STEVE KEEN

Finance and economic breakdown: modeling Minsky's "financial instability hypothesis"

From as long ago as 1957, Minsky has argued that an advanced capitalist economy with developed financial institutions is fundamentally unstable, and liable to fall into a depression in the aftermath of a period of debt-financed "euphoria." His strictures were comfortably neglected during the long boom of the 1960s, and even during the oil and Third World debt shocks of the 1970s. However, this hypothesis cannot be ignored after the long period of economic instability ushered in by the crash of 1987. The late 1980s were manifestly a period of euphoria, financial innovation supported the boom, and the desire of both corporations and banks to recover from excessive debt is, to lay observers at least, a major factor in the "jobless recovery" of the early 1990s. Clearly, current economic circumstances warrant a more considered evaluation of Minsky's theories.

This paper models four basic insights of the "financial instability hypothesis" on the foundation of Goodwin's limit cycle model: the tendency of capitalists to incur debt on the basis of euphoric expectations; the importance of long-term debt; the destabilizing impact of income inequality; and the stabilizing effect of government. The introduction of these concepts into Goodwin's framework converts his stable but cyclical system into a chaotic one, with the possibility of a divergent breakdown—the simulation equivalent of a depression.

Keynesian foundations

Minsky's financial instability hypothesis derives from his distinctive reading of Keynes, which is based largely on chapter 17 of *The General*

The author is in the Department of Economics at the University of New South Wales, Kensington, NSW, Australia. He would like to thank Carolyn Currie, Geoff Fishburn, Craig Freedman, Bill Junor, Peter Kriesler and two anonymous referees for comments on this paper.

Theory of Employment, Interest and Money (Keynes, 1936), and the 1937 papers, "The General Theory of Employment" (Keynes, 1937a) and "Alternative Theories of the Rate of Interest" (Keynes, 1937b). Minsky argues that in these papers Keynes developed a perspective on the motive for investment that differs radically from the "marginal efficiency of capital" argument that was the basis for the conventional analysis of investment after Keynes. There are three key facets to Keynes' distinctly expectations-based explanation of investment in these three works: a dual price level; a volatile basis for the formation of expectations, which determines the desire to invest; and a finance-based demand for money, in addition to the traditional triad of transactions, precautionary and speculative demand.

In chapter 17, Keynes argued that investment is motivated by the desire to produce "those assets of which the normal supply-price is less than the demand price" (Keynes, 1936, p. 228), where the demand price was determined by the influences of prospective yields, depreciation, and liquidity preference. This insight was further refined in "The General Theory of Employment," where Keynes talks of the progress toward equilibrium between different prospective investments leading to "shifts in the money-prices of capital assets relative to the prices of money-loans." The concept of two price levels and the focus on capital appreciation as the motive for investment are even more evident in the observation that the scale of production of capital assets "depends, of course, on the relation between their costs of production and the prices which they are expected to realise in the market" (Keynes 1937a, p. 217).

Keynes' discussion of uncertainty in this article is allied to an increased use of the concept of asset prices, and a much diminished status for the marginal efficiency of capital. Keynes associates the latter with the view that uncertainty can be reduced "to the same calculable status as that of certainty itself" via a "Benthamite calculus," whereas the kind of uncertainty that matters in investment is that about which "there is no scientific basis on which to form any calculable probability whatever. We simply do not know" (Keynes, 1937a, pp. 213, 214). Keynes argues that in the midst of this incalculable uncertainty, investors form fragile expectations about the future, which are crystalized in the prices they place upon capital assets, and these prices are therefore subject to sudden and violent change—with equally sudden and violent consequences for the propensity to invest. Seen in this light, the marginal efficiency of capital is simply the ratio of the yield from an asset to its current demand

price, and therefore there is a different "marginal efficiency of capital" for every different level of asset prices (Keynes, 1937a, p. 222).

Keynes' explanation for the formation of expectations under true uncertainty has three components: a presumption that "the present is a much more serviceable guide to the future than a candid examination of past experience would show it to have been hitherto"; the belief that "the existing state of opinion as expressed in prices and the character of existing output is based on a correct summing up of future prospects"; and a reliance on mass sentiment: "we endeavour to fall back on the judgment of the rest of the world which is perhaps better informed" (Keynes 1936, p. 214). The fundamental effect of shifts in expectations is to change the importance attributed to liquidity, thus shifting the apportionment of funds between assets embodying varying degrees of liquidity, with volatile consequences for the level and composition of investment.

Keynes strengthens this increasingly financial focus with the observation that there exists a finance demand for money, which must be exercised and fulfilled before investment is undertaken. Having neglected this concept in the *General Theory*, he argues here that "it is, to an important extent, the 'financial' facilities which regulate the pace of new investment." It is therefore not a lack of savings that inhibits investment, but a lack of finance consequent upon "too great a press of uncompleted investment" (Keynes, 1937b, p. 247).

Potent though these observations of Keynes' may be, they are not as systematic as those in the *General Theory* on the marginal efficiency of capital, let alone as structured as the model in "Mr. Keynes and the Classics" (Hicks, 1937), which led to IS-LM analysis with its static treatment of expectations (Hicks, 1982). Since Keynes adhered to the concept of diminishing returns in the short run, it was difficult for him to explain how the two price levels could diverge; there was no explanation for the state of expectations at any given time, nor for why shifts might occur; there was no integration of the question of expectations with the question of supply of finance, and the notion of an endogenously variable supply of finance sits uneasily with the exogenous view of the supply of money presented in the General Theory. It is therefore little wonder that these insights have not been developed in the conventional literature.

Minsky's contribution has been to codify these insights, with the aim of developing a theory of investment consistent with the occurrence of periodic economic disturbances of the kind experienced in the 1930s

and, arguably, in the 1980s. He has filled the gaps in Keynes' picture by considering the development of expectations over time, within an explicitly monetary framework.

Post Keynesian essentials

Two factors are needed to provide a foundation for Minsky's model—a theory of prices that allows for two price levels and the development of noncorrecting divergence between them in the medium term; and a perspective on the supply of money that is consistent with variations in finance affecting the level of investment.

As a Post Keynesian, Minsky argues that the prices of most (end-consumer) commodities are set by a markup on prime cost (see Reynolds, 1987, pp. 53–62). The largely independent price level of assets—broadly defined as items whose ownership gives rise to claims to a stream of future cash flows—is based, not on the original cost of production of the assets, but on the net present value of anticipated cash flows. These in turn depend on the general state of expectations, which vary systematically over the financial cycle, lagging behind current prices in a slump, running ahead of them in a recovery and boom. Though asset prices must eventually return to some kind of harmony with current prices over the very long term, this perspective allows for significant divergence between the two price levels as expectations rise and fall over the medium term.

Minsky argues that the supply of money is essentially endogenously determined, and provides two reasons why the controls of a regulated system do not make it strictly exogenous. First, if the current regulatory regime limits the supply of finance for investment to less than that desired by the private sector, then intermediation will occur and innovative financial products will be developed, increasing velocity. Second, if a financial institution gets into difficulties, the authorities will normally guarantee its deposits to prevent a "run"; in this case, either the money base will be expanded or the credit multiplier will be increased. In other words, in times of potential financial crisis, the conventional money equation works backwards, from the supply of money to the base and multiplier. The resulting endogenous increase in the money stock then persists through time.

In a deregulated system, where the central bank has influence over only the monetary base and the rediscount rate, expansion of the money supply can occur much more easily, through both increased willingness

of banks to lend—which increases the credit multiplier—and through financial innovation. The more difficult and slower path of intermediation is no longer required (though it can still be practised).

The basic Minsky model

Minsky's analysis of a financial cycle begins at a time when the economy is doing well (the rate of economic growth equals or exceeds that needed to reduce unemployment), but firms are conservative in their portfolio management (debt to equity ratios are low and profit to interest cover is high), and this conservatism is shared by banks, who are only willing to fund cash-flow shortfalls or low-risk investments. The cause of this high and universally practised risk aversion is the memory of a not too distant systemwide financial failure, when many investment projects foundered, many firms could not finance their borrowings, and many banks had to write off bad debts. Because of this recent experience, both sides of the borrowing relationship prefer extremely conservative estimates of prospective cash flows: their risk premiums are very high.

