Working Paper No. 766

Heterodox Shocks

by

Greg Hannsgen*
Levy Economics Institute of Bard College

June 2013

*This paper is a revised version of one presented at the Eastern Economic Association 39th Annual Conference in New York City on May 9, 2013. The author wishes to thank Michalis Nikiforos, who organized the session, which was titled "Macroeconomic Policies and Growth." He also wishes to thank Marc Lavoie, the impromptu session chair, and Frederico Jayme Jr., the paper's discussant, as well as the other participants. Sadly, circumstances beyond everyone's control made it difficult for all comments that might have been on the audience members' minds to be aired. The author also thanks Peter Skott for timely correspondence that resulted in improvements in the paper, and Jörg Bibow for posing a question a number of years ago that stimulated further exploration of the topic.

Levy Economics Institute
P.O. Box 5000
Annandale-on-Hudson, NY 12504-5000
http://www.levyinstitute.org

ISSN 1547-366X

ABSTRACT

Should shocks be part of our macro-modeling tool kit—for example, as a way of modeling discontinuities in fiscal policy or big moves in the financial markets? What are shocks, and how can we best put them to use? In heterodox macroeconomics, shocks tend to come in two broad types, with some exceptions for hybrid cases. What I call Type 1 shocks are one-time exogenous changes in parameters or variables. They are used, for example, to set computer simulations in motion or to pose an analytical question about dynamic behavior outside of equilibrium. On the other hand, Type 2 shocks, by construction, occur at regular time intervals, and are usually drawn at random from a probability distribution of some kind. This paper is an appreciation and a survey of shocks and their admittedly scattered uses in the heterodox macro literature, along with some proposals and thoughts about using shocks to improve models. Since shocks of both types might appear at times to be ad hoc when used in macro models, this paper examines possible justifications for using them.

Keywords: Shocks; Discontinuity; Dynamic Macro Models; Heterodox Macroeconomics; Growth and Fluctuations; Simulation Methodology

JEL Classifications: B40, E12, E17, E30, E60

"My personal point of view is that the shocks are there in any case…I think it is most important to keep a theory of the cycle flexible so that it will be capable of accommodating all the exogenous influences: the history, the accidents, and that a simple endogenous model cannot possibly take into account." (Steindl 1989)

"Discontinuity, far from being an anomaly best ignored, is an essential ingredient of markets that helps set finance apart from the natural sciences." (Mandelbrot and Hudson 2004)

"By the kaleidic theory I mean the view that the expectations, which together with the drive of needs or ambitions make up the 'spring of actions', are at all times so insubstantially founded upon data and so mutably suggested by the stream of 'news', that is, of counter-expected or totally unthought-of events, that they can undergo complete transformation in an hour or even a moment, as the patterns in the kaleidoscope dissolve at a touch." (Shackle 1974)

INTRODUCTION

Shocks generally are one type of sudden, or abrupt, change. They are one device used by economists to make heterodox models move.[1] They allow us to view dynamic pathways that are not derivable from equilibrium analysis, as they often are in dynamic neoclassical theory, or from the analysis of dynamical systems, as in many heterodox models. Applied heterodox macroeconomists use them to perform experiments of sorts, though not in a truly scientific mode.

We talk about such shocks routinely in our conference presentations. Yet a comprehensive account of their meaning has not been written. Moreover, shocks sometimes seem to be ad hoc. If we simply assume that an exogenous shock occurs at a point in time that we call t_0 to get a model moving, who is to say that a shock cannot occur again at any time t_s?

[1] I will not enter into a discussion of the definition of heterodox economics in this paper. One can easily come up with a list of the schools of thought involved. These might include, for example, (Old) Institutionalist, neo-Kaleckian, neo-Marxian, Post Keynesian, post-Keynesian, etc. In the field of macro-modeling, these approaches overlap somewhat in practice.

