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Predicting the 'Global Financial Crisis': Post-Keynesian Macroeconomics

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The 'Global Financial Crisis' is widely acknowledged to be a tail event for neoclassical economics (Stevens, 2008), but it was an expected outcome for a range of non-neoclassical economists from the Austrian and post-Keynesian schools. This article provides a survey of the post-Keynesian approach for readers who are not familiar with this literature. It will briefly cover the history of how post-Keynesian economics came to diverge so much from the neoclassical mainstream, and focus on post-Keynesian macroeconomics today and its alternative indicators of macroeconomic turbulence.

I A 'Black Swan'?

> I do not know anyone who predicted this course of events … What we have seen is truly a 'tail' outcome—the kind of outcome that the routine forecasting process never predicts. (Stevens, 2008, p. 7).

RBA Governor Glenn Stevens' remarks succinctly expressed the neoclassical reaction to the 'Global Financial Crisis' (GFC). It was not anticipated by any neoclassical economic model – *au contraire*, in 2007 all such models predicted a continuance of 'the Great Moderation' (Bernanke, 2004a,b), with the OECD's observation that 'the current economic situation is in many ways better than what we have experienced in years' (OECD, 2007, p. 7) being typical of official forecasts for 2008.

In the wake of those dramatically wrong forecasts, the crisis continues to be regarded by neoclassical modellers as an inherently unpredictable event, due to the scale of unanticipated and unforeseeable exogenous shocks. Once shocks of the required magnitude and variability are injected into DSGE models, the behaviour at the time of the crisis emerges (McKibbin & Stoeckel, 2009; Ireland, 2011; but see Solow, 2003, p. 1), but this behaviour could not have been anticipated prior to the crisis (Figure 1).

However, a number of economists *claim* to have anticipated the crisis (Bezemer, 2009; see also Fullbrook, 2010). Bezemer identified twelve individuals with a legitimate claim to having foreseen this crisis, on the basis of four selection criteria:

> Only analysts were included who provide some account on how they arrived at their conclusions. Second, the analysts included went beyond predicting a real estate crisis, also making the link to real-sector recessionary implications, including an analytical account of those links. Third, the actual prediction must have been made by the analyst and available in the public domain, rather than being asserted by others. Finally, the prediction had to have some timing attached to it. (Bezemer, 2009, p. 7).

However, to evaluate whether this crisis could have been forecast, one has to compare like with like: Are there *mathematical* models of the macroeconomy that did what neoclassical models did not – anticipate the GFC? And are there

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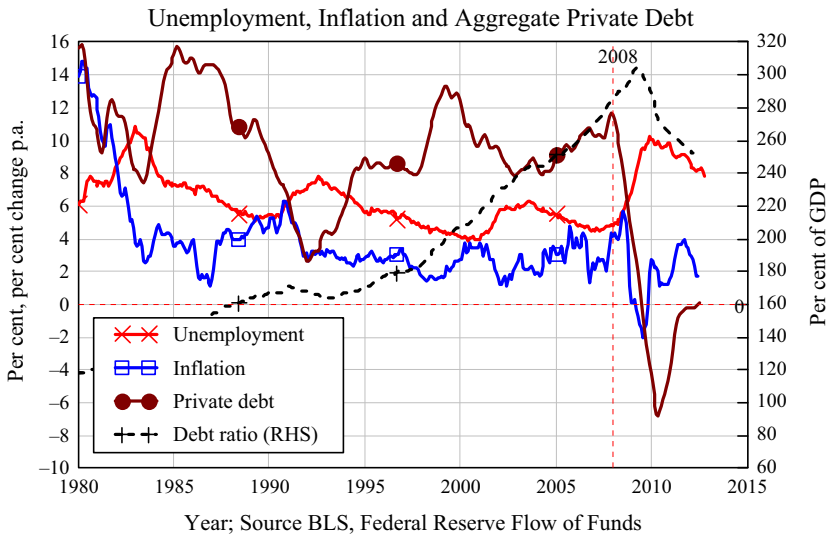
FIGURE 1
The Sudden Transition from Great Moderation to Great Recession in the USA



empirical indicators that are not included in neoclassical macroeconomic models that did indicate that a crisis was approaching, and which in turn could be used to warn of future crises?

Only two of Bezemer's twelve individuals were guided by mathematical models: Wynne Godley (Godley & Wray, 2000; Godley & Izurieta, 2002, 2004; Godley & Lavoie, 2007a,b,c) and myself (Keen 1995, 1996, 1997, 2000, Keen, 2007a,b) – see Table 1, which is adapted from Bezemer (2009), p. 9.

The two contending mathematical approaches are therefore Godley's 'Stock-Flow Consistent' framework, and my complex systems approach to Minsky's 'Financial Instability Hypothesis' (Minsky, 1977); and two key indicators – sectoral imbalances and the ratio of private debt to GDP.

This survey article will introduce these post-Keynesian models and indicators to an audience far more familiar with neoclassical modelling and empirical concerns. Some time is spent on criticisms of neoclassical macroeconomics, 'What Keynes Really Meant' textual exegesis, and the history of post-Keynesian economics, but these are only preliminaries. This article is not a history of post-Keynesian economics – for that, see King (2003, 2012).

II Divergence: Equilibrium, Expectations, Microfoundations and Money

There are six key areas in which modern post-Keynesian macroeconomics differs from neoclassical macroeconomics: the role of equilibrium, the nature of expectations, the need for microfoundations, the model of production, the role of money and the role of government. These differences are set out below, not in an attempt to persuade neoclassical readers, but to introduce them to the tradition of thought from which post-Keynesian models emanate, as well as to make it clear that one cannot *a priori* reject this competing approach to macroeconomic modelling because it fails to incorporate some undoubted neoclassical truth.

(i) Equilibrium

The IS-LM model was developed by Hicks rather than Keynes (Hicks, 1937), but was accepted 'as a convenient synopsis of Keynesian theory' (Hicks, 1981; p. 139) by neoclassical economists. Post-Keynesian macroeconomics economists instead rejected 'Mr Keynes & the 'Classics' (Hicks, 1937) as 'an article which … misses Keynes' point completely' (Minsky, 1969, p. 225).

The elder Sir John Hicks agreed with the critics and disowned the IS-LM model as an inadequate

TABLE 1
Predictors of the Global Financial Crisis (Adapted from Bezemer, 2009, table 1)

Analyst	Academic	Affiliation	School	Orientation	Model
Dean Baker	Yes	Center for Economic and Policy Research	Neoclassical	Keynesian	No
Wynne Godley	Yes	Levy Institute; Deceased 2010	Post-Keynesian	Lerner	Yes
Fred Harrison	No	UK Media	Georgist		No
Michael Hudson	Yes	University of Missouri, Kansas City	Classical	Marx	No
Eric Janszen	No	US Website	Eclectic	Austrian	No
Stephen Keen	Yes	University of Western Sydney	Post-Keynesian	Minsky	Yes
Jakob Brøchner Madsen & Jens Kjaer Sørensen	Yes	Copenhagen University (Monash University since 2006)	Neoclassical	Keynesian	No
Kurt Richebächer	No	Deceased 2007	Austrian		No
Nouriel Roubini	Yes	New York University	Neoclassical	Keynesian	No
Peter Schiff	No	Euro Pacific Capital	Austrian		No
Robert Shiller	Yes	Yale University	Neoclassical	Behavioural	No

basis for macroeconomics, not because of its poor microfoundations but because it required the unacceptable assumption that the economy was in equilibrium at all times. Writing in 1981, Hicks observed first that he had conceived of IS-LM 'before I wrote even the first of my papers on Keynes' (Hicks, 1981; p. 140) and second that it was Walrasian rather than Keynesian in origin (Hicks, 1981, p. 141–142).

One essentially Walrasian foundation of IS-LM was the representation of a three-market system as a two-market model under the assumption that if two of the markets were in equilibrium, then so was the third by Walras' Law. Hicks therefore ignored the market for loanable funds (and also the labour market) in the IS-LM model:

> One did not have to bother about the market for 'loanable funds', since it appeared, on the Walras analogy, that if these two 'markets' were in equilibrium, the third must be also. So I concluded that the intersection of IS and LM determined the equilibrium of the system as a whole. (Hicks, 1981, p. 142).

However, this Walrasian analogy applied in reverse in disequilibrium: if one of the two markets in IS-LM was out of equilibrium, then necessarily so was the other – and/or the other markets ignored in equilibrium had also to be considered. Consequently, the only point in the IS-LM diagram that 'makes any claim to representing what actually happened' (Hicks, 1981, p. 149) is the intersection of the IS and LM curves. This in turn requires assuming that the economy is *always* in equilibrium.

This had to be rejected, Hicks argued, because assuming continuous equilibrium also meant assuming that expectations were fulfilled at all times, whereas at crucial turning points in the economy 'the system was not in equilibrium. There were plans which failed to be carried through as intended; there were surprises' (Hicks, 1981, p. 150). Macroeconomics therefore had to be about disequilibrium:

> When one turns to questions of policy … the use of equilibrium methods is still more suspect. … There can be no change of policy if everything is to go on as expected—if the economy is to remain in what (however approximately) may be regarded as its existing equilibrium. (Hicks, 1981, pp. 152).

This proposition that macroeconomics must be a study of disequilibrium states is a common theme in post-Keynesian economics (Fisher, 1933; Kaldor, 1940, 1951; Goodwin, 1967, 1986; Kornai, 1971; Robinson, 1974).

(ii) Expectations

A long line of non-neoclassical economists have emphasised the role of uncertainty in economics. Keynes once famously described economic theory prior to his work as 'one of these pretty, polite techniques which tries to deal with the present by abstracting from the fact that we know very little about the future' (Keynes, 1937, p. 215). To post-Keynesians, the 'Rational Expectations Revolution' replaced this with the assumption that the future could be anticipated by agents endowed with 'rational expectations'.