However, the combination of a growing economy and conservatively financed investment means that most projects succeed. Two things gradually become evident to managers and bankers: "Existing debts are easily validated and units that were heavily in debt prospered: it pays to lever" (Minsky, 1982, p. 65). As a result, both managers and bankers come to regard the previously accepted risk premium as excessive. Investment projects are evaluated using less conservative estimates of prospective cash flows, so that with these rising expectations go rising investment and asset prices. The general decline in risk aversion thus sets off both growth in investment and exponential growth in the price level of assets, which is the foundation of both the boom and its eventual collapse.

More external finance is needed to fund the increased level of investment and the speculative purchase of assets, and these external funds are forthcoming because the banking sector shares the increased optimism of investors (Minsky, 1980, p. 121). The accepted debt to equity ratio rises, liquidity decreases, and the growth of credit accelerates.

This marks the beginning of what Minsky calls "the euphoric economy" (Minsky, 1980, pp. 120–124), where both lenders and borrowers believe that the future is assured, and therefore that most investments will succeed. Asset prices are revalued upward as previous valuations

are perceived to be based on mistakenly conservative grounds. Highly liquid, low-yielding financial instruments are devalued, leading to a rise in the interest rates offered by them as their purveyors fight to retain market share.

Financial institutions now accept liability structures for both themselves and their customers "that, in a more sober expectational climate, they would have rejected" (Minsky, 1980, p. 123). The liquidity of firms is simultaneously reduced by the rise in debt to equity ratios, making firms more susceptible to increased interest rates. The general decrease in liquidity and the rise in interest paid on highly liquid instruments triggers a market-based increase in the interest rate, even without any attempt by monetary authorities to control the boom. However, the increased cost of credit does little to temper the boom, since anticipated yields from speculative investments normally far exceed prevailing interest rates, leading to a decline in the elasticity of demand for credit with respect to interest rates.

The condition of euphoria also permits the development of an important actor in Minsky's drama, the Ponzi financier (Minsky, 1982, pp. 70, 115; Galbraith, 1954, pp. 4–5). These capitalists profit by trading assets on a rising market, and incur significant debt in the process. The servicing costs for Ponzi debtors exceed the cash flows of the businesses they own, but the capital appreciation they anticipate far exceeds the interest bill. They therefore play an important role in pushing up the market interest rate, and an equally important role in increasing the fragility of the system to a reversal in the growth of asset values.

Rising interest rates and increasing debt to equity ratios eventually affect the viability of many business activities, reducing the interest rate cover, turning projects that were originally conservatively funded into speculative ones, and making ones that were speculative "Ponzi." Such businesses will find themselves having to sell assets to finance their debt servicing—and this entry of new sellers into the market for assets pricks the exponential growth of asset prices. With the price boom checked, Ponzi financiers now find themselves with assets that can no longer be traded at a profit, and levels of debt that cannot be serviced from the cash flows of the businesses they now control. Banks that financed these assets purchases now find that their leading customers can no longer pay their debts—and this realization leads initially to a further bank-driven increase in interest rates. Liquidity is suddenly much more highly prized; holders of illiquid assets attempt to sell them in return for liquidity. The

asset market becomes flooded and the euphoria becomes a panic, the boom becomes a slump.

As the boom collapses, the fundamental problem facing the economy is one of excessive divergence between the debts incurred to purchase assets, and the cash flows generated by them—with those cash flows depending upon both the level of investment and the rate of inflation. The level of investment has collapsed in the aftermath of the boom, leaving only two forces that can bring asset prices and cash flows back into harmony: asset price deflation, or current price inflation. This dilemma is the foundation of Minsky's iconoclastic perception of the role of inflation, and his explanation for the stagflation of the 1970s and early 1980s.

Minsky argues that if the rate of inflation is high at the time of the crisis, then though the collapse of the boom causes investment to slump and economic growth to falter, rising cash flows rapidly enable the repayment of debt incurred during the boom. The economy can thus emerge from the crisis with diminished growth and high inflation, but few bankruptcies and a sustained decrease in liquidity. Thus, though this course involves the twin "bads" of inflation and initially low growth, it is a self-correcting mechanism in that a prolonged slump is avoided. However, the conditions are soon reestablished for the cycle to repeat itself, and the avoidance of a true calamity is likely to lead to a secular decrease in liquidity preference.

If the rate of inflation is low at the time of the crisis, then cash flows will remain inadequate relative to the debt structures in place. Firms whose interest bills exceed their cash flows will be forced to undertake extreme measures: they will have to sell assets, attempt to increase their cash flows (at the expense of their competitors) by cutting their margins, or go bankrupt. In contrast to the inflationary course, all three classes of action tend to further depress the current price level, thus at least partially exacerbating the original imbalance. The asset price deflation route is, therefore, not self-correcting but rather self-reinforcing, and is Minsky's explanation of a depression.

The above sketch basically describes Minsky's perception of an economy in the absence of a government sector. With big government, the picture changes in two ways, because of fiscal deficits and Reserve Bank interventions. With a developed social security system, the collapse in cash flows that occurs when a boom becomes a panic will be at least partly ameliorated by a rise in government spending—the classic "automatic stabilizers," though this time seen in a more monetary light. The

collapse in credit can also be tempered or even reversed by rapid action by the Reserve Bank to increase liquidity. With both these forces operating in all Western economies since World War II, Minsky expected the conventional cycle to be marked by "chronic and . . . accelerating inflation" (Minsky, 1982, p. 85). However, by the end of the 1980s, the cost pressures that coincided with the slump of the early 1970s had long since been eliminated, by fifteen years of high unemployment and the diminution of OPEC's cartel power. The crisis of the late 1980s thus occurred in a milieu of low inflation, raising the specter of a debt deflation.

Modeling Minsky

A complete modeling of Minsky's hypothesis would require a model of considerable complexity. However, the essence of Minsky's analysis—the proposition that in a capitalist economy with finance, an endemic tendency toward euphoric expectations will generate both cycles and a secular trend of rising debt, leading ultimately to a debt-induced crash—can easily be modeled by introducing a prototypal "real" finance sector and two "stylized facts" into Goodwin's 1967 model of the trade cycle (Goodwin, 1982).

Goodwin's model is driven by the single stylized fact that workers are more likely to demand real wage rises during times of high employment than during times of high unemployment—a "Phillips curve." The adaptation that follows introduces a similar stylized fact for capitalists, that they are more willing to invest during booms than during slumps. When a banking sector is introduced, the interest rate is treated as consisting of a base rate determined by external fiat, and a variable component reflecting an increasing risk premium as the debt to output ratio rises. This tempers the extreme "horizontalist" (see Moore, 1988) position of the model, in that otherwise the finance sector is treated as having an unlimited capacity to finance capitalist investment.[1]

[1] A more complete model would have bank financial reserves being related to past and present capitalist profits, with a variable money multiplier expanding and contracting the finance these profits can generate. However, the model as specified allows us to focus on the basic antinomy between profits, investment, and long-term debt. Its openness only becomes an issue when the system approaches breakdown—at which time it indicates that capitalists can afford to finance exponentially increasing debt, when in fact they would go bankrupt. The modeling of bankers' income also abstracts from the fact that bankers make their profit on the spread between deposit and loan interest rates.

The following equations define the basic Goodwin model and the finance extension[2]:

$a = a_0 \times e^{\alpha t}$ = Exponential growth of disembodied labour productivity;

$N = N_0 \times e^{\beta t}$ = Exponential growth of the labour force;

$Y = a \times L$ = Output decisions of capitalists determine employment, given productivity;

$K = \nu \times Y$ = A fixed accelerator relation;

$\lambda = \frac{L}{N}$ = The employed fraction of the work force;

$\frac{dw}{dt} = w[\lambda] \times w$ = The rate of change of real wages is a nonlinear function of the rate of employment;

$I = \frac{dK}{dt} = k\left[\frac{\Pi}{K}\right] \times Y - \gamma \times K$ = Net investment is a function of profit times the level of output minus depreciation.

