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Endogenous credit and endogenous business cycles

1. Introduction

Attempts to connect monetary phenomena and business cycles often have been the province of economists who also accepted the Walrasian full employment paradigm. Monetary explanations of business cycles preceded Keynes (cf. Zarnowitz, 1985), and in the post Keynesian era Monetarists of different varieties have also advanced them. Old style Monetarists (e.g., Poole, 1978) have tried to integrate money into a disequilibrium account of fluctuations. By assuming a demand for money proportional to nominal income, lags in price adjustment, and an exogenous money supply, they depict movements of the money supply as a main source of fluctuations. In this scheme an increase in the money supply, with prices constant, translates into an increase in real demand. This causes an increase in real output, even if markets are initially at the point of Walrasian general equlibrium. However, when perceptions catch up with reality and nominal prices adjust, so will real output. Decreases in the money supply cause fluctuations in the opposite direction. New style Monetarists reject the disequilibrium elements of this story and insist on rational expectations. The assumptions of market clearing and rational expectations are integrated into a monetary theory of cycles by introducing new assumptions

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about the availability of information. Lucas (1981), for example, suggests that changes in the exogenous money supply cause changes in nominal prices in ways that are only partially understood—i.e., with Friedman's notorious "long and variable lags." This makes it difficult for firms to distinguish changes in price levels from changes in relative prices. Optimizing firms react to perceived increases in relative prices by increasing productive capacity. To the extent that changes in the money supply have fooled them, they will have excess capital stock, which will need to be worked off. Hence the pro-cyclical behavior of investment demand under conditions of market clearing everywhere.

Post Keynesian economists reject old and new style Monetarism, and have sought an amplified version of Keynes' monetary theory as a theoretical alternative. This has produced a garden variety of ideas, as the review articles of Lavoie (1984, 1985) demonstrate. Two major tenets of this group are the endogeneity of the money supply and the importance of credit to the accumulation of capital. These ideas can easily be used to counter Monetarism. If the money supply is endogenous, it cannot be a cause of cycles in the way Monetarists say it is; and if demand for money is related to investment finance, then the demand for money described by the quantity equation is probably wrong.

Such critical results are of course important in themselves. However, it will be the purpose of this paper to show that a particular interpretation of endogeneity, when joined to the concept of effective demand, implies the existence of self-sustained growth cycles under certain conditions. That is, the Post Keynesian account of credit and interest, which has been used to counter Monetarist ideas, itself contains the elements of a theory of capitalist instability that have so far gone unexploited. These points will be made by means of a dynamic model. In the process of developing it, Goodwin's (1982) idea that the normal functioning of capitalism is correctly described by a model of self-sustained growth cycles is extended. The interaction of finance and capital accumulation are shown to be capable of generating growth cycles, just as Goodwin showed that accumulation and reserve army phenomena can do. In addition, the model explicitly considers effective demand, an issue not addressed in many growth cycle models.

2. The endogeneity of money and credit

Economists seeking to develop a Keynesian view of money and finance have taken two somewhat divergent directions. On the one hand, economists such as Davidson (1972, pp. 246–81) and Robinson and Eatwell (1973, pp. 218–19) have emphasized the importance of bank decision-making in the process of capital accumulation. The willingness of banks to provide the flow of credit needed for increasing the level of investment is viewed as a necessary, if not sufficient, condition for the success of an economy. Thus, in a discussion of the prerequisites to an expansion of investment, Davidson (1972, p. 279) writes:

> If additional finance is to be obtained, and if the banks are unwilling to create it, then some members of the community must be induced to give up some of their portfolio money holdings in exchange for securities, if entrepreneurs are to carry through their orders of fixed capital goods. Hence the market price of securities must intially fall (the rate of interest must rise). . . . Of course the equilibrium level of output in $t + 1$ will be lower and the interest rate higher than if the money supply had expanded in pace with the additional investment demand.

