 0$
H
$\overline{H}$
$\dot{H} = 0$

Figure 7

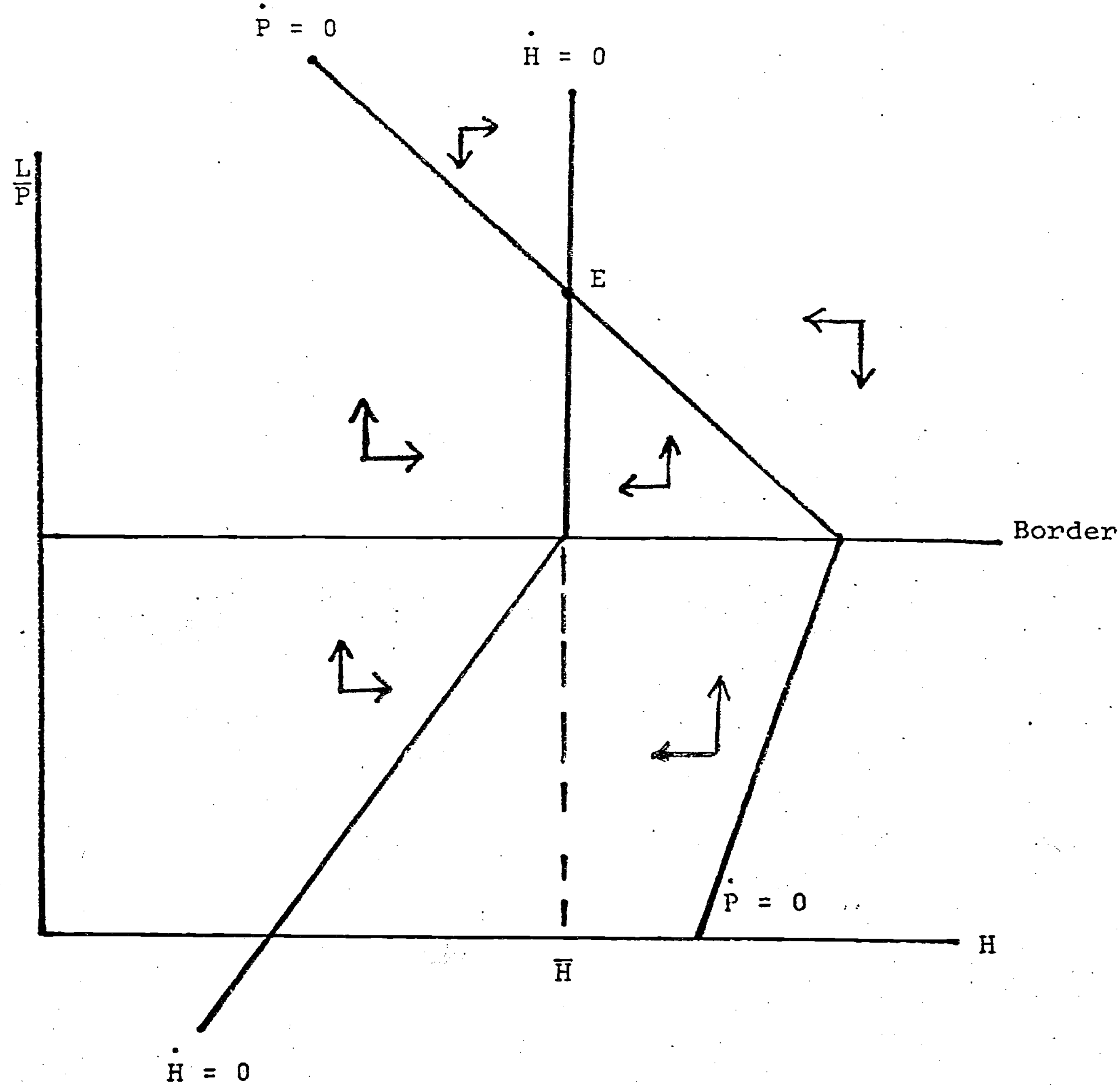


Figure 8

Figures 3b and 4b. This case is qualitatively similar to Figure 5: the economy can be credit rationed for a period, but it always returns to the Keynesian equilibrium. Nothing more need be said.

(b) Figure 9, however, depicts a more interesting possibility: the economy's only equilibrium is credit- rationed, but it might not be stable. Following a perturbation, the economy exhibits a cyclical adjustment period which might alternate between periods of rationed and unrationed credit. The adjustment process could be stable (spiralling in to point R) or unstable (spiralling away). The unstable case tells a story that is similar to that told by our preliminary model in Section 3.1.

4. CREDIT RATIONING AND FIXED CAPITAL

One valid objection to the model of Section 3 is that credit rationing there affects only aggregate supply, whereas in reality it is commonly believed that rationing has important effects on aggregate demand (such as for housing and consumer durables). To meet this objection, this section develops a model in which credit rationing impinges on capital formation, and therefore affects both aggregate demand (in the short run) and aggregate supply (in the long run).