A functional form is needed for the wage change and investment functions for the subsequent numerical simulations. The equation used is generalized from that first suggested by Blatt (1983, p. 213). It has the desired characteristics of nonlinearity, falling to a near constant level at low levels of the triggering variable, and rising asymptotically at high levels.

For the wage change function, the equation is $w(\lambda) = (A/[(B - C \times \lambda)^2) - D$, which given the parameter values used ($A = 0.0000641$; $B = 1$; $C = 1$; $D = 0.0400641$), results in workers accepting a constant real wage at an unemployment rate of 3.6 percent, accepting real wage cuts at higher levels of unemployment (to a maximum of 4 percent per period), and demanding real wage rises at lower rates (rising asymptotically at full employment).

Capitalist investment is modeled using the same functional form,

[2] In the following numerical simulations, the parameter and initial values used are: $a = 1$, $N = 100$, $\alpha = 0.015$, $\beta = 0.035$, $\gamma = 0.02$, $\nu = 3$, $\lambda = 0.9$, $\omega = 0.96$.

$$k\left[\frac{\pi}{\nu}\right] = \frac{E}{(F - G \times \frac{\pi}{\nu})^2} - H, \pi \geq 0 .$$

With the parameter values used (E = 0.0175; F = 0.53; G = 6; H = 0.065), investment is zero at and below zero profit, rising to equal profits when the profit share is 10 percent, and exceeding profits for higher profit shares (figure 1).

Continuing with the definitions:

$\frac{\Pi}{K} = \frac{\Pi}{\nu \times Y} = \frac{\pi}{\nu}$ = The rate of profit equals profit share over the accelerator;

$\pi = 1 - \omega - b$ = Profit share is a residual after workers and bankers income;

$\omega = \frac{W}{Y} = \frac{w \times L}{L \times a} = \frac{w}{a}$ = The wages share of national income;

$b = \frac{B}{Y} = \frac{r \times D}{Y}$ = Bankers income is the interest rate times outstanding debt;

$\frac{dD}{dt} = r \times D + I - \Pi$ = Capitalists use debt solely to finance investment;

$r = \zeta + \varphi \times \frac{D}{Y}$ = The interest rate is a linear function of the debt to output ratio.

The derivation is as follows:

$\frac{dY}{dt} = \frac{d}{dt}\frac{K}{\nu} = \left(\frac{k\left[\frac{\pi}{\nu}\right]}{\nu} - \gamma\right) \times Y$ = The rate of change of output;

$\frac{dL}{dt} = \frac{d}{dt}\frac{Y}{a} = \frac{1}{a} \times \left(\frac{dY}{dt} - \alpha \times Y\right)$ = The rate of change of employment;

$$\frac{d\lambda}{dt} = \frac{d}{dt}\frac{L}{N} = \lambda \times \left(\frac{k\left[\frac{\pi}{\nu}\right]}{\nu} - \alpha - \beta - \gamma \right) = \text{The rate of change of the employment rate;}$$

$$\frac{d\omega}{dt} = \frac{d}{dt}\frac{w}{a} = \omega \times (w(\lambda) - \alpha) = \text{The rate of change of workers' share of output;}$$

$$\frac{dd}{dt} = \frac{d}{dt}\left(\frac{D}{Y}\right) = b - \pi - (\nu - d) \times \left(\frac{k\left(\frac{\pi}{\nu}\right)}{\nu} - \gamma \right) = \text{The rate of change of the debt ratio;}$$

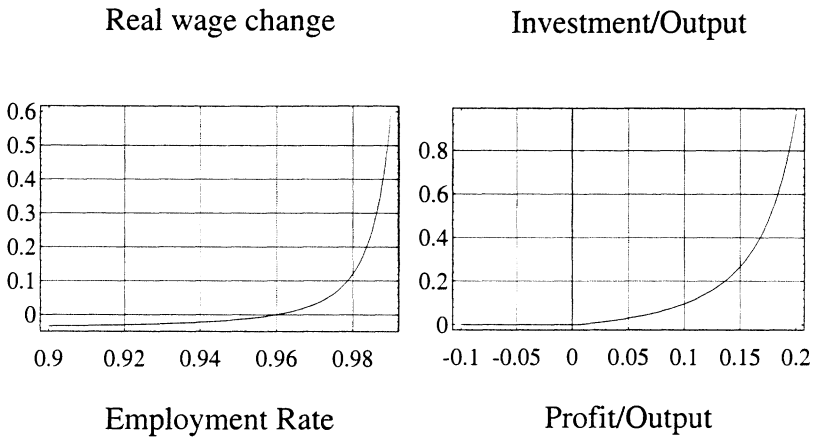
$$\frac{db}{dt} = \frac{d}{dt}\frac{r \times D}{Y} = (\varphi \times d + r) \times \left(b - \pi - (\nu - d) \times \left(\frac{k\left(\frac{\pi}{\nu}\right)}{\nu} - \gamma \right) \right) = \text{The rate of change of bankers share.}$$

Simulations

Basic Goodwin limit cycle

In the basic Goodwin system, where $k\,[\pi/\nu] = 1 - \omega$, the equations for $d\lambda/dt$ and $d\omega/dt$ are sufficient to describe the behavior of the system. With capitalists passively investing all their profits, the driving force in the model is the reaction of workers to the level of employment, as expressed in the rate of change of the wages share of output, ω. An initially above-equilibrium level of wages share results in less investment than is needed to sustain the rate of output growth above the growth of the work force, and hence employment falls. Workers accept wage cuts, resulting in a higher profit share, increasing investment and faster output growth, which eventually reverses the decline in employment. However, workers' share of output continues to fall for a while since employment is still below the level at which workers demand a constant real wage, leading to still higher investment, growth, and eventually extreme demands for higher real wages. The initial conditions are thus restored and the cycle repeats. The same fundamental condition applies

Figure 1 Behavioral functions for workers and capitalists



when the propensity to invest function replaces the presumption that all profits are invested. The major change is that the cycles are more frequent (figure 2).[3]

The essentially stable nature of this model can be seen in the phase diagram in figure 3, which shows the time paths in employment and wages share emanating from four different sets of initial conditions, two of which generate equilibrium outcomes, and two of which generate cycles.

Finance and instability

The introduction of a finance sector means that capitalists can borrow to finance their investment plans, and hence accumulate long-term debt. This possibility fundamentally alters the nature of the model: a stable limit cycle is replaced by either of two possibilities, given the values of key parameters: a system that tends to stability, or a system that "breaks down," by achieving an unsustainable debt to output ratio. In the following simulations, the key parameter whose value is varied is the interest rate. Two kinds of variations are considered: an increase in the base rate (corresponding to conventional governmental action to control

[3] While time in this model is clearly historic (in that the time path of the system is crucial), it is in no way intended to match actual time. The objective of the modeling is to capture aspects of the cyclical behavior and stability properties of an actual economy, but not to accurately quantify this behavior. One of the lessons of nonlinear dynamics is that such accurate quantification is in fact impossible. The emphasis of modeling therefore shifts from prediction to simulation.