Other economists such as Kaldor (1982) and Moore (1979, 1983, 1985) take a somewhat different view. They tend to treat the money supply as a passive, demand-driven magnitude. Constraints on accumulation exist only to the extent that the cost of reserves—as determined by the central bank—affects the market rate of interest. Central bank willingness to accommodate the banks' needs for reserves is explained by the requirements of policy (Kaldor, 1982, p. 25):

> Whilst monetarists continually emphasize that the Central Bank can or should directly determine the quantity of money, or at least the 'base stock' of money, consisting of bank notes and bankers' reserves (or balances) with the Central Bank, in fact they can do no such thing, as recent experience with the Federal Reserve or the Bank of England shows. . . . They cannot prevent either a depletion or an accumulation of 'high powered money' (or reserve money) except by a policy of en- or discouragement—by raising or lowering the rate at which they are prepared to create reserves by discounting (or re-discounting) Treasury bills and bonds. But the Central Bank cannot close the 'discount window' without endangering the solvency of the banking system; they must maintain their function of lender of last resort. Equally they cannot prevent any depletion of Government balances with the Bank of England due to an excess of outgo over inflow from reappearing as an addition to high powered bank

money—not unless they refuse to honor cheques issued by HMG—which would be a rather drastic step for monetarists to take.

The endogenous money supply is an institutionally generated reality. Central banks cannot control the supply of credit, because they are captives of the banking system. The banking system itself is seen to be responding passively to the wishes of its borrowers.

The empirical evidence on the issue of endogeneity is not decisive. Basil Moore has discussed evidence for passive endogeneity. He has noted (Moore, 1985, pp. 15–18) institutional data consistent with this position: Growth rates of members and non-members of the Federal Reserve system are not markedly different, even though reserve requirements for member banks are higher. He has also done econometric work (Moore, 1979, 1983) that shows banks loans and money supply to be related to money wage changes. His interpretation is that changes in money wages affect demand for working capital, which is translated into changes in the money supply.

While Eichner believes that the supply of credit has endogenous determinants, his empirical work is not consistent with the idea that the Federal Reserve is a purely passive supplier of reserves. In his work (Eichner, 1986, pp. 166–68), the federal funds rate is explained by the ratio of net free reserves to total reserves; and by liquidity pressure, defined as the ratio of total loans to total deposits in the banking system. The first term has a negative impact on the federal funds rate, the second has a positive impact. The results indicate that policy decisions about reserves are important to interest rate determination.

The model developed in the following section explores some implications of assuming that bank behavior, along with credit demand, affects the supply of money and finance. In particular, it shows that bank decision-making—in conjunction with decisions about accumulation—can combine to produce self-sustaining growth cycles. It thus produces additional reasons for viewing the degree of endogeneity of money as an important issue.

3. Endogenous credit and the business cycle

In order to explore some of the implications of endogeneity and accumulation, let us begin with a model of a closed economy. Let Y be the real value of GNP, and K the real value of the capital stock. Then Y will be determined by the Kaleckian multiplier relation

(1) $$Y = mgK$$

where g is the gross rate of accumulation, and $m = 1/(1 - w)$, w being labor's share in Y. For the purposes of this exercise it will be assumed that w is constant. While this ignores the behavior of income shares over the cycle, it is an acceptable simplification in a model that seeks to isolate the contributions of financial factors to the generation of cycles. It also allows us to ignore pricing and capital theory problems with a slightly clearer conscience. Given these assumptions, the rate of accumulation will be equal to the rate of profit.

To make use of (1) it is necessary to say something about the determinants of g. To do so we will utilize an idea of Kalecki (1971, pp. 105–109), whose work is an important source of inspiration for many Post Keynesians. In his discussion of the principle of increasing risk, Kalecki suggests that there are two significant limitations, given a firm's basic estimate of economic reality, on the capital accumulation it will undertake. They are the value of a firm's existing capital and the existence of increasing risk. The value of capital limits accumulation because internal finance is limited by it and because the market value of a firm's assets, which may be used as collateral, sets a limit on borrowing. Regardless of the interest rate a firm may be willing to pay, there is an upper limit to borrowing because capital needs to stand as security for the loan or bond. Accumulation is further limited by risk in the sense that the larger the expansion of capacity in relation to existing capital, the greater the threat to the existence of the firm if the investment is not profitable, or causes losses. If there has been significant borrowing, failure of the investment may mean failure of the firm. Both these factors make current profits important in determining the possibilities of accumulation. The greater the flow of current profits, the more easily a firm can pay for already existing investments or begin new ones without seeking financing.