4.1 Structure of the Model

Since the capital stock adds an additional dynamic variable,

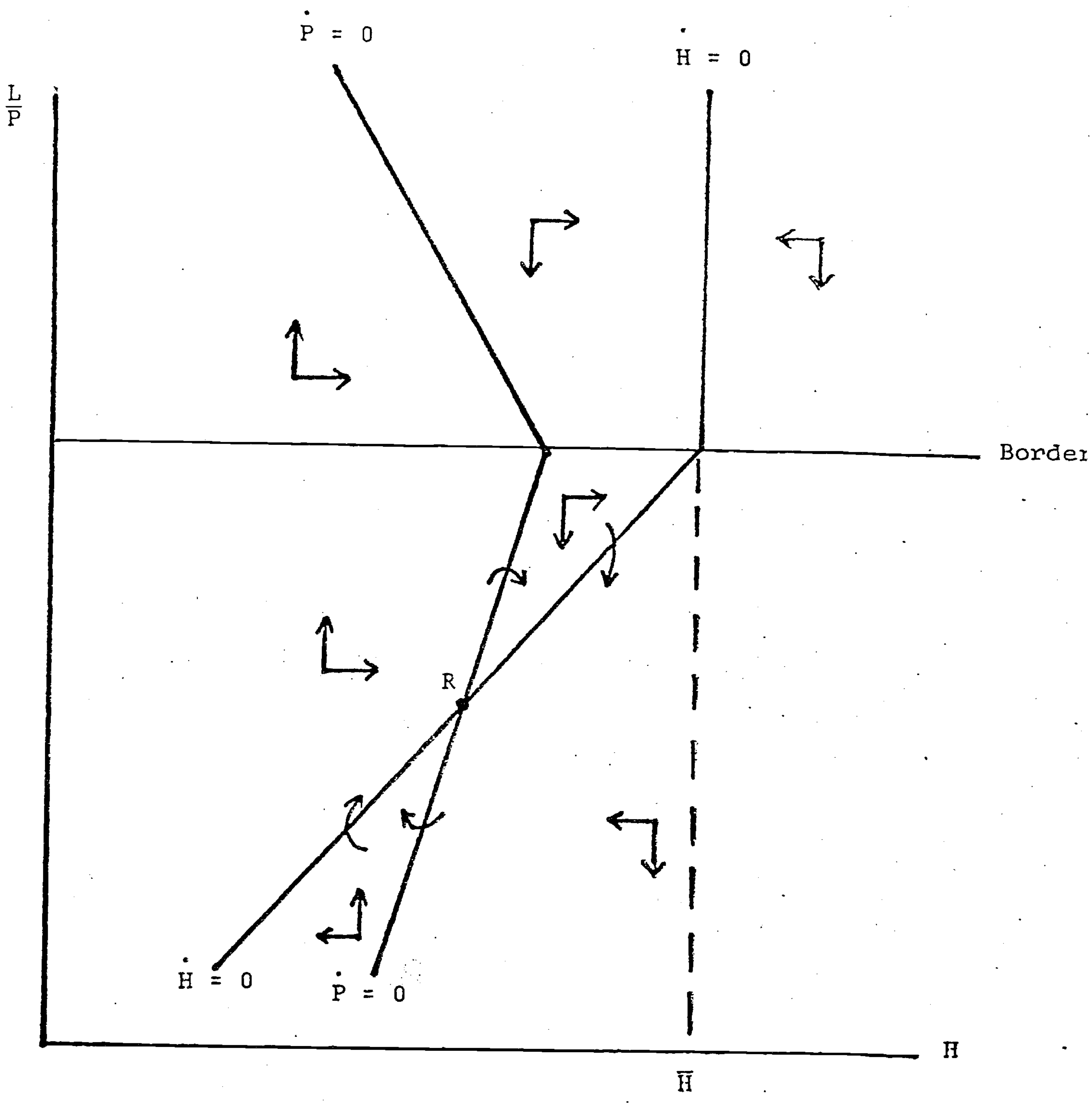


Figure 9

and since I want to keep the dynamics to second order, I eliminate inventory changes by assuming that firms always produce to meet demand (y=x).

To allow for capital accumulation, it is, of course, necessary to distinguish between fixed capital, K, and other factors of production -- which I call "labor," N. Hence the simple production technology of Section 3 will no longer do. The supply side of the investment model is best understood by referring to Figure 10, which is a standard isoquant diagram. Ray OE shows the expansion path of a firm with constant returns to scale under the given wage-rental ratio. Since the wage-rental ratio is assumed constant throughout the analysis, the cost-minimizing input combinations all lie along OE.

Suppose the firm wants to produce y_0, because that is the amount demanded. The optimal capital stock for this level of output is ϕy_0 (point A). Suppose the firm's actual capital stock is only K_0. Its short-run strategy, I assume, is to produce y_0 by using K_0 units of capital and N_0 units of labor (point B), where N_0 is obtained from the production function. This is a disequilibrium situation in two respects. First, output is above normal "capacity" -- which is most naturally defined as K_0/ϕ. The firm is not producing y_0 at minimum cost, and so will want to acquire more capital. Second, while I assume that workers supply as much (or as little) labor as is demanded in the short run, the level of employment, N_0, may not match the notional supply of labor. If it does not, there will be either upward or downward