The transition from IS-LM to Rational Expectations macroeconomics began with the Lucas Critique (Lucas, 1976), and its well-founded objections to using historical relations to predict behaviour under future policy regimes. However, that paper also continued a research agenda into the 'Natural Rate Hypothesis' (*NRH*) in which Lucas had previously acknowledged that the *NRH* required the assumption that inflationary expectations are accurate, and that assuming 'expectations are *rational* in the sense of Muth' was equivalent to adding the assumption that inflationary expectations were accurate 'simply … as an additional axiom' (Lucas, 1972, p. 55).

This was one axiom too many for post-Keynesian economists, who insisted that expectations formation under uncertainty was a crucial aspect of reality, and that this had to allow for investors on occasions making decisions that 'in a more sober expectational climate, they would have rejected' (Minsky, 1972, 1982; p. 117). Rational expectations, to coin a phrase, meant 'never having to say you were drunk'. Post-Keynesian models allow for expectations to be based on inaccurate estimates of future outcomes, while still being derived from reasoned responses to current information, given the inherent uncertainty of the future (Blatt, 1979, 1980).

(iii) Microfoundations

Lucas pithily summarised the key motivation behind the evolution of neoclassical macroeconomics as 'we were going to tie it together with microeconomics and that was the job of our generation' (Lucas, 2004; p. 20). The major argument in favour of a micro-founded macroeconomics was that microanalysis could provide the 'deep parameters' that were invariant to policy changes (Estrella & Fuhrer, 1999, 2003; Ljungqvist & Sargent, 2004; pp. xxvi–xxvii). Post-Keynesians rejected the argument that macroeconomics could be derived from microeconomics (Kregel, 1985), as microeconomic 'deep parameters' are lost in the non-linear interactions between agents. Deriving macroeconomics directly from microeconomics was deemed a hopeless task.

The issue of complex interactions between agents has also long been recognised by neoclassical research, but these arguments have not been rigorously accounted for in the development of neoclassical macroeconomics. The Sonnenschein–Mantel–Debreu theorems (Shafer & Sonnenschein, 1993) argue that under general conditions, the 'Law of Demand' does not apply even at the level of a single market, even if all consumers in that market are rational utility maximisers:

> we prove that every polynomial … is an excess demand function for a specified commodity in some *n* commodity economy… every continuous real-valued function is approximately an excess demand function. (Sonnenschein, 1972, pp. 549–550).

The SMD theorems express a common phenomenon arising from the interaction of multiple entities in a system, which physicists have dubbed 'Emergent Properties': the system itself cannot be understood from the properties of the entities themselves, as its behaviour depends on non-linear interactions between them. As Physics Nobel Laureate Philip Anderson put it:

> The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear, and the understanding of the new behaviors requires research which I think is as fundamental in its nature as any other … (Anderson, 1972, p. 393).

Anderson continued that 'psychology is not applied biology, nor is biology applied chemistry' (Anderson, 1972, p. 393), and post-Keynesians similarly assert that 'macroeconomics is not applied microeconomics'.

(iv) Production

Substitutability of inputs, rising marginal cost and diminishing marginal productivity are familiar elements of neoclassical micro- and macroeconomics. Post-Keynesians instead assume fixed proportions between inputs, constant or even falling marginal costs, and abjure the relevance of changing marginal productivity.

The post-Keynesian position is based on empirical research – commencing with the Oxford Economists Research Group in 1934 in the UK (Hall & Hitch, 1939; Lee, 1981; Besomi, 1998; Simon & Slater, 1998) and Gardiner Means in the USA (Means, 1936) – which has found that, despite its *a priori* appeal, diminishing marginal productivity and rising marginal cost are the exception rather than the rule for industrial companies.

The most recent work confirming this was done by Alan Blinder, who after a careful survey of 200

firms that collectively accounted for 7.6 per cent of US GDP (Blinder, 1998, p. 68), reported that:

> The overwhelmingly bad news here (for economic theory) is that, apparently, only 11 per cent of GDP is produced under conditions of rising marginal cost … (Blinder, 1998; p. 102) … Firms … rarely report the upward-sloping marginal cost curves that are ubiquitous in economic theory. Indeed, downward-sloping marginal cost curves are more common. (Blinder, 1998, p. 302; see Table 2).

This result is consistent with inputs being used in fixed proportions, and post-Keynesian macroeconomic models treat production as linearly related to labour and intermediate good inputs (with variable utilisation of fixed capital in some instances), a position first put logically by Sraffa (1926).

(v) Money

Money neutrality is an essential aspect of the neoclassical approach, in which macroeconomic models abstract from the existence of money, private debt and banks. In contrast, in post-Keynesian models, money and debt matters and changes in debt lead to changes in unemployment.

To neoclassicals, the argument that changes in monetary variables impact upon real economic variables smacks of the fallacy of money illusion, and the difficulty lies in reconciling this principle with the empirical record. As Lucas explains, under monetary neutrality, observed price changes in recessions would be related to nominal shocks, while only supply shocks would affect employment and output (Lucas, 1972, p. 51).

Post-Keynesian economists rejected money neutrality on the basis of Keynes's argument that a monetary economy 'is essentially one in which changing views about the future are capable of influencing the quantity of employment and not merely its direction' (Keynes, 1936, p. xxii), thus conflating money with uncertainty. They also rejected the applicability of the concept of money illusion in a credit-based economy with nominal debts, as even Friedman's statement of money illusion conceded that it was only strictly true if debts were denominated in real terms:

> nothing is so unimportant as the quantity of money expressed in terms of the nominal monetary unit … let the number of dollars in existence be multiplied by 100; that, too, will have no other essential effect, *provided that all other nominal magnitudes (prices of goods and services, and quantities of other assets and liabilities that are expressed in nominal terms) are also multiplied by 100*. (Friedman, 1969, p. 1; emphasis added)

Later work on the mechanics of money creation strengthened the case for distinguishing the macroeconomics of a monetary economy from a non-monetary one. Basil Moore (1979) argued that bank lending was not effectively constrained by the reserve-setting behaviour of central banks, using both empirical analysis and the mechanics of Federal Reserve behaviour, which Federal Reserve Bank of New York Vice President Alan Holmes described in the following way:

> In the real world, banks extend credit, creating deposits in the process, and look for the reserves later… the reserves required to be maintained by the banking system are predetermined by the level of deposits existing 2 weeks earlier. (Holmes, 1969; p. 73; O'Brien, 2007, table 12, p. 52. The lag is now 30 days.)

These operational perspectives on the endogenous creation of money by banks were confirmed by empirical work into the timing of economic variables by Kydland and Prescott, where they concluded that

> The difference of M2–M1 leads the cycle by … about three quarters… The fact that the transaction component of real cash balances (M1) moves contemporaneously with the cycle while the much larger nontransaction component (M2) leads the cycle suggests that credit arrangements could play a significant role in future business cycle theory. (Kydland & Prescott, 1990, pp. 4, 15)

These empirical realities alone are not sufficient to support a critical role for banks, money and debt in macroeconomics: there must also be a link between change in monetary variables and

TABLE 2
Blinder's Survey Results on Firm Cost Structures (pp. 100–106)

Property of marginal costs	Per cent of firms
Increasing	11%
Constant	48%
Decreasing	41%

change in real economic activity. The proposition that there is such a link was first put by Schumpeter, when he argued that the dominant source of funds for entrepreneurial investment was the creation of additional spending power by banks – not by transferring funds from savers to borrowers, but by the process of simultaneously creating both a deposit and a debt for a borrower without reducing the spending capacity of savers.

In Schumpeter's model, entrepreneurs were individuals with concepts that could transform production or distribution in a discontinuous way – and thus yield 'super-normal' profits to themselves – but no money with which to put these concepts into action. They therefore had to borrow:

> the entrepreneur … can only become an entrepreneur by previously becoming a debtor… Before he requires any goods whatever, he requires purchasing power. He is the typical debtor in capitalist society. (Schumpeter, 1934, p. 102)

Schumpeter conceded that some of this finance could arise from saving – abstaining from consumption – but argued that this was minor compared to the endogenous creation of additional spending power by banks:

> Even though the conventional answer to our question is not obviously absurd, yet there is another method of obtaining money for this purpose … the creation of purchasing power by banks… It is always a question, not of transforming purchasing power which already exists in someone's possession, but of the creation of new purchasing power out of nothing… (Schumpeter, 1934, p. 73)

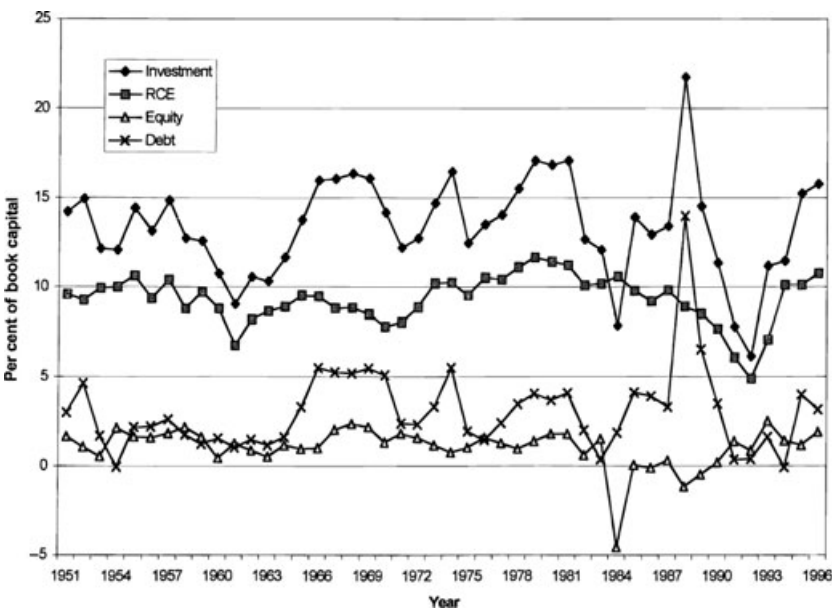
This theoretical argument received empirical support from research by Fama and French, who calculated aggregate non-financial corporate investment, and correlated it with equity issue, retained earnings and new debt (see Figure 2).