Given its estimates of longer run profitability and its current profitabilty, the firm will also take into account the current rate of interest. If borrowing, the rate will be a cost of funds; and if not, it will be a measure of opportunity cost. Thus we may represent the desired rate of accumulation by

(2) $$g^d = a + b^* g - cr$$

where g^d is the desired rate of accumulation, r is the rate of interest, and a, b^*, and c are positive constants. The positive value for a reflects a "normal" period in a capitalist economy, in which the longer term prospects of profits are secure enough that, unless current profits fall low enough and the rate of interest rises high enough, there will be positive desired expenditures on capital goods. The term in g represents the influence of profitability, since with constant income shares the rate of profit will equal the rate of growth.

To determine movements in g, the difference between g^d and current g will be put in a partial adjustment framework of the form

$$\dot{g}/g = n\,(g^d - g) \tag{3}$$

with n a positive constant. This formulation has some highly desirable properties from an economic point of view. It acknowledges the difficulties of adjusting actual to desired capital stock. Since for many capital goods there are notable order and construction lags, this is an important concession to reality. Also, by writing the investment function in this way, it is impossible for any positive pair of interest and growth rates to induce a negative value for g. This is a necessary attribute for any sensible description of the behavior of gross rates of accumulation. While it is certainly possible to describe the motion of g in more complex ways—reducing, for example, the tendency of deviations to produce larger responses with higher growth rates—there is value in keeping the constituent elements as simple as one can.

Given a value of $b^* > 1$, and assuming without loss of generality that $n = 1$, equation (3) can be written as

$$\dot{g} = g\,(a + bg - cr) \tag{4}$$

where $b = b^* - 1 > 0$.

As it stands, however, (4) is still an inadequate representation of the determinants of g, since it implies that any rate of accumulation is possible. We need to take account of capacity limitations. To do so we will include a negative term in g^2 in (4) to obtain

$$\dot{g} = g\,(a + bg - cr - dg^2) \tag{5}$$

This puts an upper limit to the rate of accumulation since there is a maximum value of g for which $\dot{g} > 0$. At higher values of g, $\dot{g}$ will certainly be negative.

To model the interest rate, a financial sector must be added. For present purposes the central bank, commercial banks, and firms will be the actors in that sector. Commercial banks will determine the real supply of credit according to the supply of reserves provided by the central bank, the rate of interest they can earn on loans, the risk involved in making loans, and the legal and institutional constraints on their use of reserves. This gives a supply function of the form

(6) $$C^S = C\, r^{\alpha}\, Y^{\beta}$$

An increase in C reflects an increase in reserves or a financial innovation by the banks. An increase in α represents an increase in central bank accommodation or an increase in bank responsiveness to loan possibilities. If there were complete accommodation, r would be fixed and α would be infinite. We assume rather, in line with the theoretical work of Davidson and the empirical work of Eichner, that accommodation is partial so that α is finite and the rate of interest does vary. A larger value for Y indicates a higher level of profits, and may be taken by banks as an index of the soundness of firms. A decrease in β signals an increased risk aversion by banks.

The real demand for credit will be given by

(7) $$C^D + Y^{\gamma}\, r^{-\kappa}$$

The term in Y represents both transactions demand and finance demand, since Y is a function of gK. The interest rate terms reflects the willingness of businesses and households to economize on transactions balances, and represents liquidity preference considerations. The model is closed by assuming that the credit market clears

(8) $$C^S = C^D$$

To study the dynamics of this system we need to see how the rate of interest moves through time. Differentiation of (6) gives

(9) $$\dot{C}^S/C^S = \varepsilon + \alpha\dot{r}/r + \beta\,(\,\dot{g}/g + g - \delta\,)$$

where $\varepsilon = \dot{C}\,/C$. Similarly, equation (7) gives

(10) $$\dot{C}^D/C^D = \gamma\,(\,\dot{g}/g + g - \delta\,) - \kappa\dot{r}/r$$

Using (1), (9), and (10) gives the dynamics of r in the form

(11) $$\dot{r} = r\,(\,\lambda_1\,\dot{g}/g + \lambda_1 g - \lambda_2\,)$$

where $\lambda_1 = (\gamma - \beta)/(\alpha + \kappa)$, and $\lambda_2 = (\varepsilon + (\gamma - \beta)\delta)/(\alpha + \kappa)$. With $(\gamma - \beta) > 0$, r will begin to increase when the sum of $\dot{g}/g$ and g are large enough. Since this is the case in which we are interested, and since a positive value is necessary to a positive g, r fixed point for the system, we will assume this expression is positive. Note that the coefficients λ_1 and λ_2, which determine how strongly the rate of interest responds to real sector variables, are in part determined by α and β, parameters reflecting the endogeneity of credit.