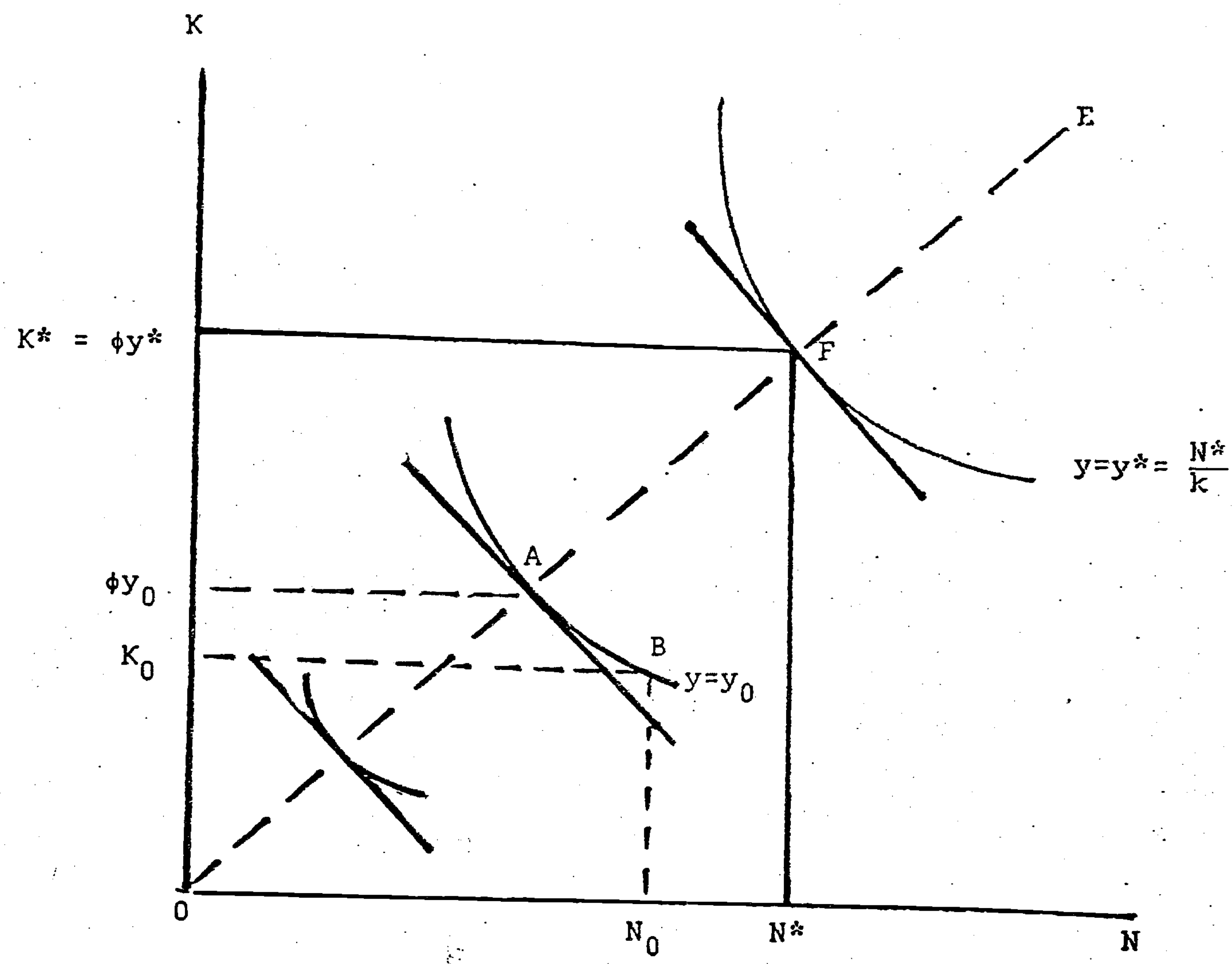


Figure 10

pressure on wages and prices. (The real wage is constant.)

The long-run equilibrium is determined by the notional supply of labor, N^* in the diagram. To employ the labor force fully, output must be y^* (point F); and the capital stock must be $K^* = \phi y^*$. Hence, while I assume that output is demand-determined in the short run, it is supply-determined in the long run.

A set of equations that captures these ideas is:

(27)	$\bar{y} = K/\phi$	(capacity)
(28)	$N = N(y,K)$	(employment)
(29)	$\dot{K} = I = \beta(\phi y - K)$	(investment)

where output is determined by (13) augmented by the addition of investment:

(30) $$y = a + by + s(L/P) + I,$$

and the function N(.) in (28) is obtained by inverting the production function.

Two factors influence prices (and wages): the pressure of output (y) on normal capacity ($\bar{y}$), and the pressure of employment (N) on the available supply of labor (N^*). Hence the price equation is:

(31) $$\dot{P} = \lambda(y - \bar{y}) + \gamma(N - N^*),$$

where N^* is the (exogenous) natural level of employment and $\bar{y}$ is the (endogenous) capacity level.

The model is completed by specifying the credit market. The credit constraint now says that the volume of working capital, N, and end-of-period fixed capital (K+I) cannot exceed the real supply of credit:

(32) $C/P \geq N + K + I.$

(Here the real wage is normalized to unity and the price of a capital good is assumed equal to the price of a consumption good.) The supply of credit is still given by:

(33) $C/P = L/P + \alpha y.$

Equations (27)-(33) constitute the entire model. If (32) holds as an equality, we are in the credit-rationed regime; if it holds as an inequality, we are in the Keynesian regime.

4.2 The Keynesian Regime

When the credit constraint is not binding, output is determined by the conventional Keynesian multiplier formula. From (29) and (30):

(34) $$y = \frac{a + s\frac{L}{P} - \beta K}{1-b-\beta\phi}.$$

In the steady state, of course, y will be equal to the natural rate, y^*, which is defined implicitly by $N^* = N(y^*, \phi y^*)$. Similarly, K will be equal to $K^* = \phi y^*$; so (34) becomes:

$$(35) \quad y^* = \frac{a + s\frac{L}{P}}{1-b} \quad ,$$

which determines the price level so long as the existence condition (18) holds.

Using (29) and (34), investment in the model will be:

$$(36) \quad \dot{K} = I = \beta(1-b-\beta\phi)^{-1} \quad [\phi(a + s(L/P)) - (1-b)K] \quad ,$$

so that each dollar of autonomous expenditure "crowds in"

$$\frac{\partial I}{\partial a} = \frac{\beta\phi}{1-b-\beta\phi} > 0$$

dollars of investment. Equation (36), of course, defines the $\dot{K}=0$ locus which appears in Figure 11.

The rest of the dynamics of the model follow by substituting (34) into (31) to get a nonlinear equation for $\dot{P}$. Appendix B shows that the $\dot{P} = 0$ locus can be linearized around equilibrium to get a line whose slope is less than the slope of the $\dot{K}=0$ locus. Hence the phase diagram for the Keynesian region looks like Figure 11. The Keynesian equilibrium at E is stable (if it exists).