They concluded that 'the source of financing most correlated with investment is long-term debt':

> The correlation between it and dLTDt is 0.79… These correlations confirm the impression … that debt plays a key role in accommodating year-by-year variation in investment. (Fama & French, 1999a, p. 1954)

FIGURE 2

Correlations of Investment to New Equity, Retained Earnings and New Debt (Fama & French, 1999a; p. 1954)



There is, hence, a very important link between changes in monetary aggregates and real economic activity. The banking sector is also essential, as its financing of investment by the endogenous expansion of the money supply is a vital component of a growing economy.

(vi) Government

With its view of a market economy as self-equilibrating, the neoclassical school has had a tendency towards a critical perspective on the role of government, which culminated in the 'Policy Inefffectiveness Proposition' that:

> by virtue of the assumption that expectations are rational, there is no feedback rule that the authority can employ and expect to be able systematically to fool the public. This means that the authority cannot expect to exploit the Phillips Curve even for one period. (Sargent & Wallace, 1976, p. 178)

Post-Keynesian work has instead adhered to Keynes's perspective that the market economy can generate insufficient aggregate demand to guarantee full employment (Keynes, 1936, p. 25). This leads post-Keynesians in general to argue that the government has both a responsibility and a capacity to boost aggregate demand during recessions, though there are differences in how effective such policies are expected to be.

III Convergence: Structure, Dynamics, and Minsky

That concludes an overview of the ways in which the broad post-Keynesian tradition diverges from neoclassical practice. The next topic is the positive themes in post-Keynesian economics that the approaches reviewed here share.

(i) Structure

Post-Keynesian theory has stressed the need to accurately model the institutions and structure of the economy that constrains individual behaviour. This emphasis began with Sraffa's empirically oriented criticism of Marshall (Sraffa, 1926; Robertson *et al.*, 1930), and led to his input–output critique of neoclassical production theory (Sraffa, 1960) and the development of an input–output-oriented approach to macrodynamics (Pasinetti, 1973, 1988, 1993; Salvadori & Steedman, 1988; Kurz & Salvadori, 1993, 2006; Salvadori, 1998). This has caused conflict within the broad post-Keynesian tradition akin to the Saltwater–Freshwater divide in neoclassical economics between those who insist that input–output relations are a 'brute fact about modern industrial economies' (Steedman, 1992; p. 126) and those who develop 'corn economy' models (Kriesler, 1992; Sawyer, 1992; Steedman, 1993; but see Keen, 1998).

(ii) Dynamics

Post-Keynesian models emphasise dynamics and disequilibrium rather than comparative statics and equilibrium, in a tradition that dates back to Kalecki (1935, 1937) and Harrod (1939, 1960). Post-Keynesian macroeconomic models are iterative in nature and do not have a long-run equilibrium towards which the economy is assumed to converge (Arestis, 1989; Sawyer, 1995a,b).

(iii) Minsky: Can 'It' Happen Again?

Hyman Minsky's 'Financial Instability Hypothesis' has become a unifying vision in post-Keynesian economics, crystallising the many differences between this school's approach and the neoclassical model. As he is still relatively unfamiliar to neoclassical economists, it is important to set out his analysis at length here. Minsky's guiding principles were first that a model of capitalism must be able to generate a depression as one of its possible outcomes:

> Can 'It'—a Great Depression—happen again? And if 'It' can happen, why didn't 'It' occur in the years since World War II?… To answer these questions it is necessary to have an economic theory which makes great depressions one of the possible states in which our type of capitalist economy can find itself. (Minsky, 1982, p. 5)

and second that capitalism is inherently unstable:

> The alternative polar view, which I call unreconstructed Keynesian, is that capitalism is inherently flawed, being prone to booms, crises, and depressions. This instability, in my view, is due to characteristics the financial system must possess if it is to be consistent with full-blown capitalism. Such a financial system will be capable of both generating signals that induce an accelerating desire to invest and of financing that accelerating investment. (Minsky, 1969, 1982, p. 279)

Minsky's verbal model 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 system-wide 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, therefore, 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, 1982; 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, 1982, 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, 1982, 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 trigger 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, as 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 the Ponzi financier (Minsky, 1982; pp. 70, 115; Galbraith, 1954, pp. 4–5). These capitalists are inherently insolvent, but profit by trading assets on a rising market, and must incur significant debt in the process:

> A Ponzi finance unit is a speculative financing unit for which the income component of the near term cash flows falls short of the near term interest payments on debt so that for some time in the future the outstanding debt will grow due to interest on existing debt… Ponzi units can fulfill their payment commitments on debts only by borrowing (or disposing of assets)… a Ponzi unit must increase its outstanding debts. (Minsky, 1982, p. 24)

The servicing costs for Ponzi debtors exceed the cash flows of the businesses they own, but the capital appreciation they anticipate far exceeds their debt servicing costs. They therefore play an 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 realisation 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 on 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 market deflation or current goods 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 re-established 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 stabilisers', 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.

Hence, although Minsky argued that financial instability was inevitable, he argued that depressions could be avoided by a combination of deficits resulting from 'Big Government' and 'Lender of Last Resort' interventions by the Central Bank – so long as, in addition, we 'establish and enforce a 'good financial society' in which the tendency by business and bankers to engage in speculative finance is constrained' (Minsky, 1977, 1982, p. 69).

IV Anticipating the Black Swan I: Debt Deflation and Complexity

An essential aspect of Schumpeter and Minsky's shared vision of capitalism is that it is inherently cyclical, rather than a system that tends to equilibrium. Schumpeter saw this as a strength of capitalism, and essential to its vitality (Schumpeter, 1928). Minsky was rather less sanguine, arguing that 'the tendency to transform doing well into a speculative investment boom is the basic instability in a capitalist economy'. (Minsky, 1977, 1982, p. 67)

A cyclical model was thus required to underpin Minsky's hypothesis. I used Goodwin's growth cycle model (Goodwin, 1967), following Blatt's advice that its flaw 'of an equilibrium which is not unstable' could be remedied by the 'introduction of a financial sector, including money and credit as well as some index of business confidence' (Blatt, 1983; pp. 210–211; Harvie, 2000; Harvie *et al.*, 2007; Keen, 2009).[1]

[1] Harvie (2000) criticised the empirical fit of the Goodwin model to OECD data. However, there was what Harvie described to me as a 'typical schoolboy error' in that paper, where the linear Phillips Curve equation was stated in percentages and not converted to ratios for the econometric testing. When that error was corrected, the fit was quite good (see Keen, 2009; p. 165) and non-linear functional forms improve it further (see Harvie *et al.*, 2007).

(i) Goodwin's Growth Cycle

Goodwin's model can easily be laid out in a causal chain:

- The level of capital K determines output Y via the accelerator relation v: $Y = K/v$
- Output determines employment L via labour productivity a: $L = Y/a$
- Employment determines the rate of employment λ given population N: $\lambda = L/N$
- The employment rate determines the *rate of change* of the wage rate w—a Phillips Curve relation: $1/w \cdot (dw/dt) = P_h(\lambda)$
- Output minus the wage bill $W = w \cdot L$ determines profits Π: $\Pi = Y - w \cdot L$
- All profits are invested, so that $I = \Pi$ where investment I is of course the rate of change of capital: $dK/dt = I = \Pi$
- Goodwin assumed constant growth in labour productivity $da/dt = \alpha \cdot a$ and constant population growth $dN/dt = \beta \cdot N$.

The model reduces to two system states in the employment rate λ and the wages share of output $\omega = W/Y = w/a$ (for a simple exposition of the derivation, see Blatt, 1983, pp. 211–216):

$$\begin{aligned} \frac{d\lambda}{dt} &= \lambda \cdot \left(\frac{1-\omega}{v} - (\alpha + \beta) \right) \\ \frac{d\omega}{dt} &= \omega \cdot (P_h(\lambda) - \alpha). \end{aligned} \tag{1}$$

Although Phillips insisted the employment-rate-wage-change relationship was non-linear (and that the rate of change of employment and inflation were also factors in wage determination – see Phillips, 1958; pp. 283–284), Goodwin used a linear form for his model[2]:

$$P_{hG}(\lambda) = \rho \cdot (\lambda - \lambda_G). \tag{2}$$

Blatt employed a non-linear form:

$$P_{hB}(\lambda) = \frac{A}{(1-\lambda)^2} - B. \tag{3}$$

As Goodwin illustrated, this model has a non-trivial equilibrium which is neutral, resulting in the model generating a closed curve in (λ, ω) space for any non-equilibrium initial conditions, whatever form is assumed for the Phillips Curve. The model's sustained cycles occur even if the model's behavioural form is linear, because the cycles emanate from the inherent non-linearity of multiplying the two variables w and L together to derive profits (and hence the level of investment). Non-linear behavioural relations are used, not to cause cycles, but to add realism – in Blatt's case, to ensure that the employment rate could not exceed 100 per cent.