Figure 2 Wage share and employment, basic Goodwin model

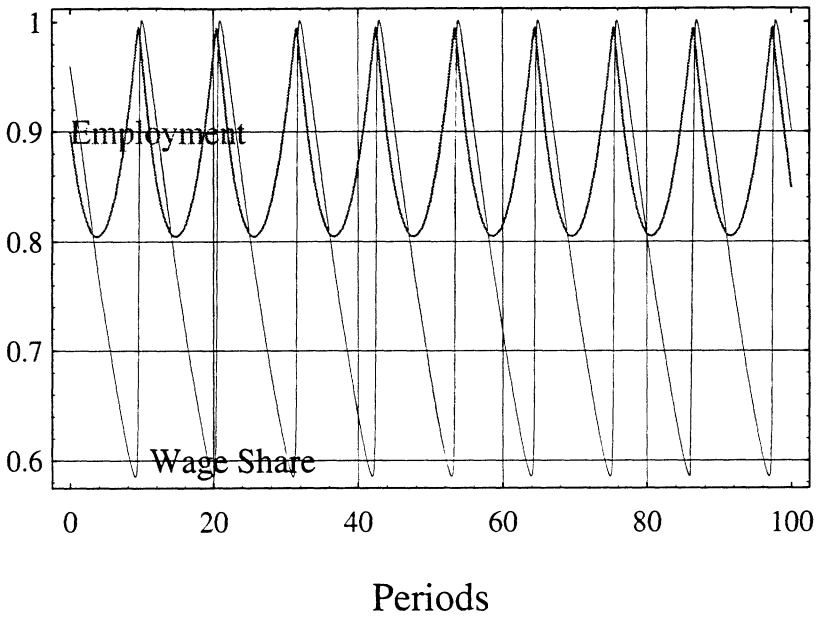
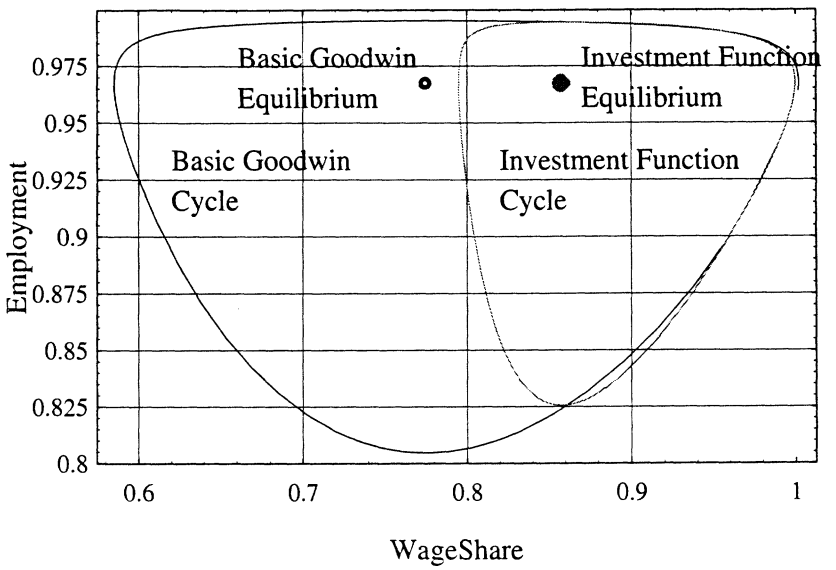


Figure 3 Cyclical and equilibrium time paths



an overheated economy using monetary policy), given zero bank sensitivity to the debt to output ratio; and different levels of bank sensitivity to the debt to output ratio, given a constant base rate.

Base rate variations

Stability

With the parameter values used in these simulations, a base rate of less than 4.6 percent results in a system which, over time, approaches a stable equilibrium. At this level of the rate of interest, the interest payments occasioned by the growth in debt (which results from capitalists borrowing to finance investment during booms) gradually attenuate the level the booms reach. This results in capitalist investment cyclically tapering down to a level at which the ratio of debt to output stabilizes. Constant income shares then ensue for the three "classes" in the model—workers, capitalists, and bankers—and the system thereafter grows at a steady pace (see figures 4–6).

A phase space diagram (figure 6) with three dimensions (workers' share of output, bankers' share, and the employment rate) now replaces the workers' income/employment phase space of the basic Goodwin system. The dynamics of the above route to stability are graphically apparent in the figure.

Instability—rising debt with a wages blowout: At a base interest rate of 4.6 percent or above, a different dynamic emerges. An initially low level of workers' share and zero bankers' share leads to high investment and rapid growth of employment. The investment is financed by borrowing, resulting in a rise in bankers' share. The increased employment eventually results in sharply rising workers' share, which, coming on top of a rise in bankers' share, reduces profit and results in a fall-off in investment. The reduced investment leads to lower employment, which initially tempers and then reverses the increase in workers' share. In the early stage of the cycle, profits then exceed investment, resulting in some bank debt being repaid and hence a falling bankers' share. The decline in bankers' and workers' share restores capitalist profits, but since bank debt has not been completely repaid, the cycle is not as extreme when it next repeats.

However, rather than the cycle being damped away, the higher rate of interest leads to the formation of a wage-employment vortex, where bankers' share continues to grow rather than reaching a plateau. From