4.3 The Credit-Rationed Regime

Two possible variants of credit rationing can be accommodated within the structure of this model, depending on whether it is fixed or working capital that is rationed. Since

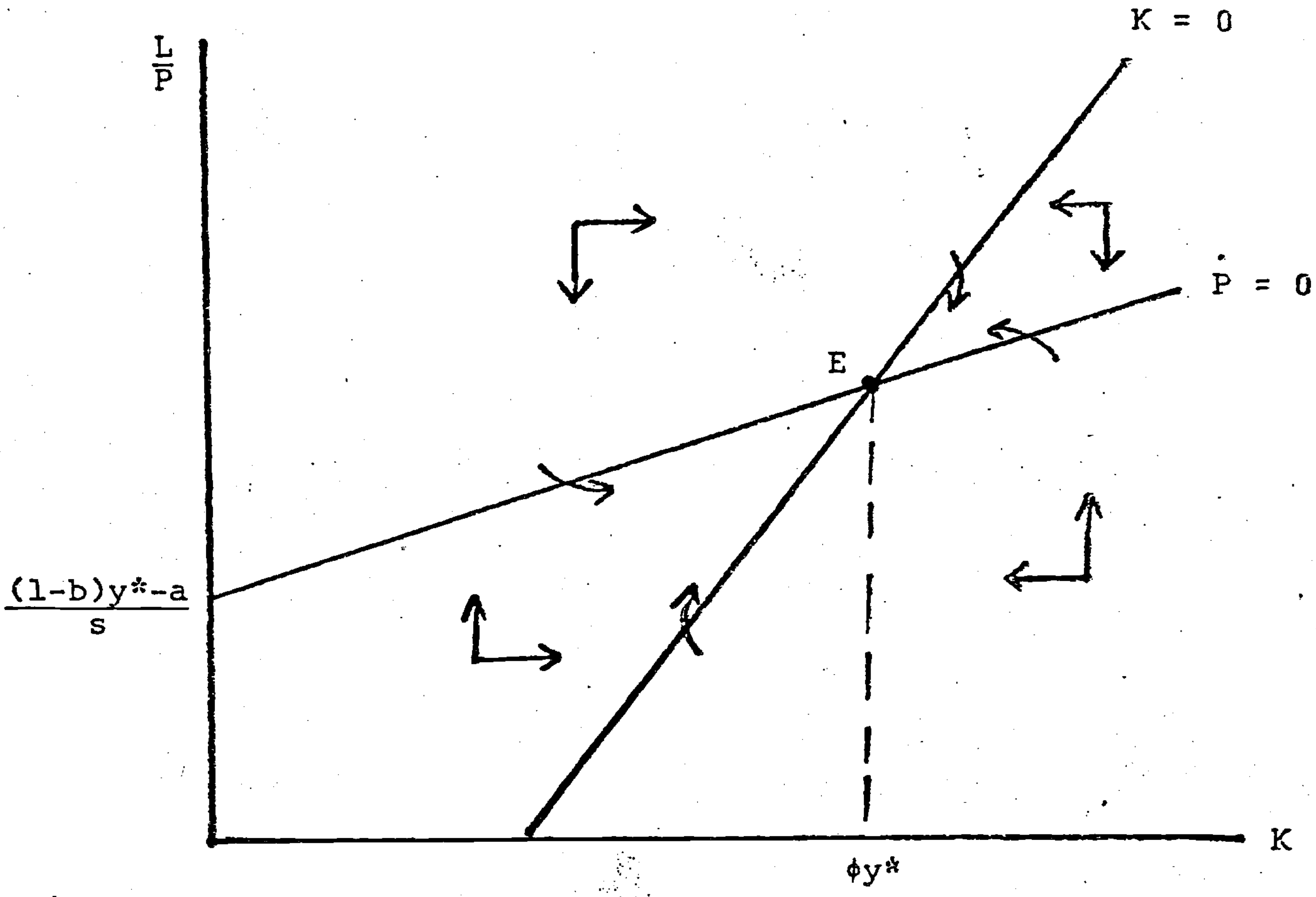


Figure 11

rationing of working capital was studied in Section 3, I assume here that it is investment that gets rationed when the credit constraint is binding. Hence, when (32) holds as an equality, we have:

$$C/P = N(y,K) + K + I,$$

which, using (33), means that investment is rationed to:

$$I = L/P + y - N(y,K) - K.$$

Of course, a reduction of I will make y fall as well, as is standard in Keynesian analysis. Substituting for I into (30) gives an equation for the level of output under credit rationing:

$$y = a + by + s(L/P) + L/P + \alpha y - N(y,K) - K,$$

which implicitly defines:

$$(37)\quad y = Y(\underset{+}{a}, \underset{+}{L/P}, \underset{-}{K})$$

with the signs of the partial derivatives as indicated.

Appendix B shows that $\partial Y/\partial a$ is smaller than the corresponding multiplier in the Keynesian case (see equation (34)), and that $\partial Y/\partial(L/P)$ is larger. These comparisons echo those of Section 3, though the multiplier for autonomous expenditure is no longer zero when credit is rationed.

Using (37), the constrained rate of investment is found to be:

$$(38)\quad \dot{K} = I = L/P - K + \alpha Y(a,L/P,K) - N[Y(a,L/P,K),K].$$

Hence, using the expression for $\partial Y/\partial a$ derived in the appendix, the degree of crowding out is:

$$\frac{\partial I}{\partial a} = -\frac{N_y - \alpha}{1-b+N_y-\alpha},$$

which is between 0 and -1.