A phase diagram can be used to analyze the behavior of the system given (5) and (11). As is shown in the Appendix, if the coefficient b—which reflects investment response to profits—is large enough and the coefficient a is suitably restricted, the phase diagram will correspond to that in Figure 1. There are four fixed points in the system. The one of interest is at the intersection of the $\dot{r} = 0$ and $\dot{g} = 0$ isoclines, labeled point A. Its stability properties can be discovered from the Jacobian matrix

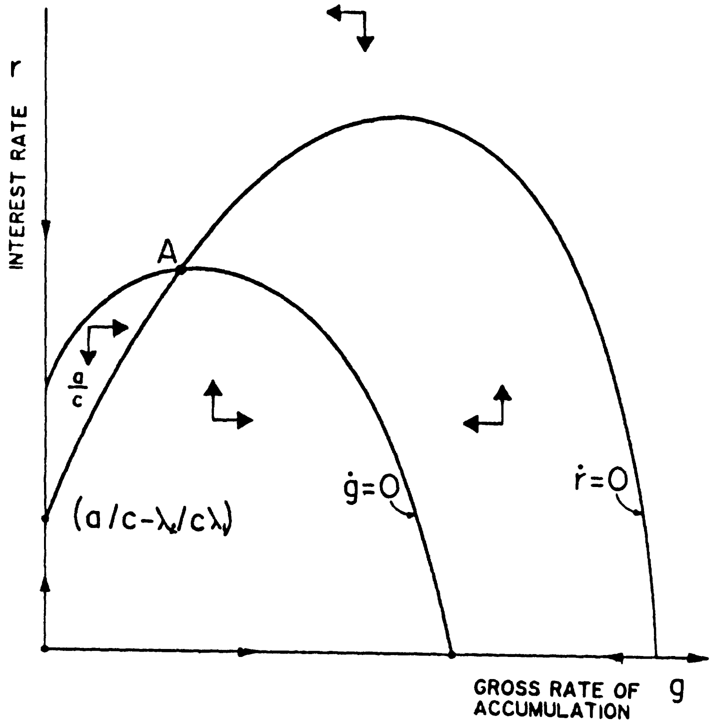
(12) $$J = \begin{bmatrix} \partial\dot{g}/\partial g & \partial\dot{g}/\partial r \\ \partial\dot{r}/\partial g & \partial\dot{r}/\partial r \end{bmatrix}$$

As is shown in the Appendix, $Tr(J) = (1 - \lambda_1)bg^* + 2(\lambda_1 - 1)dg^{*2} - \lambda_1 a$ and $Det(J) = \lambda_1 crg^*$, where r^* and g^* are the values of r and g at the fixed point A. Since $Det(J) > 0$, the fixed point will not be a saddle point. It will be unstable when $Tr(J) > 0$, that is when $b > [\lambda_1 a + 2(\lambda_1 - 1)dg^{*2}]/(1 - \lambda_1)$

When A is an unstable point, it can be shown (see Appendix) that the system will generate a limit cycle around the fixed point. A limit cycle is a closed orbit on which motion is self-sustained, and to which neighboring trajectories will be attracted in this case. The limit cycle for this model will be qualitatively like the one drawn in Figure 2. Hence, under the conditions described, the interaction of aggregate demand and the financial sector combine to cause self-sustaining fluctuations in the rate of capital accumulation and the rate of interest.

The economic processes involved in generating such cycles can now be examined. The instability of the fixed point A—which is necessary to the existence of the cycle—is in large measure a consequence of strong accelerator effects in the investment function. If changes in the growth rate are sufficiently self-amplifying, which will be the case if the coefficient b is relatively large, then the system will not have a stable equilibrium at the fixed point. However, upward and downward explosiveness does not occur when the economy is displaced from this point. When there are upward movements in the rate of accumulation, there are increases in the demand for credit. Although there are regions where