Figure 4 Employment and wage share at low interest

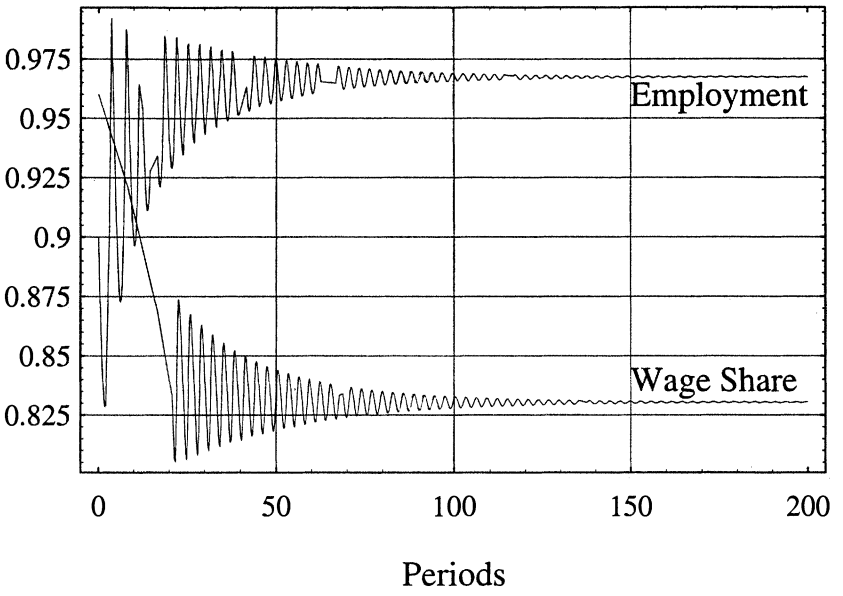


Figure 5 Profit, investment, and bank share at low interest

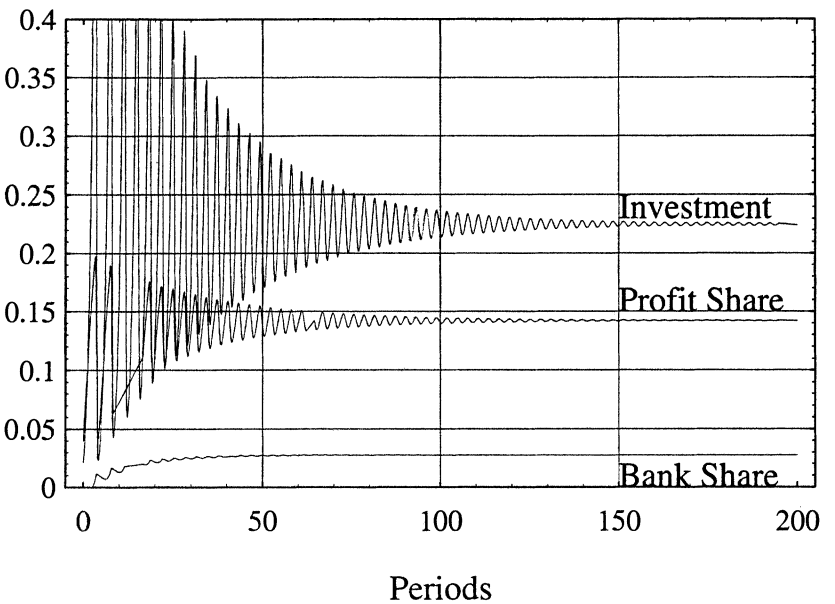
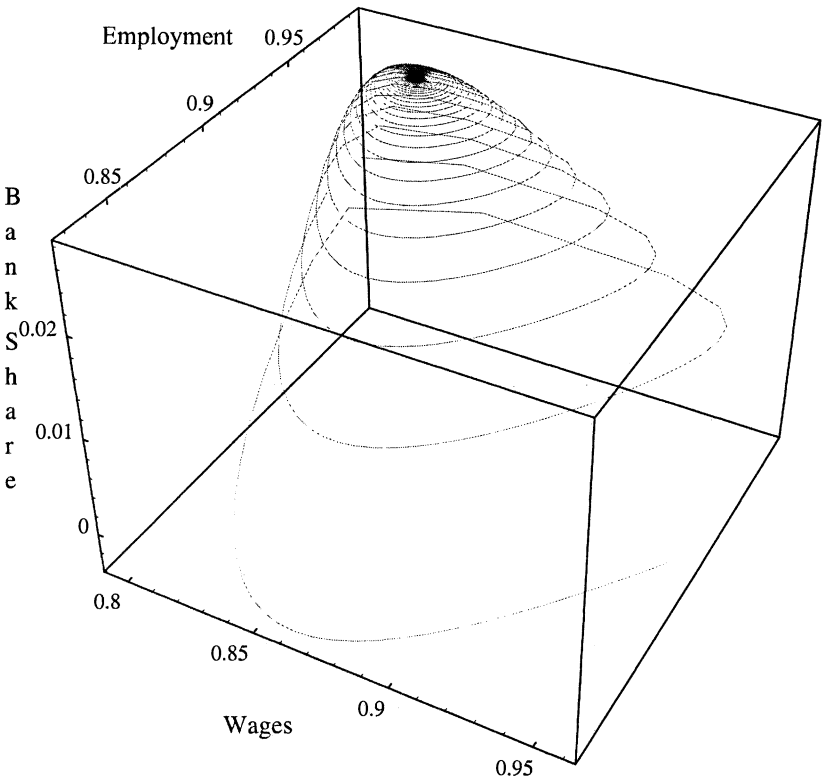
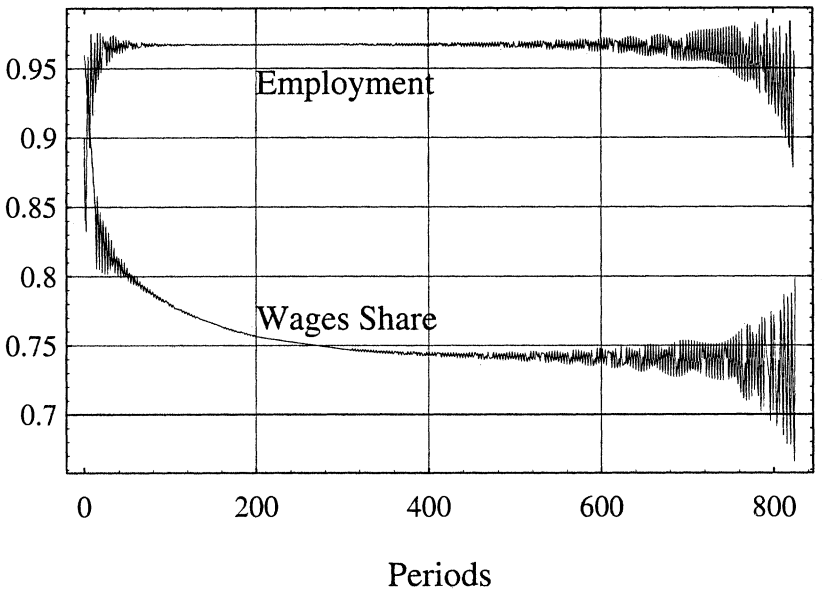


Figure 6 Income and employment stability at low interest



this point on, the rise in bankers' share causes a fall in investment, leading to a drop in employment and hence a (slightly sharper) fall in workers' share. This causes an increase in profits and hence investment, leading to further debt and a rise in bankers' share again. Rather than attenuating, the cycles now become more intense, with the strong fall in workers' share causing a big growth in profits, a commensurately larger surge in investment (given the nonlinear investment function), a further increase in debt, then the increase in workers' share due to increased employment (and the nonlinear wage change function), and a renewal of the cycle at a higher pitch. Eventually the boom is so extreme that the extra debt incurred results in profits falling and remaining below zero, given the level of debt that has been accumulated. The system then collapses toward zero employment, wages, and profits, with bankers' share spiraling ever upward. It is now in a debt-induced breakdown,

Figure 7 Instability at "high" interest



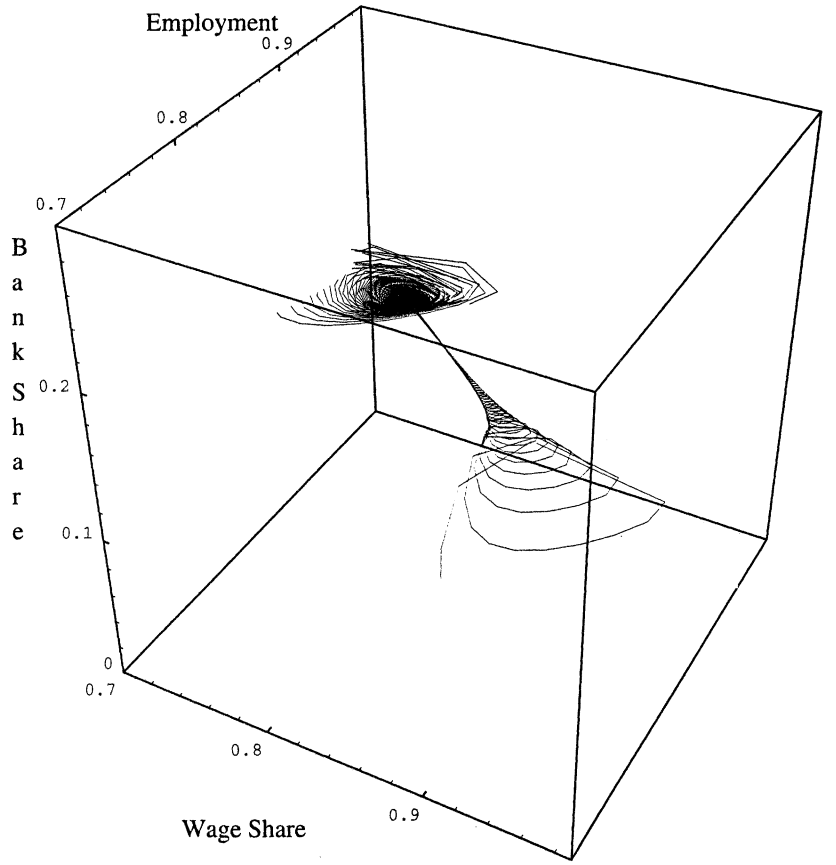
from which—without a change in the rules, such as a debt moratorium—it cannot escape (figures 7 and 8).

Debt sensitivity variations

At a low level of sensitivity to debt and a base rate that of itself leads to stability, a variable interest rate causes the model to stabilize rapidly. Higher levels of debt sensitivity lead to a quite different form of breakdown than results from increases in the base rate (figures 9 and 10). Whereas a high base rate of interest set in train forces that led to an extreme investment boom, followed by an extreme wages blowout and then a collapse, the collapse with high debt sensitivity is precipitated by a very low key investment "boom" and only a temporary reversal of a secular trend to a falling wages share.

The falling workers' share sustains profits at a level at which the excess of investment over profits causes the debt to output ratio to rise over time. This leads to a rising rate of interest and a rising bankers share of output, whose dampening effects on capitalist investment are, for some time, balanced by the falling workers' share. An increase in the pace of decline in workers' share provides an additional boost to profits, hence

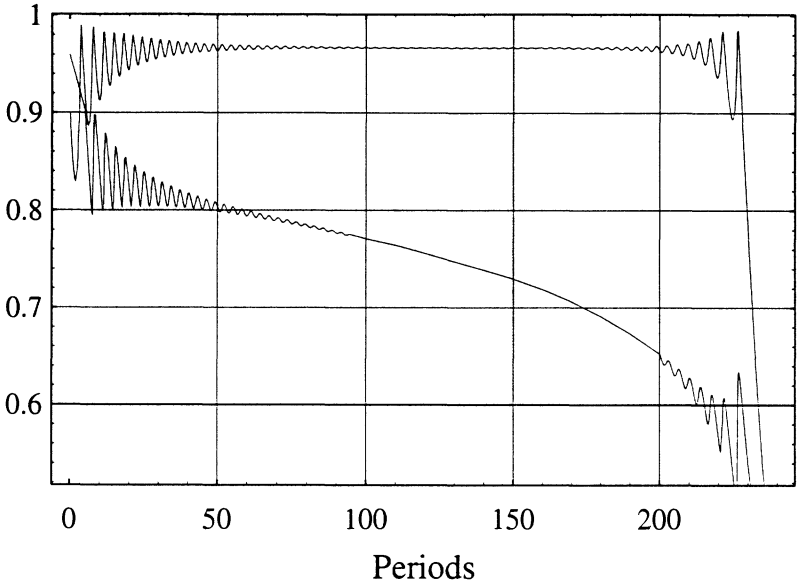
Figure 8 Instability at "high" interest



causing a minor investment boom (which causes a minor boost to employment and momentarily checks the fall in the workers' share of output). The combination of a momentary pause in the fall of workers' share of output with an investment-induced rise in the growth of the debt ratio and an acceleration of the rate of growth of the rate of interest, leads to the rate of growth of bankers share exceeding the rate of decline of workers share. The residual, the rate of profit, drops below zero and the model breaks down.