I added a similar non-linear function for investment, replacing the unrealistic assumption that capitalists invest all their profits with an investment function where the level of investment as a percentage of GDP depended on the rate of profit (which equals $\Pi/K = \pi/v$, where π is the profit share of income: $\pi = 1 - \omega$):

$$I_K(\pi) = \frac{C}{\left(D - E \cdot \frac{\pi}{v}\right)^2} - F. \tag{4}$$

With depreciation δ introduced as well, Goodwin's equations are now:

$$\begin{aligned} \frac{d\lambda}{dt} &= \lambda \cdot \left(\frac{I(\pi)}{v} - (\alpha + \beta + \delta) \right) \\ \frac{d\omega}{dt} &= \omega \cdot (P_h(\lambda) - \alpha) \end{aligned} \tag{5}$$

The dynamics of the three versions of the Goodwin model are illustrated in Figure 3.[3]

(ii) Modelling Minsky

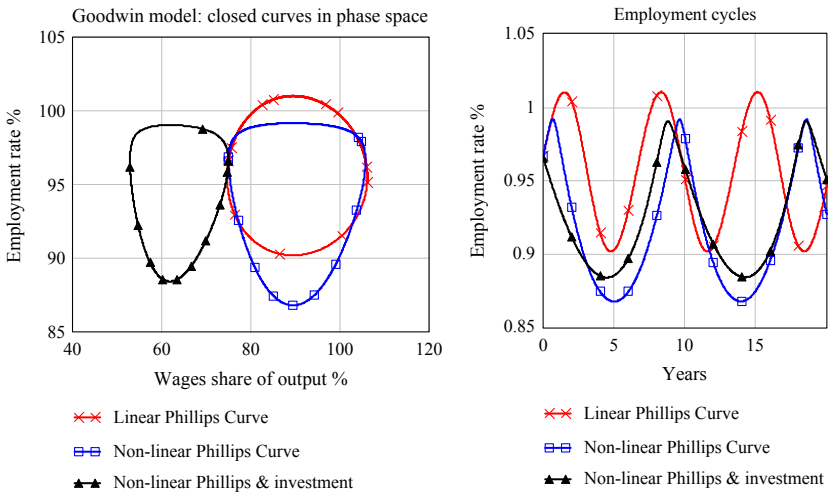
Goodwin's model was extended to represent the core of Minsky's hypothesis by adding the relationship that 'more investment tends to generate more debt, while higher earnings are used to reduce debt' (Fama & French, 1999b, p. 9). In dynamic terms, this says that the rate of change of debt D is investment minus profits (where profits are now net of interest payments, which equal the interest rate r times the debt level):

$$\begin{aligned} \frac{dD}{dt} &= I - \Pi \\ \Pi &= Y - w \cdot L - r \cdot D. \end{aligned} \tag{6}$$

[2] I have made some minor changes to Goodwin's notation, including indicating the employment level at which wage change is zero by λ_G.

[3] The parameter values are v = 3, α = 1.5 per cent, β = 2 per cent, ρ = 3, δ = 2 per cent, λ_G = 96 per cent, A = 0.000064, B = 0.040064, C = 0.0175, D = 0.53, E = 2, F = 0.065. Initial conditions are $\lambda(0)$ = 96 per cent, $\omega(0)$ = 75 per cent.

FIGURE 3
Closed Cycle in the Original Goodwin Model



This introduced a third system state into the model: the ratio of debt to output, d. The basic Minsky model is thus:

$$\begin{aligned}\frac{d\lambda}{dt} &= \lambda \cdot \left(\frac{I(\pi)}{v} - (\alpha + \beta + \delta)\right)\\ \frac{d\omega}{dt} &= \omega \cdot (P_h(\lambda) - \alpha)\\ \frac{d}{dt}d &= I(\pi) - \pi - d \cdot \left(\frac{I(\pi)}{v} - \delta\right).\end{aligned} \tag{7}$$

This third dimension introduces the possibility of complex behaviour and sensitive dependence on initial conditions: an equilibrium that is technically stable can nonetheless be a repeller rather than an attractor for some initial conditions (Li & Yorke, 1975; May & Oster, 1976). The many equilibria of this system depend on inverse functions of the non-linear Phillips and Investment functions:

$$\begin{aligned}\pi_e &= I^{-1}(v \cdot (\alpha + \beta + \gamma))\\ \lambda_e &= P_h^{-1}(\alpha)\\ d_e &= \frac{v \cdot (\alpha + \beta + \gamma) - \pi_e}{\alpha + \beta}.\end{aligned} \tag{8}$$

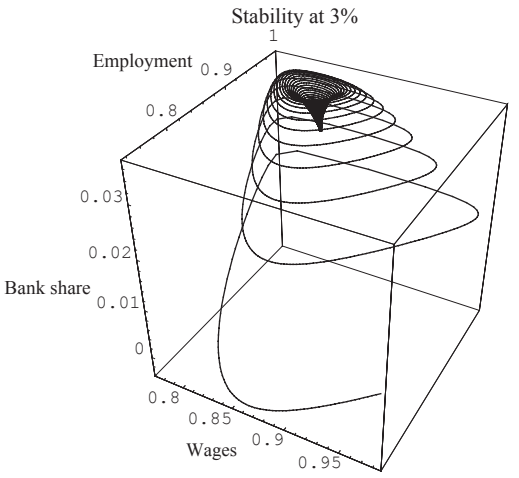
The model's general mathematical properties are fully explored in Grasselli and Costa Lima (2013), where they identify two non-trivial equilibria: one with positive values for the first two system states (ω, λ) and a finite value for (d), and the other with zero values for ω and λ but an infinite value for (d): this is the debt-deflationary terminal point of a depression. On the latter equilibrium, Grasselli and Costa Lima observe that what appears to be a desirable situation from a neoclassical point of view – in that it is a condition that guarantees the absence of rational bubbles – leads to depression in this dynamic model:

> a sufficient condition for $(\omega_2, \lambda_2, u_2) = (0, 0, 0)$ to be a locally stable equilibrium … is that the real interest rate r exceeds the growth rate of the economy at the equilibrium $(\omega_1, \lambda_1, d_1)$, which resembles the condition derived by Tirole for the absence of rational bubbles in an overlapping generation model, corresponding to an 'efficient' economy. (Grasselli and Costa Lima, p. 11)[4]

My own simulations in Keen (1995) illustrated this possibility of a debt-induced collapse if the rate of interest was too high. For a low

[4] Here, u_2 is the inverse of d. Grasselli and Costa Lima's different but equivalent rendition of the debt ratio equation makes the dependence on the rate of interest more obvious: $\frac{d}{dt}d = d \cdot (r - (\frac{I(\pi)}{v} - \delta)) + I(1 - \omega - r \cdot d) - (1 - \omega)$.

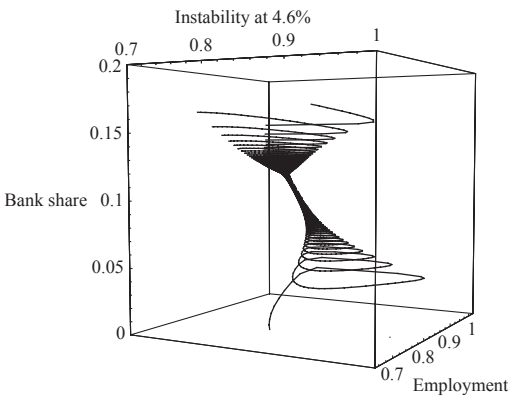
FIGURE 4
Convergence to Equilibrium with a Low Real Interest Rate (Keen, 1995, Figure 6, p. 622)



rate, a convergence to equilibrium occurred (Figure 4):

At a higher rate, the system approached the infinite debt to output ratio equilibrium, but in a curious way: the cycles in employment and income distribution diminished as the crisis approached. An economic theory which ignored the role of private debt could therefore interpret this process as indicating a trend towards stability rather than breakdown (Figure 5).

FIGURE 5
Apparent Stability and then Breakdown with a High Real Interest Rate (Keen, 1995, Figure 8, p. 624)



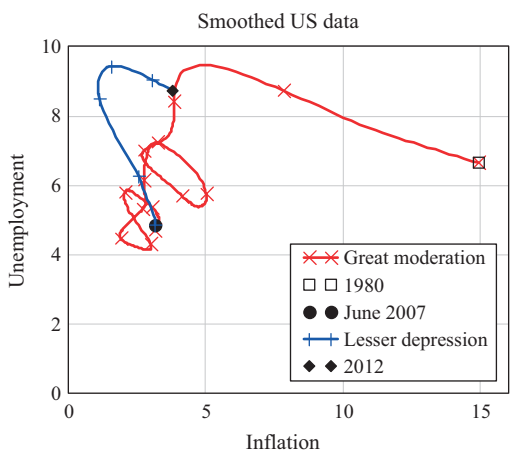
The conclusion of my 1995 paper focused on this striking characteristic of the model:

> 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 which 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. (Keen, 1995, p. 634)

The declining volatility in inflation and unemployment from 1980 till mid-2007 shown in Figure 1 was interpreted as 'the Great Moderation' by many neoclassical macroeconomists, with Bernanke in particular eulogising it as 'this welcome change in the economy' (Bernanke, 2004b) (Figure 6).

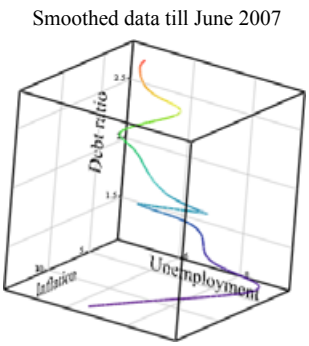
From the point of view of my Minsky model, where the debt ratio is a crucial variable omitted by neoclassical macroeconomics, this period was really the 'lull before the storm' (see Figure 7).[5]

FIGURE 6
US Inflation & Unemployment Trends from 1980



[5] The vertical axis in Figure 5 is the bank share of income, which is the debt ratio times the real rate of interest, which was held constant in Keen (2005a,b): it is thus a linearly scaled version of the debt ratio. Figure 7 shows only the debt ratio.