The $\dot{K} = 0$ locus is defined by setting (38) equal to zero, and the $\dot{P} = 0$ locus follows from (31). Appendix B shows that, at least locally, the slope of the $\dot{P} = 0$ locus exceeds that of the $\dot{K} = 0$ locus. Hence the credit-rationed equilibrium, if one exists, is a saddle point such as R in Figure 12.

To see whether a credit-rationed equilibrium can exist, we need to consider how the Keynesian and credit-rationed regions fit together.

4.4 The Borderline between the Regions

The borderline is easily determined. In the Keynesian regime, the real demand for credit is:

$$N(y,K) + K + \beta(\phi y - K),$$

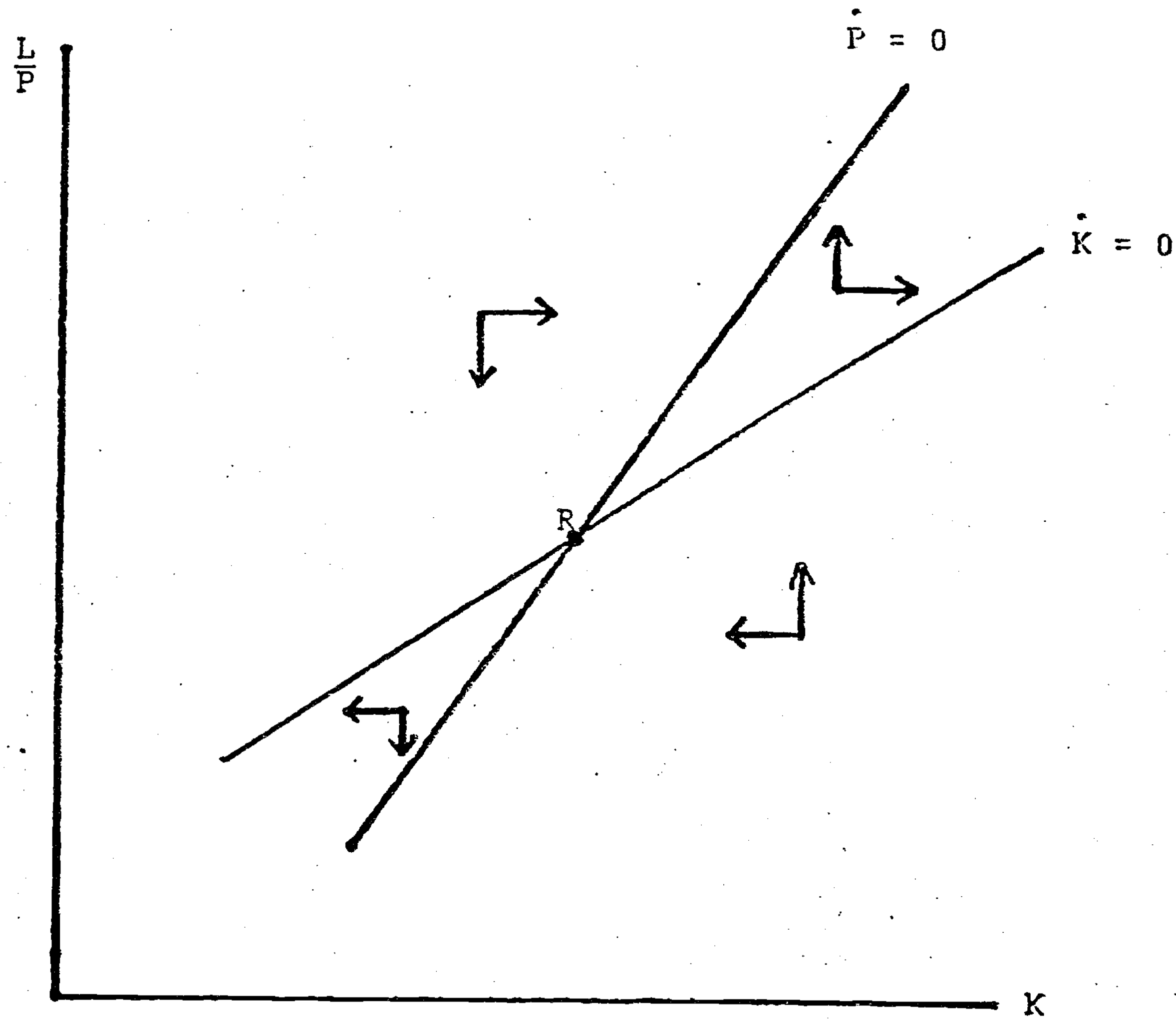


Figure 12

and the real supply of credit is:

$$L/P + \alpha y,$$

where in both cases y is given by (34). Setting these two equal defines the border. Even after linearization, the slope of the borderline could have either sign.

4.5 Dynamic Analysis

Combining Figures 11 and 12 leaves two main possibilities, depending on whether or not a credit-rationed equilibrium exists. (I assume that a Keynesian equilibrium does exist.)

In Figure 13 there is no credit-rationed equilibrium because the two stationaries intersect outside the positive quadrant. If the model gets into the credit-rationed region, deflation eventually forces L/P up until credit is no longer rationed. The model always converges to the Keynesian equilibrium (point E). Figure 13 looks much like Figure 5 for the working capital model. Since its comparative dynamics are essentially identical, I will not bother to repeat the analysis.