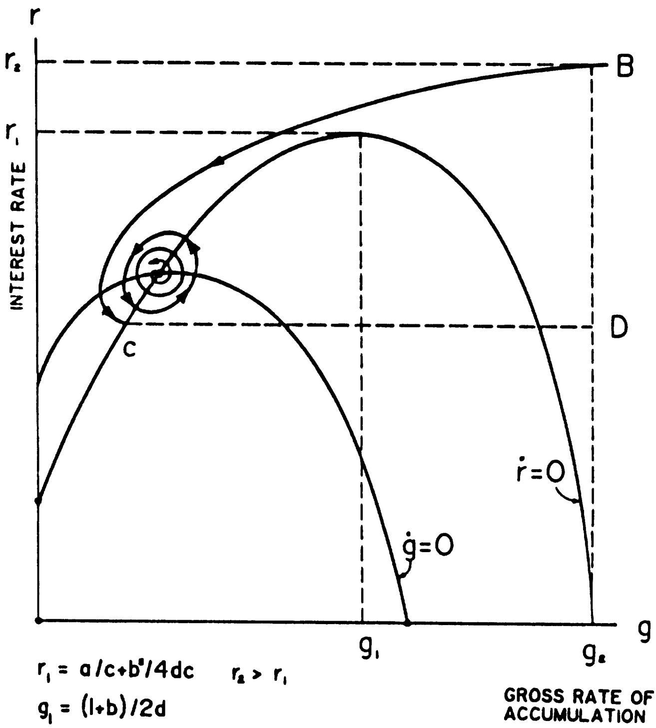
Figure 1



growth rates are increasing and interest rates are falling (because potential credit supply is growing faster than demand) conditions in the credit market ultimately change. Demand grows faster than potential supply at the going rate of interest, which causes that rate to rise. This eventually causes the growth rate to decline. The decreases in the growth rate do not induce collapse. After the growth rate has declined sufficiently, so does the rate of interest. This relieves negative pressure on accumulation, as opportunity costs decline. In itself, this would not prevent collapse in a world where effective demand is an issue. Indeed, what prevents total collapse of aggregate demand in this model is the assumption that long-term investment plans remain steady. That is, the positive value of the coefficient a assures that once the interest rate has declined sufficiently, existing accumulation will again have positive accelerator effects.

The phase diagram in Figure 2 shows that the model generates a lagged pattern of responses between interest rates and accumulation rates. As

Figure 2



the system traverses the cycle orbit, there are segments where the growth rate falls while the interest rate continues to increase. These lags come from the partial adjustment permitted by the investment function, as can be seen from equation (11). For example, when the sum of g and $\dot{g}/g$ are large enough to induce increases in r, it will take time for the negative effects of higher interest rates to reduce the sum.

In summary, it might be said that the oscillatory behavior generated by this model comes from the interaction of real and financial factors. Interest rates determine upper and lower turning points in conjunction with accelerator effects. The financial sector makes its contribution to the cycle not as a source of shocks, but by being less than infinitely accommodating in the upturn, and by aiding the process of accumulation in the downturn. Thus the idea of endogenous credit creation can be used to construct a plausible, non-Monetarist account of business cycles. The interested reader might compare these results to those of Foley (1987), who has produced similar interactions in a simulation model with trade credit; and of Rose (1969), which is neoclassical in orientation and derives its dynamics from disequilibria in goods and money markets.

4. Conclusion

This exercise indicates that the existence of an endogenous, but not purely passive, money supply has important implications for the understanding of capitalist economies. When the idea of endogenous credit is linked to the the theory of effective demand, it is possible to construct examples of business cycles that are endogenously generated and self-sustaining. This extends the range of Goodwin's original growth cycle analysis, since it suggests that monetary as well as reserve army factors can interact with investment decisions to cause fluctuations. It also indicates that policy solutions are likely to be more complex than static models with exogenous money supplies usually suggest. The interaction of financial and industrial capitalists need not cause the economy to converge to a happy equilibrium. It may be the case that a goal of containing inherent instability, rather then actually exerting control, is the best to which policy makers can aspire.

Appendix

1. Construction of phase diagrams.

For the two isoclines to have the shape displayed in Figures 1 and 2, it is necessary that g_1, the value for $\dot{g} = 0$ isocline when $r = 0$, be less than g_2, the value of g for the $\dot{r} = 0$ isocline when $r = 0$. That is, the solution for g from $a + bg - dg^2$ must be less than the solution for g from $[a - \delta - \varepsilon/(\gamma - \beta)] + (b + 1)g - dg^2$. Also both values of g must be positive.

A sufficient condition for $g_2 > g_1$ is that $(2b + 1) > 4d(\delta + \varepsilon/(\gamma - \beta))$, which also assures the non-negative value of g_2. It can be seen that the value of g_1 will be always positive.