FIGURE 7
Inflation, Unemployment and Debt Till June 2007



The transition from the Great Moderation to the 'Great Recession' was inexplicable from a neoclassical point of view, but could be inferred from my Minsky model.

However, this was still only an inference, since the 1995 model lacked price dynamics. In a methodological convergence with the stock-flow consistent approach, I have since developed a strictly monetary version of Minsky's model in which price dynamics can be explored (Keen).

(iii) Monetary Macroeconomics

The monetary flows in a simple model economy can be derived from the flows between bank accounts in a stylised financial system. The simplest possible monetary model of Minsky's hypothesis has a single banking sector with accounts for the firm sector, workers and the banking sector itself:

- a 'Bank Vault' in which bank notes are stored while not in circulation;
- a 'Firm Loan' account, a ledger that records the loans currently extant to the firm sector;
- a 'Firm Deposit' account, where money lent to firms is stored;
- a 'Worker Deposit' account into which wages are paid; and
- a 'Bank Safe' account, through which interest payments pass.

Table 3 shows the basic flows in this economy, including – on rows 12 and 13 – the financing of investment by the endogenous expansion of the money supply. The table is not double entry and does not follow the Flow of Funds convention (which is employed by Godley) but a systems engineering one, in which outflows from a system state have a negative sign, and inflows to a system state have a positive sign.[6]

As the entries in each row represent the flows into and out of the bank accounts, the symbolic sum of each column describes the rate of change of each bank account – see Equation (9).

$$\begin{aligned}
\frac{d}{dt}B_V &= \text{Repay} - \text{Loan}\\
\frac{d}{dt}F_L &= \text{Loan} - \text{Repay} + \text{Invest}\\
\frac{d}{dt}F_D &= \text{Loan} - \text{Repay} + \text{Invest} - \text{Compound}\\
&\quad + \text{Dep}_F - \text{Wages} + \text{Cons}_W + \text{Cons}_B\\
\frac{d}{dt}W_D &= \text{Wages} + \text{Dep}_W - \text{Cons}_W\\
\frac{d}{dt}B_S &= \text{Compound} - (\text{Dep}_F + \text{Dep}_W + \text{Cons}_B).
\end{aligned} \tag{9}$$

The 'placeholder' entries in equation (9) are replaced by non-linear behavioural relations for lending, debt repayment and investment based on the rate of profit, and, for simplicity, linear consumption functions.[7]

$$\text{Loan} = \frac{B_V}{\tau_L(\pi_r)} \tag{10}$$

[6] In a convergence with Godley's method, I have since adopted a strict double-entry approach to deriving monetary models, which is embedded in an Open Source simulation program 'Minsky': see https://sourceforge.net/p/minsky/home/Home/.

[7] Variable relations could easily be used for consumption. In this simulation, parameter values were v = 3, α = 1.5 per cent, β = 2 per cent, δ = 1 per cent, r_D = 1 per cent, r_L = 5 per cent, τ_B = 1, τ_W = 1/26, s = 27 per cent, τ_P = 1, w = 0.1. The non-linear relations are all based on a generalised exponential function $genexp(x, x_0, y_0, s_0, \min) = (y_0 - \min) \cdot e^{\frac{s_0}{y_0 - \min}(x - x_0)} + \min$. The function values were $P_h(\lambda)$ = genexp(λ, 96 per cent, 0, 2, −4 per cent); $Inv(\pi_r)$ = genexp(π_r, 4 per cent, 4 per cent, 2, 0); $\tau_R(\pi_r)$ = genexp(π_r, 3 per cent, 10, 100, 3); $\tau_L(\pi_r)$ = genexp(π_r, 3 per cent, 2, −50, 0.5).

TABLE 3
Monetary Flows in a Stylised Pure Credit Economy

			Assets		Liabilities		Equity
	Account name		Vault	Loans	Firms	Workers	Safe
	Symbol	B_V	F_L	F_D	W_D	B_S	
Row	Transaction	Type					
1	Loan	MT	−Loan		Loan		
2	Record loan	LE		Loan			
3	Compound debt	LE		Compound			
4	Pay interest	MT			−Compound		Compound
5	Record payment	LE		−Compound			
6	Deposit interest	MT			Dep_F		$-Dep_F$
7	Wages	MT			−Wages	Wages	
8	Deposit interest	MT				Dep_W	$-Dep_W$
9	Consumption	MT			$Cons_W + Cons_B$	$-Cons_W$	$-Cons_B$
10	Repay loan	MT	Repay		−Repay		
11	Record repayment	LR		−Repay			
12	Investment finance	MT			Invest		
13	Record finance	LE		Invest			

MT, money transfer; LE, ledger entry.

$$\text{Compound} = r_L \cdot F_L$$
$$\text{Dep}_F = r_D \cdot F_D$$
$$\text{Dep}_W = r_D \cdot W_D$$
$$\text{Wages} = W \cdot L$$
$$\text{Cons}_W = \frac{W_D}{\tau_W}$$
$$\text{Cons}_B = \frac{B_S}{\tau_B}$$
$$\text{Repay} = \frac{F_L}{\tau_R(\pi_r)}$$
$$\text{Invest} = I(\pi_r) \cdot Y.$$

Behavioural relations, a wage-setting relation, a dynamic price-setting equation, and a monetary investment function link these financial equations to a Goodwin model of the physical economy.

The wage-setting equation includes all three elements noted by Phillips: a non-linear reaction to the level of employment, plus reactions to the rate of change of employment and the rate of inflation:

$$\frac{d}{dt}W = W \cdot \left(P_h(\lambda) + w \cdot \frac{1}{\lambda} \cdot \frac{d}{dt}\lambda + \frac{1}{P} \cdot \frac{d}{dt}P\right), 0 < w < 1. \tag{11}$$

The price equation was derived by equating the equilibrium rate of flows of demand and supply in a steady-state economy, and then expressing the rate of change of prices as a lagged convergence to this equilibrium price (Keen, 2010; pp. 18–19). In an unexpected result, this equation corresponded to the Kaleckian markup-pricing equation. This implies the neoclassical-post-Keynesian dispute over 'supply and demand equilibrating' versus 'cost plus markup' pricing may be a 'sham fight' rather than a substantive one (Langlois, 1989), as the former yields the latter in equilibrium:

$$\frac{dP}{dt} = -\frac{1}{\tau_P} \cdot \left(P - \frac{W}{a \cdot (1-s)}\right). \tag{12}$$

The complete model is shown in Equation (13):

FinanceSector

$$\begin{aligned} \frac{dB_V}{dt} &= \frac{F_L}{\tau_R(\pi_r)} - \frac{B_V}{\tau_L(\pi_r)} \\ \frac{dF_L}{dt} &= \frac{B_V}{\tau_L(\pi_r)} - \frac{F_L}{\tau_R(\pi_r)} + \\ &+ I(\pi_r) \cdot Y - r_L \cdot F_L + r_D \cdot F_D - W \cdot L \\ &+ \frac{W_D}{\tau_W} + \frac{B_S}{\tau_B} \end{aligned} \tag{13}$$

$$\frac{dW_D}{dt} = W \cdot L + r_D \cdot W_D - \frac{W_D}{\tau_W}$$

$$\frac{dB_S}{dt} = r_L \cdot F_L - \left(r_D \cdot F_D + r_D \cdot W_D + \frac{B_S}{\tau_B}\right)$$

Prices and Wages

$$\frac{dP}{dt} = -\frac{1}{\tau_P} \cdot \left(P - \frac{W}{a \cdot (1-s)}\right)$$

$$\frac{dW}{dt} = W \cdot \left(P_h(\lambda) + w \cdot \frac{1}{\lambda} \cdot \frac{d}{dt}\lambda + \frac{1}{P} \cdot \frac{d}{dt}P\right)$$

Production

$$Y = P \cdot Y_R$$

$$Y_R = \frac{K_R}{v}$$

$$L = \frac{Y_R}{a}$$

$$\lambda = \frac{L}{N}$$

$$\frac{dK_R}{dt} = K_R \cdot \left(\frac{I(\pi_r)}{v} - \delta\right)$$

$$\pi_r = \frac{Y - W \cdot L - (r_L \cdot F_L - r_D \cdot F_D)}{P \cdot K_R}$$

Productivity & Population

$$\frac{da}{dt} = \alpha \cdot a$$

$$\frac{dN}{dt} = \beta \cdot N.$$

The behaviour of this model under a reasonable but uncalibrated set of parameter values confirms the intuition from both Minsky's verbal hypothesis and the earlier non-price model: a period of a falling trend of diminishing cycles in unemployment and inflation can be the prelude to a debt deflation (see Figure 8).[8]

The modelling framework, which I call 'Monetary Circuit Theory', can be taken much further than shown here, and in particular can be extended to multiple sectors with non-equilibrium input–output dynamics (Schandl, 2011; pp. 153–180; see Figure 9), but a discussion of this model is beyond the scope of this article.

[8] Initial conditions were BV(0) = 0, FL(0) = 0, FD (0) = 0, WD(0) = 0, BS(0) = 0, P(0) = 1.25, W(0) = 0, K(0) = 860, L(0) = 286.67, a(0) = 1, N(0) = 300.