Figure 14 shows the other possibility. Here the economy has two equilibria: a Keynesian equilibrium at E which is locally stable, and a credit-rationed equilibrium at R which is (locally) a saddle point. Depending on the initial value of L/P, the model can converge to the Keynesian equilibrium, converge to the credit-rationed equilibrium (a knife-edge possibility), or

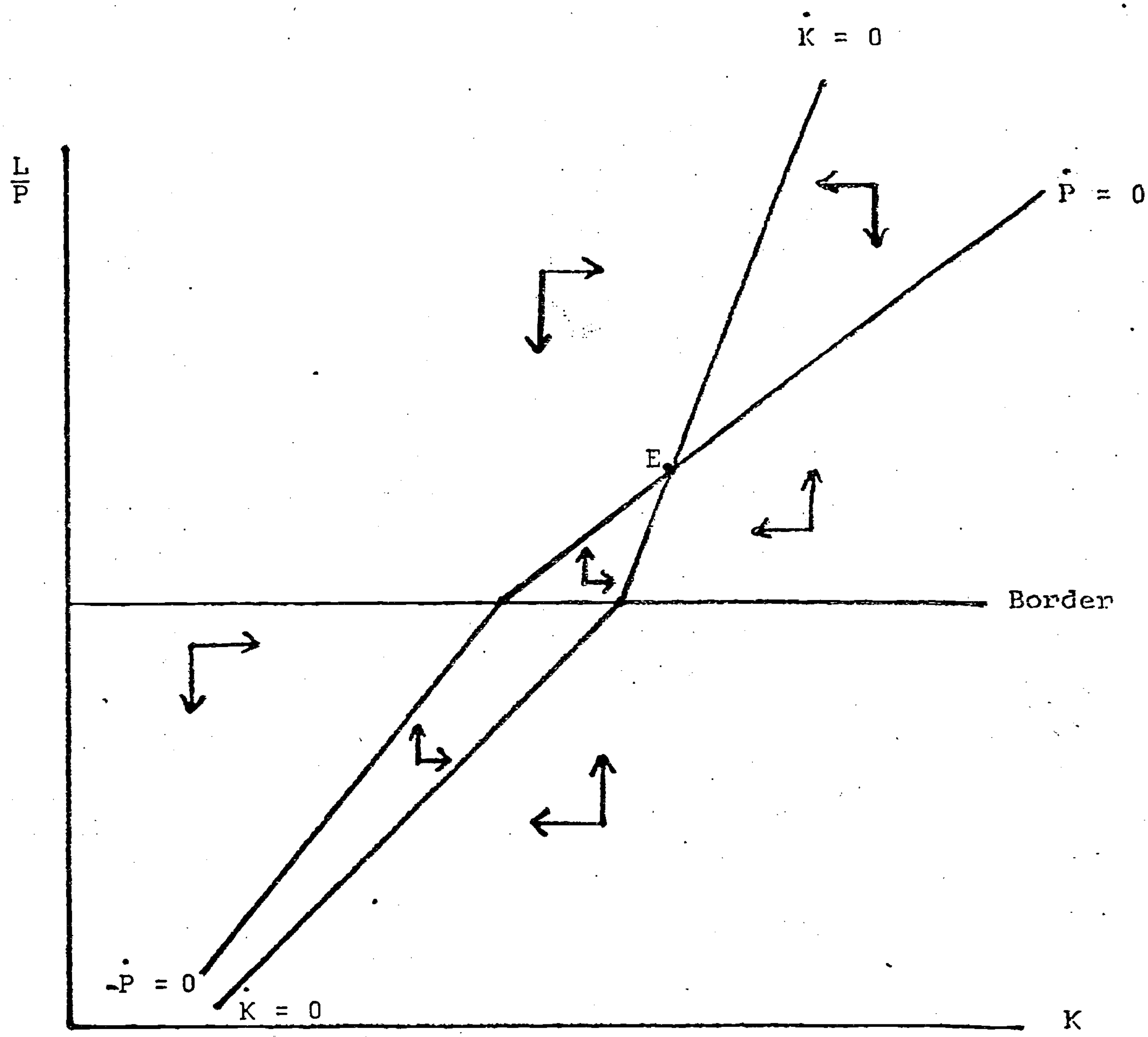


Figure 13

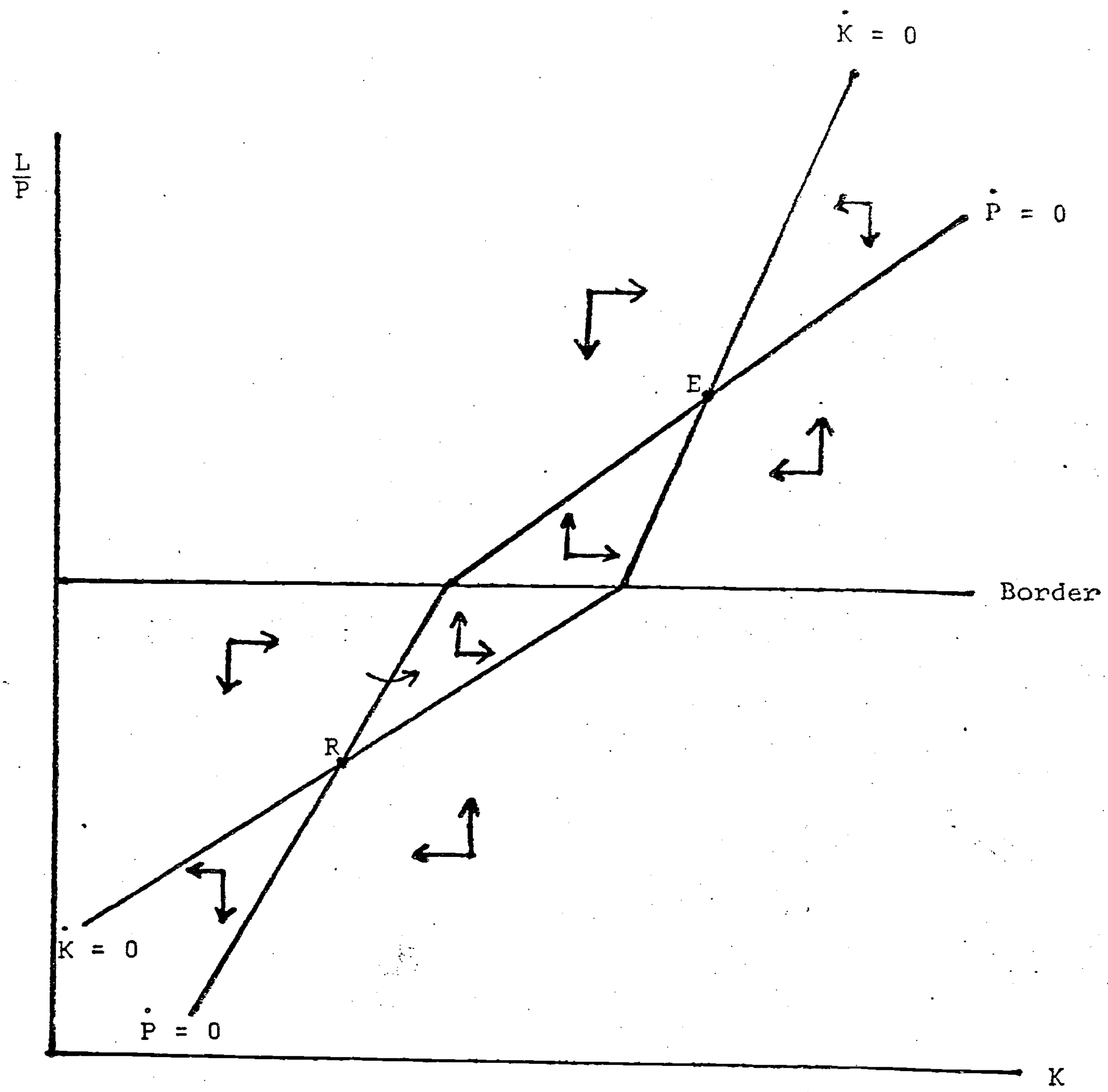


Figure 14

explode in the southwesterly direction with prices rising and capacity falling.

Some properties of the credit-rationed equilibrium are worth mentioning. Since investment is rationed, and is zero in equilibrium, K is naturally below K*. K is also below ϕy ("desired capital"), but investment is inhibited by rationing. Thus, output is above capacity, even though it is below the natural rate: $\bar{y} < y < y^*$.

The latter inequality means that there is unemployment in equilibrium. This unemployment puts downward pressure on the price level, but that is exactly offset by the inflationary pressure caused by production beyond capacity. If that sounds like a precarious equilibrium, it should--because the rationed equilibrium is a knife-edge solution. Any departure from equilibrium will lead either into the Keynesian region or to a stagflationary explosion that is reminiscent of our first model in Section 3.1.

The stagflationary mechanism is little different here than it was in the working capital model. Here rising prices reduce L/P, thereby making credit rationing tighter. This reduces investment and causes capacity to shrink, which is inflationary.

5. EMPIRICAL RELEVANCE

Economics is not an art form, so a theoretical model like this one needs to be justified. Precisely where is this model applicable? There are several possible answers.

In the contemporary U.S. economy, there seems to be a strong *a priori* case that quantity rationing is important in the housing sector--where builders are mostly small, undercapitalized firms that rely on banks for working capital. Also, if we think of households as producing services from durable goods (which they buy on credit), a similar story would apply to consumer durables. In addition, the story of firms curtailing their activities for lack of credit rings true for the small business sector (but not for giant corporations). The importance of housing and durable goods industries in business fluctuations is well known; I am now trying to assess the importance of small business in business cycles.