Also, in Figure 2 the maximum of $\dot{g} = 0$ is drawn greater than the maximum of $\dot{r} = 0$. It can be shown that this is also a consequence of the sufficient condition for $g_2 > g_1$. The maximum of $\dot{g} = 0$ occurs when $g = b/2d$. Hence the value of r at $g = b/2d$, along the $\dot{g} = 0$ isocline, is $r_1 = [a + b^2/2d]/c$. The value of r at $g = (b+1)/2d$, along the $\dot{r} = 0$ isocline, is $r_2 = [(a + (b+1)^2/2d) - (\delta + \varepsilon/(\gamma\text{-}\beta))]/c$. To have $r_2 > r_1$ requires that $(2b+1)$

$> 2d(\delta + \varepsilon/(\gamma-\beta))$. This condition will be satisfied so long as the sufficient condition for $g_2 > g_1$ is also satisfied.

In general, the isoclines in Figures 1 and 2 are guaranteed by a sufficiently large value of the coefficient *b*, relative to other coefficients.

2. Stability of fixed point A in phase diagrams.

To examine the local stability properties of fixed point *A* in Figures 1 and 2, we need to apply the linearization theorem to the system given by equations (4) and (11). This allows us to treat the elements of the Jacobian

$$J = \begin{bmatrix} \partial\dot{g}/\partial g & \partial\dot{g}/\partial r \\ \partial\dot{r}/\partial g & \partial\dot{r}/\partial r \end{bmatrix}$$

evaluated at the fixed point as if they were coefficients of a linear system. Some calculation shows that

$$J = \begin{bmatrix} bg - 2dg^2 & -cg \\ r\,(\,[b+1]\,\lambda_1 - 2\,\lambda_1 dg) & -\lambda_1 cr \end{bmatrix}$$

At point *A*, the equilibrium value of *g* is $g^* = (\varepsilon + (\gamma - \beta)\delta)/(\gamma - \beta)$, and that of *r* is $r^* = (a + bg^* - dg^{*2})/c$. Hence $Tr(J) = (1 - \lambda_1)bg^* + 2(\lambda_1 - 1)dg^{*2} - \lambda_1 a$ and $Det(J) = \lambda_1 cr^* g^*$. Since $Det(J) > 0$, *A* will not be a saddle point. If $Tr(J) > 0$, it will be unstable. The condition $Tr(J) > 0$ requires that $b > (2dg^{*2} + a\lambda_1)/[1-\lambda_1]g^*$.

3. Relation of stability conditions to geometry of isoclines.

Note that $Tr(J) > 0$ implies that $b > 2dg^*$ when $\lambda_1 < 1$. In this case the phase diagram is as drawn in Figures 1 and 2, since $b > 2dg^*$ implies $(2b + 1) > 4dg^*$, a sufficient condition for $g_2 > g_1$ and $r_2 > r_1$. When $\lambda_1 > 1$, the conditions $Tr(J) > 0$ and $(2b + 1) > 4dg^*$ together will make *A* an unstable point in the phase diagrams. In the examination of the cyclical case of this model, it is assumed that either of these two sets of conditions is being met.

4. Proof of the existence of a limit cycle.

The existence of a limit cycle for this model can be demonstrated by geometric argument. Let $\Phi_t(g(t), r(t))$ be the evolution operator for the system (5), (11), where the operator is defined as a function of the form

$(g(t), r(t)) = \Phi_{t-t*}(g(t^*), r(t^*))$. Knowing the explicit form of Φ_t would require solving (5), (11). However, the qualitative behavior of Φ_t can be known from the phase diagram of the system. For our purposes we are interested in the trajectory $\{\Phi_t(g_1, r_2) | \; t > 0\}$ in Figure 2, which will ultimately intersect the $\dot{g} = 0$ isocline at some point to the right of the vertical axis as shown. This point is labeled *C*. Now in the closed bounded set given by the curve *BCD*—minus the open set containing the locally unstable region around point *A*—there are no fixed points; and it is impossible for a trajectory within the set to exit, since trajectories of a continuous system cannot cross each other. Hence by the theorem of Poincare–Bendixson (Arrowsmith and Place, 1982, pp. 109–10), this closed, bounded positively invariant set contains a limit cycle. A limit cycle is a closed orbit on which motion is self-sustained. There may be more than one such cycle. At least one orbit will be attracting.

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