V Anticipating the Black Swan II: Stock-Flow Consistent Macroeconomics

Godley's prediction of an impending crisis (Godley & Wray, 2000; Godley, 2001; Godley & Izurieta, 2002, 2004) was derived from models of the macroeconomy that were developed using an accounting framework which he christened Stock-Flow Consistent (*SFC*) dynamic modelling (Cripps & Godley, 1976; Godley, 1999, 2004a,b; Godley & Lavoie, 2005, 2007a,b,c; Taylor, 2008). International, public and private sector imbalances identified using this approach led Godley to anticipate a severe recession from early 2000 (Godley & Wray, 2000; Godley, 2001; Godley & Izurieta, 2002, 2004; Godley, 2005).

Godley's approach to macroeconomic modelling was influenced by his period in the British Treasury (1956–1970), which he described as 'the heyday of 'stop-go' policies when we tried to forecast what would happen during the following 18 months and then design a budget which would rectify anything likely to go wrong'. His Damascene moment occurred when he realised that '*measured at current prices*, the government's budget deficit less the current account deficit is equal, by definition, to private saving net of investment' (Godley & Lavoie, 2007a, p. xxxvi). This realisation that the balance of payments could be deduced from the budget deficit and private net saving inspired him to create the Stock-Flow Consistent approach to constructing macroeconomic models, in which a framework of consistent accounts between sectors had to be set out before behavioural relations were introduced into the model.

Godley and Lavoie contrast their emphasis upon sectoral balances with pre-DSGE macroeconomics by considering what a standard national income equation looks like when portrayed in terms of transactions between sectors. They start from equation (16) in which GDP (*Y*) is broken down into consumption (*C)* plus investment *(I*) plus government expenditure (*G*), and also equated to the sum of wages (*WB*) plus profits (*F*):

$$C + I + G = Y = WB + F. \qquad (14)$$

Table 4 sets out equation (16) in terms of transactions between sectors, where, for example, consumption expenditure *C* involves a transfer of money from households to firms. The table is constructed according to the conventions of the Flow of Funds:

FIGURE 8
Debt Deflation in a Monetary Minsky Model

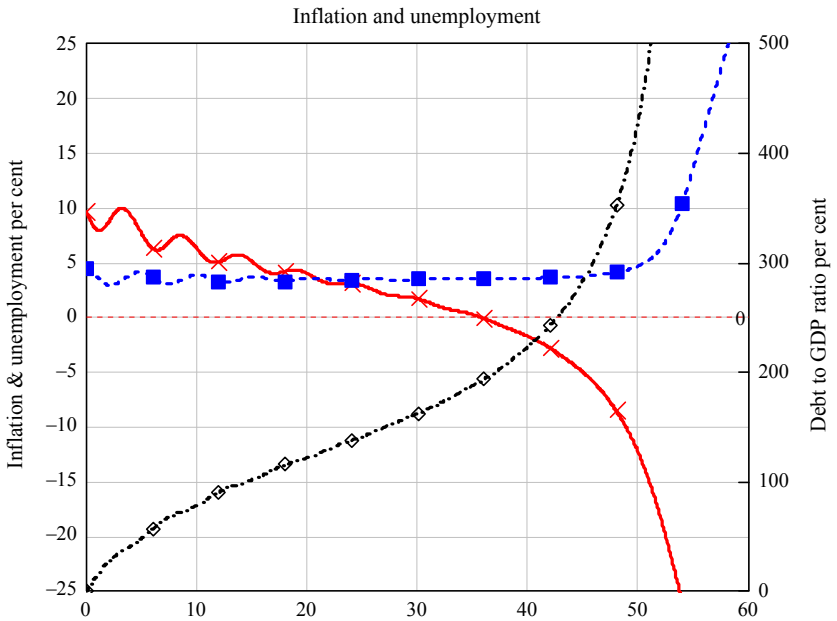


FIGURE 9
A Multisectoral Monetary Minsky Model With Sustainable Cycles (Schandl, 2011, figure 7.2 (b), p. 159)

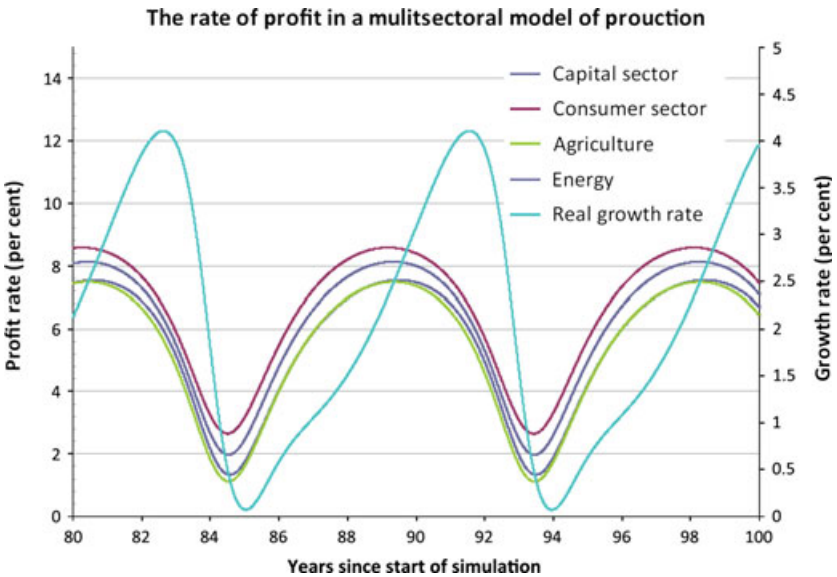


TABLE 4
Equation (16) Laid Out as a Transactions Matrix

		Business			
	Households	Current	Capital	Government	Sum
Consumption	−C	+C			0
Government expenditure		+G		−G	0
Investment		+I	−I		0
[GDP (memo)]		[Y]			
Wages	+WB	−WB			0
Profits	+F	−F			0
Tax net of transfers	−T			+T	0
Sum	SAVING	0	INVESTMENT (—)	GOVERNMENT SURPLUS	0

> Note that all *sources* of funds in a sectoral account take a *plus* sign, while the *uses* of these funds take a *minus* sign. Any transaction involving an incoming flow, the proceeds of a sale or the receipts of some monetary flow, thus takes a positive sign; a transaction involving an outgoing flow must take a negative sign. (Godley & Lavoie, 2007a, p. 40)

Godley and Lavoie point out that, expressed in this manner, deficiencies in equation (16) become obvious: for example, if there is an excess of income over expenditure, 'where does the finance for investment come from? And how are budget deficits financed?' Their revised table provides answers to these omissions by including a banking sector, and 'showing a relatively simple comprehensive system of accounts which describes all the intersectoral transactions implied … but not shown' by Table 4 (Godley & Lavoie, 2007a, p. 6).

As well as indicating that a complicated dynamic system is needed to properly express equation (16), Tables 5 and 6 also showcases Godley's principle that in a monetary economy 'everything comes from somewhere and goes somewhere', so that in his tables 'all rows and all columns sum to zero' (Godley & Lavoie, 2007a, p. 6).

Post-Keynesians who follow this approach derive systems of difference equations from tables like these, which range from simple models that abstract from private credit creation, to complicated ones that incorporate government and bank money creation and international trade (Zezza & Dos Santos, 2004; Berglund, 2005; Dos Santos, 2005; Godley & Lavoie, 2007c; Santos & Zezza, 2007).

TABLE 5
A Simple Transactions Matrix Implied by Equation (16) (Godley & Lavoie, 2007a,b,c, table 1.2, p. 7)

		Production firms				
	Households	Current	Capital	Banks	Government	Sum
Consumption	−C	+C				0
Investment		+I	−I			0
Government expenditures		+G			−G	0
Wages	+WB	−WB				0
Profits	+FD	−F	+FU			0
Taxes	−T				+T	0
Change in loans			+ΔL	−ΔL		0
Change in cash	−ΔHh			−ΔHb	+ΔH	0
Change in deposits	−ΔM			+ΔM		0
Change in bills	−ΔBh			−ΔBb	+ΔB	0
Change in equities	−Δe.pe		+Δe.pe			0
Sum	0	0	0	0	0	0

TABLE 6
The Accounting Matrix for the SIM Model (Godley & Lavoie, 2007a,b p. 62, table 3.3)

	Households	Production	Government	Sum
Consumption	−Cd	+Cs		0
Government expenditures		+Gs	−Gd	0
[Output]		[Y]		0
Wages	+W.Ns	−W.Nd		0
Taxes	−Ts		Td	0
Money stock changes	−ΔHh		+ΔHs	0
Sum	0	0	0	0

Godley and Lavoie provide a simple example of the procedure with the abstraction of a pure fiat money economy in which the government finances deficits by issuing currency only, and where firms make no profits (Godley & Lavoie, 2007a, pp. 57–98).

The discrete time model derived from this table makes behavioural assumptions about taxes (a constant θ times the wage bill) and consumption (a constant α_1 times net income plus α_2 times household wealth—which is entirely in the form of cash H_h—in the previous year) to derive a set of 11 equations:

$$
\begin{aligned}
&C_s = C_d \\
&G_s = G_d \\
&T_s = T_d \\
&N_s = N_d \\
&YD = W \cdot N_s - T_s \\
&T_d = \theta \cdot W \cdot N_s, \theta < 1 \\
&C_d = \alpha_1 \cdot YD + \alpha_2 \cdot H_{h_{-1}}, 0 < \alpha_2 < \alpha_1 < 1 \\
&\Delta H_s = H_s - H_{s_{-1}} = G_d - T_d \\
&\Delta H_h = H_h - H_{h_{-1}} = YD - C_d \\
&Y = C_s + G_s \\
&N_d = \frac{Y}{W}.
\end{aligned}
\tag{15}
$$

They simulate this model with government expenditure of \$20 p.a. (G_d = \$20), tax rate of 20 per cent (θ = 0.2), a wage rate of \$1 p.a. (W = 1), consumption out of income of 0.4 (α_1 = 0.6) and out of wealth of 0.4 (α_2 = 0.4) (see Table 7).