The phase diagram shows the more muted dynamics of this system (figure 10). The initial behavior is similar to the high base rate case; however, the dual force of the rise in the debt ratio (which itself drives the interest rate higher) and the rising interest rate, results in a greater rate of

Figure 9 Debt sensitivity driven crisis



acceleration of bankers' share, with little variation in the cyclical behavior of wages and employment. Eventually, the interest payable on outstanding debt exceeds the profits of capitalists, leading to zero investment and a final collapse of wages, employment, and output.

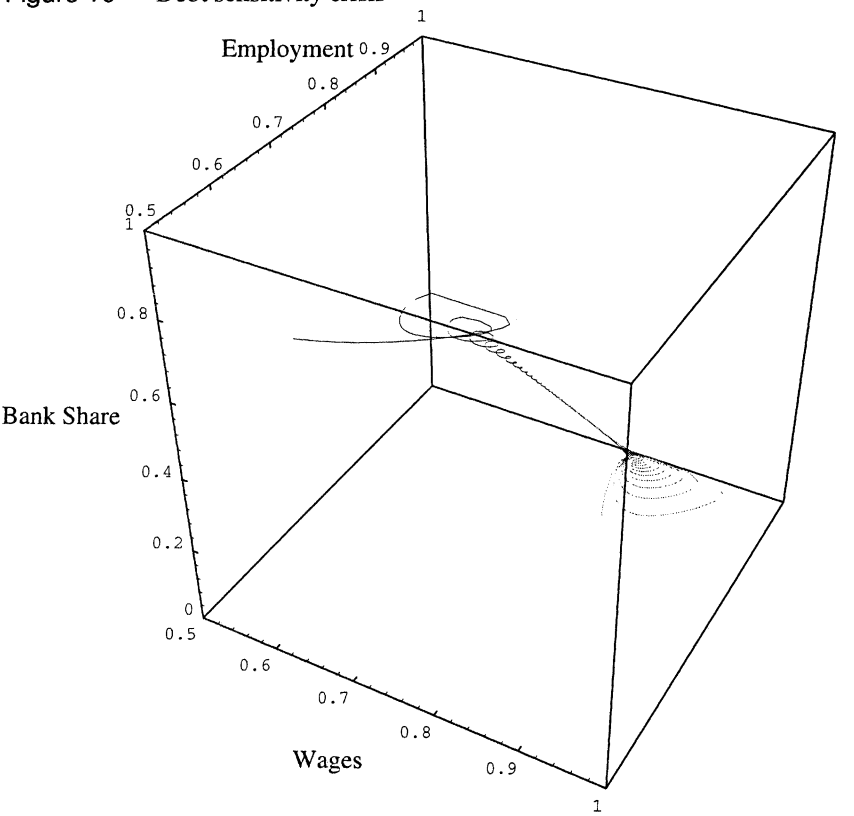
Minksian government: stabilizing an unstable economy

From a Minskian perspective, the essential role of government is to stabilize the economy by (a) preventing capitalist expectations from going into euphoria during booms, and (b) boosting cash flows to enable capitalists to repay debts during slumps. This notion of government can be introduced with two further nonlinear functions, one relating the rate of change of government spending to unemployment, the other relating the rate of change of taxation (of capitalists only) to the level of profits.[4] This extension to the model requires some redefinitions, as well as several new equations:

$\pi = 1 - \varpi$ = Gross profit term reverts to its prebanking form;

[4] The same functional form is used as before, with *i,j,k,l* and *m,n,o,p*, respectively, taking the place of *a,b,c,d* in the real wage change function. In these simulations, $i = 0.05, j = 1.2, k = 4, l = 0.05, m = 0.0175, n = 0.83, o = 5, p = 0.039$.

Figure 10 Debt sensitivity crisis



$\pi_n = 1 - \varpi - t + g \times d_k$ = Profit net of government and interest payments is the basis for capitalist investment decisions;

$\frac{dG}{dt} = g\,(1 - \lambda) \times Y$ = The rate of change of government spending is a function of unemployment;

$\frac{dT}{dt} = t\,(\pi) \times Y$ = The rate of change of taxation is a function of the rate of profit.

The impact of government debt on the rate of growth of overall debt is instructive: it does not alter the expression, but instead "redistributes" debt between private and public sectors:

Figure 11 Government behavioral functions

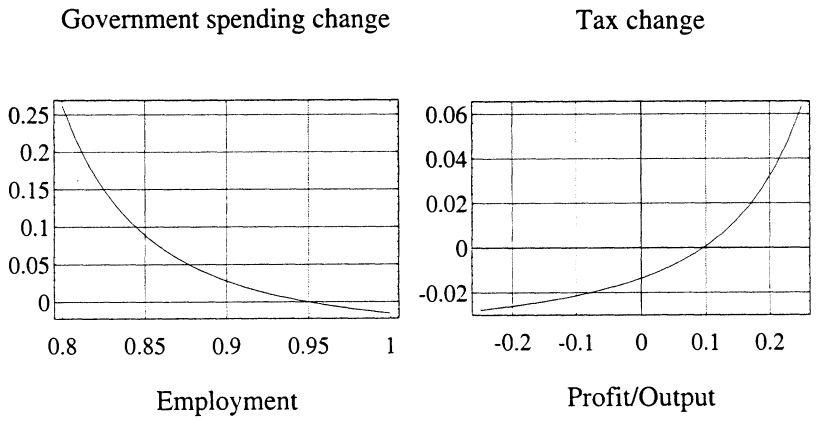
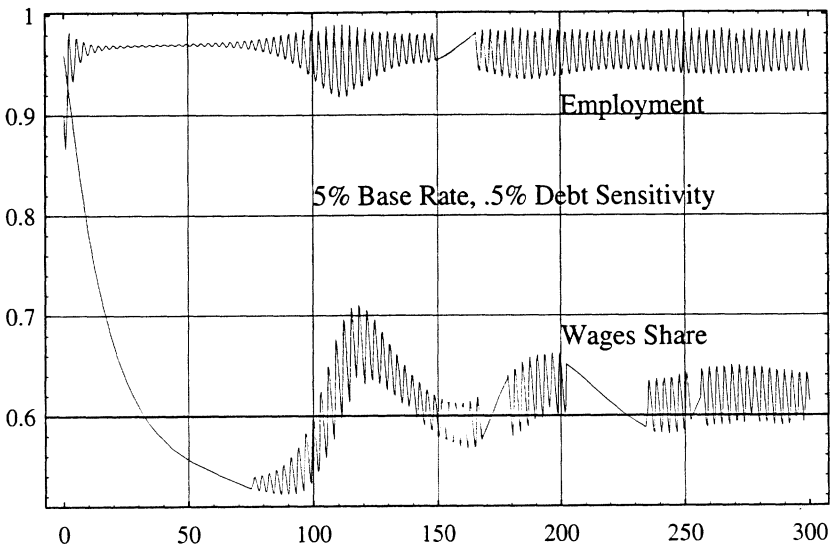


Figure 12 Persistent cycles with government



$$\frac{dD}{dt} = \frac{dD_k}{dt} + \frac{dD_g}{dt}$$

$$= (r \times D_k + I - \Pi + T - G) + (r \times D_g + G - T) = r \times D + I - \Pi .$$

Private investment decisions, however, are now based on significantly attenuated profits and losses, so that the time path of the simulation is significantly different.