It is also worth remembering that the complex, fluid financial markets that exist in the United States (and perhaps in England) are not typical of other industrial countries, where securities markets may be rudimentary and much investment is financed by banks. Indeed, the U.S. economy in the 1980s is quite different in this regard from the U.S. economy in earlier decades. In other times and places, close substitutes for bank loans were not readily available.[17]

Finally, it is not only in the industrial countries that business fluctuations are apparently linked to central bank policy. There is a growing literature in development economics that argues--on both institutional and econometric grounds--that credit restrictions which reduce the supply of credit for either working capital or investment are a major channel through which financial policies have real effects.[18]

Thus I think the approach followed here at least potentially applies to several important sectors of the U.S. economy today, to most of the economies of many other countries today, and to almost all economies in earlier times.

6. SUMMARY AND CONCLUSIONS

I have presented here two simple macro models in which "money" plays no role, but in which central bank policy has potentially strong real effects via its influence over the supply of credit. The real effects of monetary policy do not derive from interest elasticities, nor from expectational errors, but rather from credit rationing. And it is not hard (for me, at least) to imagine that this channel of influence might be quite powerful.

The central conclusions from the two models are:

(1) Depending on the relative magnitudes of central bank credit (here indicated by L/P) and autonomous expenditure (here indicated by a), the economy may or may not be credit constrained. Its behavior is qualitatively different depending on whether or not the credit constraint is binding. For example, when credit is rationed the effect of autonomous spending on output is smaller, and the effect of monetary policy is larger, than when credit is not rationed. In the investment model, autonomous expenditure crowds out investment only when credit is rationed (and then only partially); it crowds in more investment when credit is not rationed.

(2) When the economy is credit constrained, it is subject to a kind of instability owing to inflation. If it reduces supply more than demand, a reduction in credit can be inflationary and can thereby make the real supply of credit shrink further. The inflationary impact of tight credit found here is different from the more familiar cost-push mechanism (the so-called "Patman effect").[19]

(3) Despite this destabilizing mechanism, dynamic instability is by no means inevitable. Potential instability from credit rationing may be overwhelmed by other stabilizing influences in the model (represented here by the real balance effect and the Phillips curve). If so, credit rationing is a self-correcting malady.