This extremely simple model is followed by others that include banks and private credit creation as well as government money, bonds, other securities and portfolio issues, the impact of expectations failing to be realised, production and international trade.

TABLE 7
Simulation of SIM Model

Period	1	2	3	∞
G	20	20	20	20
Y = G + C	0	38.5	47.9	100
T = θ.Y	0	7.7	9.6	20
C = α1.YD + α2.H−1	0	18.5	27.9	80
ΔH_s = G − T	0	11.3	10.4	0
ΔH_h = YD − C	0	12.3	22.7	80
H = ΔH + H−1				

(i) Alternative Macroeconomic Indicators: Sectoral Imbalances

The Stock-Flow-Consistent emphasis upon sectoral balances enabled Godley to predict the Global Financial Crisis from as long ago as 2000 (Godley & Wray, 2000; Godley, 2001; Godley & Izurieta, 2002, 2004; Godley, 2005). The principal insight was that, when the government sector, the private sector and the international economy are treated as aggregates, the sectoral balances must sum to zero:

> By definition, the private sector surplus must equal the public sector deficit plus the trade account surplus. Thus, the public sector could run a surplus, which if more than offset by a trade account surplus, could still be associated with a private sector surplus. On the other hand, if the public sector runs a surplus and the trade account is negative, the private sector, by definition, must be in deficit. (Godley & Wray, 2000, p. 202)

The US sectoral position at the end of the 1990s and beginning of the 2000s was precisely that case: a public sector surplus and trade sector deficit along with a private sector deficit. They noted that the private sector deficit was 5.3 per

cent of GDP in 2000, while the government surplus was 2.2 per cent of GDP and the balance of payments deficit was 3.1 per cent. The US economy was, they argued:

> in uncharted territory, with a private sector deficit that is five times greater than anything achieved in the past (relative to GDP) and that has already persisted for twice as long as any past deficits. (Godley & Wray, 2000, p. 204)

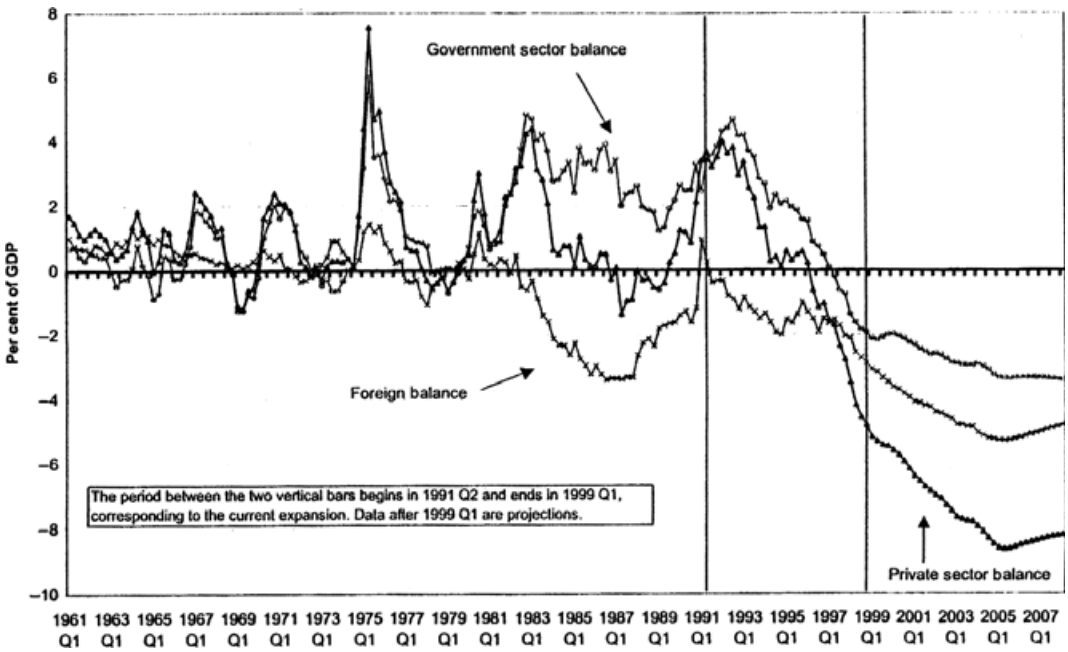
Using the CBO's projections of GDP growth rates and growing government surpluses, and 'reasonable assumptions about continued deterioration of the U.S. trade account', they argued that these trends implied a private sector deficit 'equal to 8 per cent of GDP within 5 years'. This made a recession inevitable:

> We hasten to add that we do not believe this projection. The economy will not continue to grow; the projected budget surpluses will not be achieved; private sector spending will not continue to outstrip income; and growth of private sector indebtedness will not accelerate. We present these projections only to show what would have to happen to the financial situation of the private sector in order for the CBO's projections to unfold. As soon as private sector spending stops growing faster than private sector income, GDP will stop growing. When the recession hits, the public sector budget will move from surplus to deficit, and our trade account will improve (because imports will fall). Together, these will generate private sector surpluses. (Godley & Wray, 2000; p. 204) (Figure 10)

(ii) Alternative Macroeconomic Indicators: Debt to GDP

The key indicator of impending crisis that Minsky's hypothesis adds is the ratio of private debt to GDP, and in particular its first and second derivatives with respect to time. The ratio of debt to GDP alone is an indicator of the degree of financial stress on an economy, while its servicing cost can depress both investment and consumption. Though an optimum ratio of debt to GDP has not been defined, a strong divergence from historical norms is the strongest indicator of

FIGURE 10
Prediction of Unsustainable Private Sector Deficits Given CBO Expectations of Sustained Government Surpluses (Godley & Wray, 2000; Figure 1, p. 203)

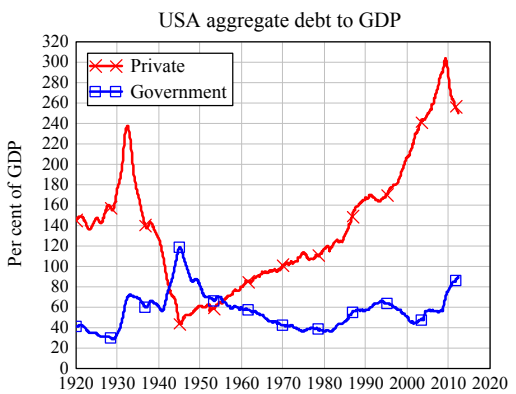


macroeconomic troubles to come (Schularick & Taylor, 2009).

On this basis alone, the potential for a severe economic crisis was implied by the level of private debt (the aggregate of household, non-financial business and finance sector debt) compared to GDP, which by early 2000 had exceeded the peak reached during the severe deflation of 1932 (see Figure 10). On this basis, I published my expectation that a financial crisis would occur in the near future in (Keen, 2001; pp. 254–257, 311–12; Keen, 2011a; pp. 1–6), and made subsequent warnings of an imminent debt-induced crisis on the basis of both Australian and US private debt data from April 2005 (Keen, 2005a,b,2006,2007a,b) (Figure 11).

I have since attempted to develop improved indicators that can actually isolate debt-induced turning points in the economic cycle. These began from Schumpeter and Minsky's arguments that the change in debt adds to aggregate demand from income alone – financing both investment (Schumpeter, 1934; p. 73) and speculation on asset prices (Minsky *et al.*, 1963; Minsky, 1982; p. 6) – which implied the need to generalise Walras' Law for a credit-based economy. Whereas aggregate supply is aggregate demand in a non-monetary economy, in a monetary economy in which banks endogenously create money (and where money is the liability of the banking sector to the non-bank public; Keen, 2010), aggregate demand is income plus the change in debt.

FIGURE 11
US Debt Levels 1920–2012



Income is primarily expended on consumption goods, while the change in debt primarily finances both investment goods purchases and net speculation on asset markets – where this depends on the level of asset prices (P_A), the quantity of assets (Q_A) and the annual turnover of assets (T_A), $0 < T_A << 1$. This implies a relation of the form shown in equation (14) (though this ignores feedback effects between the change in debt and the growth of income):

$$\begin{aligned} AD &= Y + \frac{d}{dt}D \\ AS &= C + I + P_A \cdot Q_A \cdot T_A. \end{aligned} \tag{16}$$

A sudden decline in the rate of growth of debt will therefore mean a sudden decline in the level of aggregate demand. As Figure 1 indicates, such a decline did occur in 2008, and it reduced aggregate demand from the private sector alone from $18 trillion p.a. in 2008 to under $12 trillion in 2010 (see Figure 12).

The time derivative of (14) indicates that the acceleration of debt is a major factor in causing changes in the level of output – and hence employment – and the rate of change of asset prices:

$$\begin{aligned} \frac{d}{dt}AD &= \frac{d}{dt}Y + \frac{d^2}{dt^2}D \\ \frac{d}{dt}AS &= \frac{d}{dt}C + \frac{d}{dt}I + \frac{d}{dt}(P_A \cdot Q_A \cdot T_A). \end{aligned} \tag{17}$$

This is related to the 'Financial Accelerator' (Bernanke *et al.*, 1996) but is far stronger because it involves not merely a change in the velocity of money, but a change in the rate of growth of the volume of money. Biggs, Mayer and Pick proposed the ratio of the acceleration of debt to GDP as an indicator of this effect, and dubbed it 'The Credit Impulse' (Biggs & Mayer, 2010; Biggs *et al.*, 2010). I prefer the term 'Credit Accelerator', as impulse implies a transient phenomenon. The correlations of this indicator with both change in employment and change in asset prices are striking (Figures 13 and 14).