The final system consists of six differential equations: the original

equations for employment and workers' share of output (with the investment function now depending upon net profit), plus new equations for the rates of change of government spending, taxation, government, and capitalist debt (which has replaced bankers' share of output as a determinant of net profits):

$$\frac{dg}{dt} = \frac{d}{dt}\frac{G}{Y} = g(1-\lambda) - g \times \left(\frac{k\left(\frac{\pi n}{\nu}\right)}{\nu} - \gamma \right) = \text{The rate of change of government spending as a proportion of output;}$$

$$\frac{dt}{dt} = \frac{d}{dt}\frac{T}{Y} = t(\pi) - t \times \left(\frac{k\left(\frac{\pi n}{\nu}\right)}{\nu} - \gamma \right) = \text{The rate of change of taxation as a proportion of output;}$$

$$\frac{dd_k}{dt} = \frac{d}{dt}\frac{D_k}{Y} = r \times d_k + (\nu - d_k) \times \left(\frac{k\left(\frac{\pi n}{\nu}\right)}{\nu} - \gamma \right) - (\pi - t + g) = \text{The rate of change of capitalist debt;}$$

$$\frac{dd_g}{dt} = \frac{d}{dt}\frac{D_g}{Y} = d_g \times \left(r - \left(\frac{k\left(\frac{\pi n}{\nu}\right)}{\nu} - \gamma \right) \right) + (g - t) = \text{The rate of change of government debt.}$$

The government sector plays the role of a countercyclical stabilizer to the profit-driven investment behavior of capitalists. When falling worker and/or banker shares cause profit to approach levels that previously induced "euphoric" levels of investment, rapidly rising taxation and rapidly falling government expenditure reduce net profit; when rising worker and/or banker shares induce an investment slump, diminished taxation and increased government expenditure boost capitalist net income, enabling debts to be serviced.

Government intervention greatly diminishes the possibility of complete breakdown, but it does not eliminate cycles. Instead, the system displays apparently random, irregular cycles (figure 12).

The economic interpretation of this apparently bizarre behavior is that the objectives of the various economic actors are not consistent. In particular, in this simulation, the government spending function (which

is directed at alleviating unemployment) does not have the same stable point as the taxation function (which is directed at preventing excessive investment levels). The product of countercyclical behavior—taxes rising and subsidies falling when profits (and hence investment) are rising, vice versa when employment is falling—is cyclical stability, as the system passes endlessly and ever more regularly from near the employment to near the investment target. The truly countercyclical operation behavior of the government sector can be seen in the public/private sector plots in figure 13.

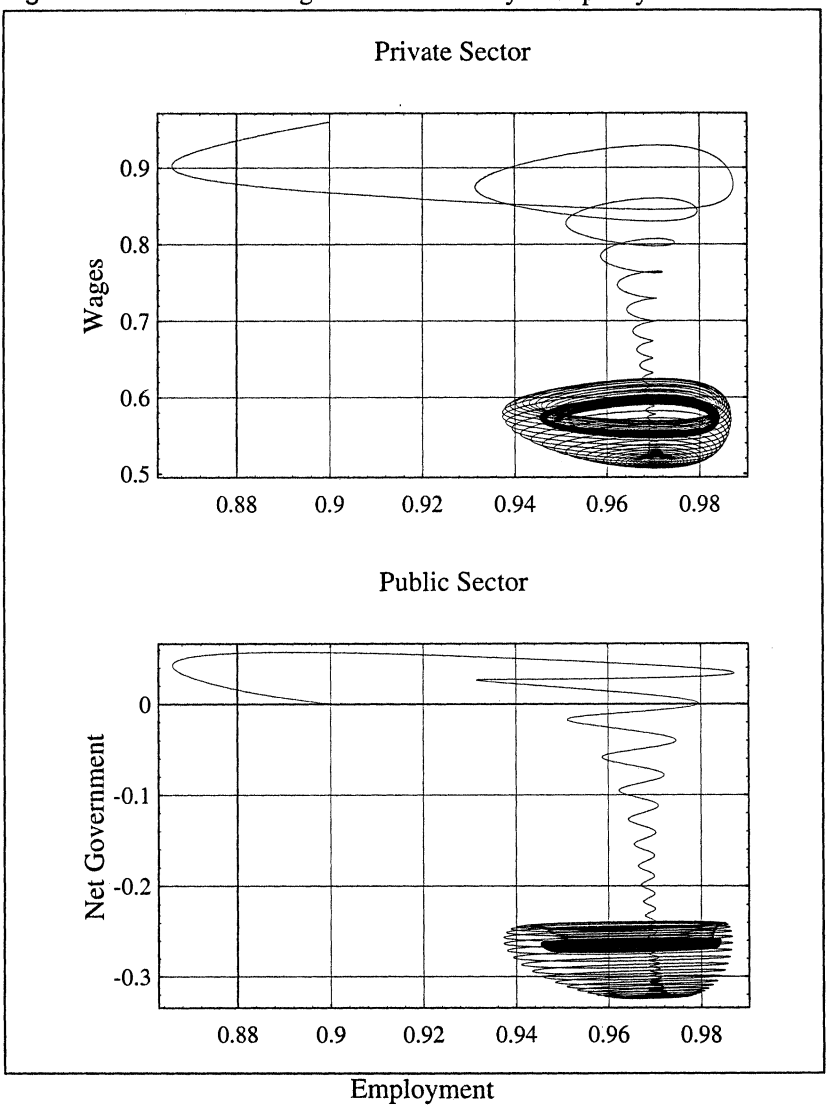
From the perspective of chaotic dynamics, the introduction of a government sector converts the system from a three-dimensional system—which had a stable fixed point attractor only while the interest rate was below the critical level, and which above this level, necessarily progressed toward breakdown—to a six-dimensional system. This introduces the likelihood of complex attractor behavior, with interactions we can no longer visualize (since we can only "see" three dimensions) causing a phase plot to move from one orbit around an apparent equilibrium point to another distinct orbit, and then back again. Sustained irregular cyclical behavior is therefore, somewhat paradoxically, a probable consequence of successful stabilization policy. However, as is crucial from the point of view of the financial instability hypothesis, this prevented a debt-induced breakdown at levels of the rate of interest that previously caused a breakdown (figure 14).

The final outcome, for a wide range of interest rates and initial conditions, was a cyclical attractor (see Lorenz, 1993, p. 35) between wage share and employment. Unlike the rigid two-dimensional limit cycle of the basic Goodwin model, this is in fact the consequence of a complex balance between the opposing forces underlying the simulation—the procyclical behavior of workers and capitalists, the "memory" function of banks and long-term debt, and the two-dimensional countercyclical behavior of government (with taxation based on income shares, and spending based on employment) (figure 15). The catastrophic simulations of the previous section can be seen, in contrast, as indicating the behavior of an economy lacking the crucial homeostatic input of government intervention.

Actual government?

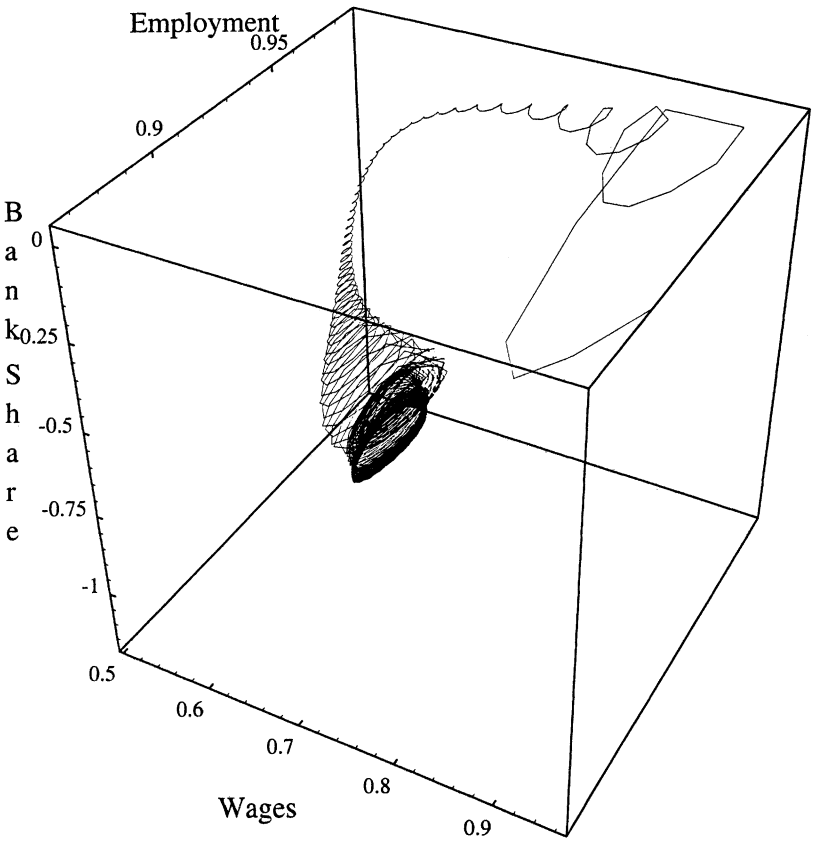
The above simulations establish that a government that behaves as a countercyclical force can greatly diminish the possibility that a capitalist