I believe that these conclusions are likely to be quite robust, and hence are more interesting than the particular models used to derive them. The paper is, nonetheless, only a fragment of a more complete model. Its most important contribution, I hope, is to start down the road toward a theory of effective supply based on credit rationing (and perhaps on other phenomena as well). When more fully developed, the principle of effective supply may take its place alongside the Keynesian principle of effective demand as the twin pillars of non-classical macroeconomics.

FOOTNOTES

1. Bernanke (1981) sketches a similar scenario.

2. Nakamura (1984) argues for an important economy of scope in banking: banks get information from managing a firm's deposit account that is not available to others and that enables banks to reduce the riskiness of their loans.

3. Empirically, however, we do not observe a negative correlation between (detrended) bank loans on the one hand and either (detrended) trade credit or (detrended) commercial paper on the other. So this "escape hatch" may not be as important as many economists have supposed.

4. Or as a model of an economy without a developed capital market. In fact, after circulating a first draft of this paper, I learned about several papers in development economics that are based on the use of bank credit to finance working capital. See, for example, van Wijnbergen (1983), who attributes the idea to Cavallo (1977), or Leff and Sato (1982).

5. Blinder (1984) constructs a precise micro model along these lines, building on the foundations laid by Stiglitz and Weiss (1981) and Jaffee and Russell (1976).

6. Banks sell the bonds to households, who pay with money. (Households do not care how much money they hold.) Presumably, interest rates would have to rise to clear the bond money market. But interest rates play no role in the model, so this is ignored.

7. If the rationing is effective, then $B_t = \hat{B}_t$. If firms do not take up all the available credit, then B_t is found residually from (1c).

8. Of course, it is always possible to associate a shadow price--in this case, a shadow interest rate--with any quantity rationed equilibrium and thereby translate the quantity story into a price story. In general, I think allowing interest rate channels would mainly reinforce the phenomena discussed in this paper.

9. If firms enlarge their holdings of money as output expands, they must sell some other asset. Implicitly, this "other asset" (whose market is surpressed by Walras' Law) is government bonds. Banks may buy some of these bonds, but there are two conflicting effects: inflows of deposits lead banks to expand their holdings of all assets (including government bonds), but decreases in riskiness lead to portfolio shifts away from bonds. The remainder of the bonds are presumed to be bought by households, whose money holdings

are purely passive. See footnote 6.

10. Notice that "credit velocity," which I take to be constant, is normalized to unity.

11. Recall: The real balance effect is assumed to be "small." This is one specific definition of "small."

12. When s and u are not zero, excess demand eventually arises as long as condition (9) holds.

13. Continuous time also reduces the mathematical complexities caused by regime switching. See below, especially footnote 15.

14. The later would not be true if banks' assessment of risk was more forward-looking than assumed in equations (1) (in which only today's output matters).

15. The regime change creates problems in analyzing the dynamics. However, Honkapohja and Ito (1983) point out that, if the directions of motion are the same on both sides of the border (as is true here), the trajectory will pass through the border. Under certain other conditions, the "patched" system will be stable if the component systems are. See Honkapohja and Ito (1983).

16. In this model, there is perfect foresight and no lags. As a result, inventories do not change during this adjustment period. If production lagged, then the surge in demand would lower inventories, creating an initial point somewhat to the left of D and kicking off an inventory cycle.

17. For example, Bernanke's (1983) analysis of the Great Depression is based on this idea.

18. See, for example, the references cited in footnote 4 above. There are others.

19. But see footnote 8 above.

REFERENCES

Bernanke, Ben S., "Bankruptcy, Liquidity and Recession," American Economic Review, May 1981, pp. 155-159.

Bernanke, Ben S., "Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression," American Economic Review, June 1983, Vol. 73, No. 3, pp. 257-76.

Blinder, Alan S., "Inventories and Sticky Prices: More on the Microfoundations of Macroeconomics," American Economic Review, June 1982, pp. 334-348.

Blinder, Alan S., "Notes on the Comparative Statics of a Stiglitz-Weiss Bank," mimeo, Princeton, December 1984.

Blinder, Alan S. and Stanley Fischer, "Inventories, Rational Expectations, and the Business Cycle," Journal of Monetary Economics, November 1981, pp. 277-304.

Blinder, Alan S. and Joseph E. Stiglitz, "Money, Credit Constraints, and Economic Activity," American Economic Review, May 1983, pp. 297-302.

Cavallo, Domingo F., "Stagflationary Effects of Monetarist Stabilization Policies," unpublished Ph.D. dissertation, Harvard University, 1977.

Honkapohja, S. and T. Ito, "Stability with Regime Switching," Journal of Economic Theory, 29, 1983, pp. 22-48.

Jaffee, Dwight M. and Thomas Russell, "Imperfect Information and Credit Rationing," Quarterly Journal of Economics, November 1976, pp. 651-666.

King, Robert G. and Charles I. Plosser, "Money, Credit, and Prices in a Real Business Cycle," American Economic Review, June 1984, pp. 363-380.

Leff, Nathaniel and Kazuo Sato, "Macroeconomic Disequilibrium and Short-Run Economic Growth in Developing Countries," in M. Syrquin (ed.), Trade, Stability, Technology, and Equity in Latin America (New York: Academic Press), 1982.

Nakamura, Leonard, "Bankruptcy and the Informational Problems of Commercial Bank Lending," mimeo, September 1984.

Stiglitz, Joseph E. and Andrew Weiss, "Credit Rationing in Markets with Imperfect Information," American Economic Review, June 1981, pp. 393-410.

van Wijnbergen, Sweder, "Credit Policy, Inflation and Growth in a Financially Repressed Economy," Journal of Development Economics, 13, 1983, pp. 45-65.