VI Policy Implications

These post-Keynesian models suggest additional early warning indicators to those that emanate from neoclassical economics, and additional policy prescriptions that could avoid a future crisis – offers that should not be refused lightly, given the

FIGURE 12
The Plunge in Debt-Financed Demand in 2008

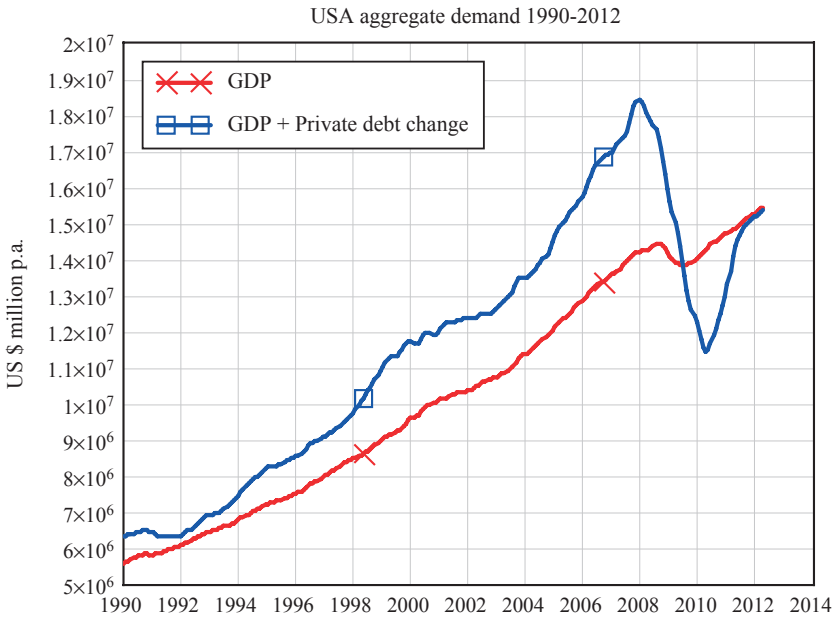
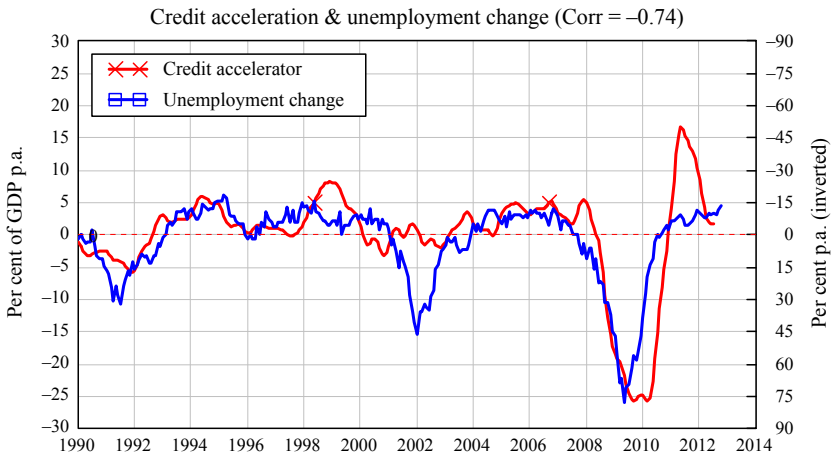


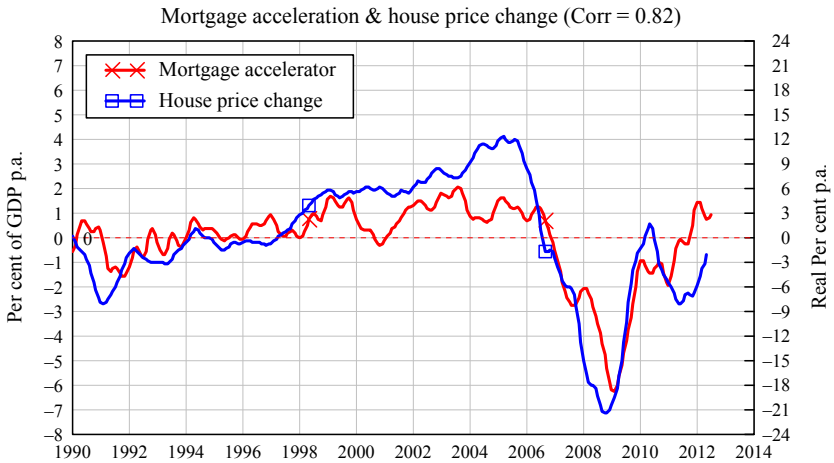
FIGURE 13
USA Credit Acceleration and Unemployment Change 1990–2012



failure of conventional indicators to warn of this crisis, and the occurrence of the crisis despite conventional policy (though see Taylor, 2010).

The key early warning indicators include the ratio of private debt to GDP, its rate of growth and acceleration, and sustained sectoral imbalances as shown in Figure 10. Although an optimal private debt to GDP ratio has not yet been defined, some guidance could be taken from history, as has been done for public debt to

FIGURE 14
Mortgage Acceleration and Real House Price Change



GDP (Reinhart & Rogoff, 2008): Australia's optimal ratio appears to be of the order of 25–30 per cent of GDP (versus a peak level of 158 per cent, see Figure 14) while America's appears to be of the order of 50–75 per cent (versus a peak level of 303 per cent, see Figure 10). A rapid rise in this ratio could warn of a speculative bubble, and it has already been shown that a rapid acceleration of private debt is a strong indicator of an approaching financial crisis (Schularick & Taylor, 2009). Figure 15

VII Predictions

One firm long-term and one tentative short-term prediction can be made from this credit-focused post-Keynesian analysis.

The former is that, in contrast to IS-LM-based analysis that asserts this crisis could easily be ended by a sufficiently large fiscal stimulus (Krugman, 2012; p. 209), this crisis will continue until private debt levels are substantially reduced – by of the order of 150 per cent of GDP in the case of the USA (see Figure 10). This implies a decade of below trend growth in nominal GDP, and persistently high unemployment.

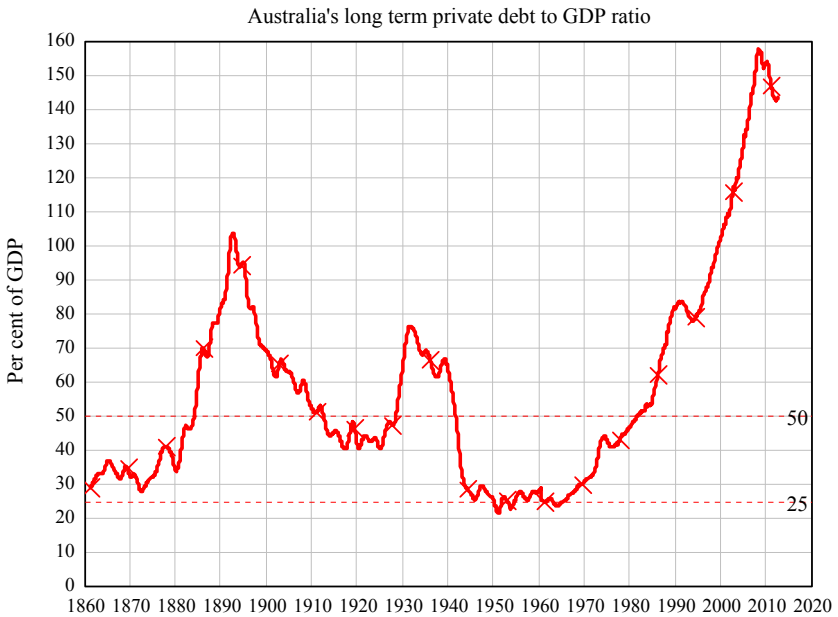
The latter is that, with both the overall Credit Accelerator now trending down – after having been trending up since early 2010 (see Figures 12 and 13 respectively) – the current trend for falling unemployment in the USA may be difficult to sustain in the medium term. However, with the Mortgage Accelerator trending upwards, the rate of change of real house prices is likely to be positive in the medium term. The 'double-dip recession' long warned of by the Economic Cycle Research Institute (www.businesscycle.com) appears feasible for 2013, but potentially in conjunction with rising house prices.

VIII Conclusion: A New Macroeconomics?

What was a 'tail event' for neoclassical macroeconomic models (Stevens, 2008; p. 7) was thus a core prediction of the post-Keynesian approach to macroeconomic modelling. While neoclassical macroeconomists have felt compelled to publish articles with titles like 'How Did Economists Get It So Wrong?' (Krugman, 2009), post-Keynesian economists have been emboldened by their success. They take no joy from the continued gloom in the global economy, but their research agenda is vibrant (Dos Santos, 2003; Zezza & Dos Santos, 2004, 2006; Lavoie, 2008; Le Heron, 2008, 2011; van Treeck, 2009; Santos & Macedo e Silva, 2010; Dallery & van Treeck, 2011; Keen, 2011b, 2013; Lavoie & Daigle, 2011; Grasselli & Costa Lima, 2013).

The confidence that neoclassical economists had in the state of macroeconomic modelling prior to the GFC (Bernanke, 2004a; Blanchard, 2009) was characterised by 'separate development', with neoclassical theory paying no attention to the work of post-Keynesian economists, though as shown here, the post-Keynesian

FIGURE 15
Australia's Long-term Private Debt to GDP Ratio



approach developed in part in reaction to neoclassical thought. Perhaps after the Global Financial Crisis, and as the 'Lesser Depression' continues, it is time for a rapprochement to occur.

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