Figure 13 The stabilizing effect of countercyclical policy



economy with sophisticated finance will experience a depression. However, actual governments do not necessarily behave in this fashion: over the last thirty years, Western governments have adopted policies antithetical to the countercyclical role they largely followed in the 1950s and 1960s. In particular, they have lessened the progressiveness of income tax scales, so that in contrast to the model explored above, the rate of change of the tax rate to income $[(d/dt)\ (T/Y)]$ is roughly zero.

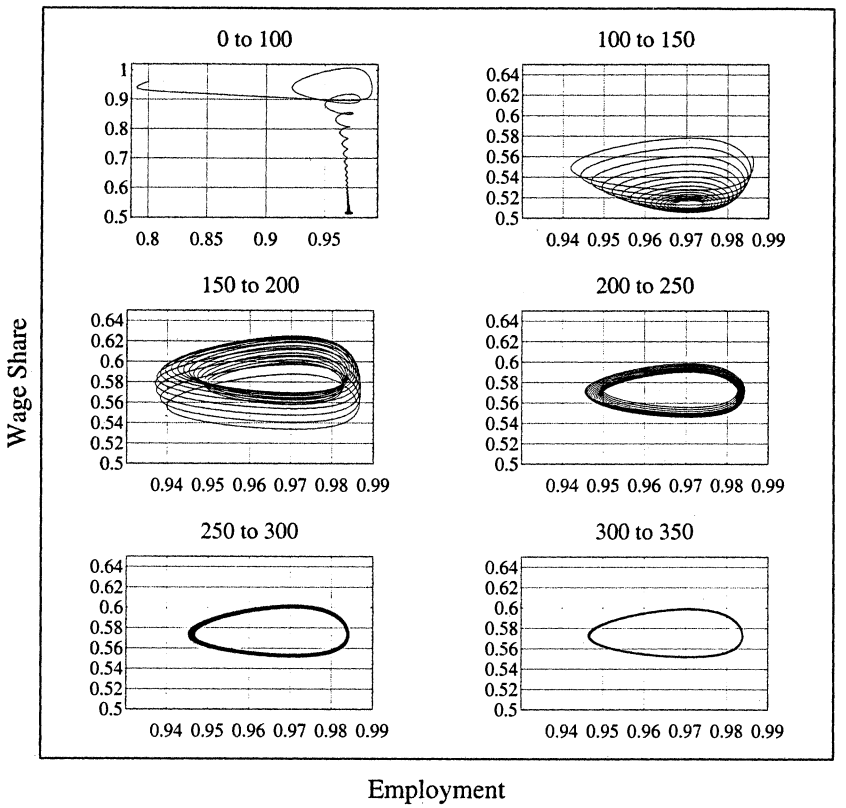
Figure 14 Complexity with government, but no breakdown



While discretionary spending has also been reduced, the existence of social security systems has meant that there is still a positive relation between the level of unemployment and the rate of change of the government spending to output ratio.

Space does not allow these issues to be fully explored in this paper. But it does appear that such a form of intervention would not attenuate the investment behavior of capitalists, with the consequence that booms would be as marked as in the nongovernment simulation. Debt-induced breakdowns would thus still occur. Increased government spending during slumps would enable recovery in the aftermath to lesser booms;

Figure 15 Cyclical stability with government



larger booms, however, could result in the rate of growth of accumulated private debt exceeding net profits for some time, thus leading to a prolonged slump. It also appears probable that a government behaving in this fashion would over time accumulate a deficit, rather than the surplus accumulated in the above Minskian simulations.

Conclusion

Minsky's ambition in constructing the financial instability hypothesis was to build a theory that "makes great depressions one of the possible states in which our type of capitalist economy can find itself" (Minsky, 1982, p. xi). His purpose was to find "an apt economic theory for our

economy" (p. 68), since it was a manifest fact that capitalist economies periodically find themselves in such a state.

This very simplified model of a capitalist economy with finance, which has been constructed via "stylized fact" extensions to Goodwin's growth cycle model, is able to demonstrate this key prediction of Minsky's hypothesis. Using plausible values for real interest rates, capitalist expectations of profit during booms can lead them to incur more debt than the system is capable of financing. The breakdown that occurs is analogous to a debt-induced depression in an actual economy. When such an event occurs, the model indicates a forever-increasing level of capitalist indebtedness. In the real world, however, the system continues but with some form of breakdown: some capitalists go bankrupt, many lenders write off bad debts and suffer capital losses.

The two types of breakdown follow paths predicted by Minsky. In the high base rate case, booms, which were unproblematic early in the simulation, become destabilizing later because of the increased debt to output ratios that develop over time. This corresponds with Minsky's predictions of a secular trend toward rising debt to equity ratios as the memory of the previous major crisis recedes, which makes the system more fragile.

In the high debt sensitivity case, falling workers' share and rising bankers share (at a slightly slower rate) lead to a minor speculative boom which, occurring at a time of greatly increased debt, leads to a runaway blowout in debt. In effect, a rise in income inequality (between workers and capitalists) leads to a period of instability and then collapse, a concept explored in Minsky (1986).

In both cases, a long period of apparent stability is in fact illusory, and the crisis, when it hits, is sudden—occurring too quickly to be reversible by changes to discretionary policy at the time. As is evident from the phase diagrams, the conventional policy response of governments to an overheated economy—increasing the interest rate with the intention of dampening investment and thus tempering the boom—acts not only upon the incentive to invest, but also upon the level of outstanding debt. If this level is already high, then increasing the interest rate may turn boom into crisis. The subsequent attempt to revive the economy by reducing interest rates—and thus stimulating investment, according to IS-LM analysis—amounts to trying to force the economy back down into the stable section of the vortex, when it has already passed into its catastrophic region. However, the centripetal forces that exist in that region—the weight of accumulated debt upon a depressed economy—

are so great that any government action at that time may be too little, too late. This emphasizes the essential policy message of the financial instability hypothesis, that we should avoid crises in the first place, by developing and maintaining institutions and policies that enforce "a 'good financial society' in which the tendency by businesses and bankers to engage in speculative finance is constrained" (Minsky, 1982, p. 69). These institutional arrangements include close and discretionary supervision of financial institutions and financial arrangements, and a bias toward income equity rather than inequality.

The importance of government is emphasized by the results of incorporating a stylized government into the model: its interventions convert situations that previously led to breakdown into ones that generate irregular cycles, of a kind reminiscent of those experienced during the long postwar boom. These simulations provide strong support for Minsky's proposition that the institutional arrangements instituted in the aftermath of the Great Depression "worked," since though cycles occurred, breakdown did not. The objective of stabilization policy was not to avoid cycles—which are endemic to any complex system—but to prevent the possibility of economic collapse. There are, however, severe doubts as to whether the kind of government that has been constructed over the last thirty years is a sufficiently powerful or balanced stabilizer to capitalist investment behavior.

From the perspective of economic theory and policy, this vision of a capitalist economy with finance requires us to go beyond that habit of mind that Keynes described so well, the excessive reliance on the (stable) recent past as a guide to the future. The chaotic dynamics explored in this paper should warn us against accepting a period of relative tranquility in a capitalist economy as anything other than a lull before the storm.

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