I will argue in this paper that heterodox shocks come in two frequently encountered forms, which I will sometimes refer to in this paper as Type 1 and Type 2 [2]:

(1) **Abrupt, sudden changes in independent variables or parameters**, such as investors' "state of confidence," technological coefficients, wages, overhead costs, or in parameters representing the stance of monetary or fiscal policy. As I explain below, these changes play a key role in Keynes's *General Theory* (1936) and in Keynes' 1937 summary of his theory, and in Pasinetti's model of the dynamics of growth and fluctuations ([1960] 1974, especially 71–75). The term "shock" is commonly used today among heterodox economists to refer to such shifts, though Keynes himself did not generally refer to changes in independent variables using this word. As we shall see, heterodox theorists use such shocks today to set in motion simulations of an economy evolving through time (e.g., Godley and Lavoie 2012) and to do analytical exercises using phase diagrams (e.g., Taylor 2010, 196).

(2) **Random, erratic, or irregular terms in model equations** that usually take on a new value during each period of a simulation in discrete time. These shocks are used to model aspects of time-series behavior that seem to lack a regular pattern (such as regular cycles or seasonality). Such shocks also come into play these days in simulation analysis of heterodox models (e.g., Chiarella, Flaschel, and Franke 2005; Godley 2012), and, in fact, the American Institutionalist Wesley Clair Mitchell, in his statistical work, may have been among the first economists to grapple with them (1927, 249–255).

So, in short, the two basic types of heterodox shocks I will discuss are: (Type 1) occasional jumps in one or more parameters or variables and (Type 2) regularly occurring shocks that are formally similar to those used in so-called "DSGE" models.

To construct an example, suppose we include "animal spirits" or "state of confidence" shift parameter among the arguments in the investment function, perhaps a step toward the vision of Keynes's (1937) and Shackle (1968, 1974). On the other hand, adding such a

[2] The two types correspond roughly to Stages 4 and 3, respectively, of business cycle theory, using the historical periodization developed by Mirowski (1985, chapters 1 and 6). Note, though, that his narrative is not addressed to shocks *per se.* Exogenous changes become crucial in his Stage 3 of business cycle analysis. In his Stage 4, he sees a continuum of sorts developing between variables and parameters, with normally fixed quantities capable of movement in a sufficiently all-encompassing dynamic theory. Other helpful sources touching on the general area of shocks in the heterodox growth and fluctuations literature include Asimakopulos (1991), Rosser (2013), and Skott (2012).

parameter to a “Kalecki-Steindl” model of aggregate demand, one might use an investment function such as

$$I/K = f(a, u, \pi)$$

where I = net investment, K = capital stock, a = an overall “animal spirits” parameter, u = capacity utilization (output divided by full-capacity output), and π = profits over K. One might start a simulation by adding a once-and-for-all Type 1 shock to this parameter, so that the dynamics of the system could be observed out of equilibrium. Alternatively, one could change it repeatedly and erratically during a simulation to model the effects of occasional Type 2 kaleidic shifts, to use Shackle’s terminology (1974).

These two alternatives do not exhaust the possibilities for heterodox shocks. I will try to mention some of relatively untried alternatives to them at the end of this paper. Moreover, some of the cases not covered by my simple typology lie somewhere between the two.

I will take a broad approach which may contribute to the cause of heterodox modeling by clarifying our own practices as macroeconomists and providing a fairly complete survey of the available alternatives. Hence, I will tend to err on the side of comprehensive coverage, rather than deep analysis. Similarly, I will try to suggest some of the main possible justifications for using shocks in macro models. I will provide examples from the recent literature in heterodox macro models.

Throughout, I will comment on the uses of shocks in the articles that I refer to. The overarching message will be the point that heterodox shocks can be categorized into the two main types mentioned a moment ago. Also, I will occasionally make reference to the uses of shocks common in the neoclassical literature, mostly in a critical vein, to help put the main questions in context. Finally, I will not discuss in any detail the uses of shocks in econometrics per se.[3]

[3] Qin and Gilbert (2001) consider various interpretations of the econometric error term. Among them are shocks. Econometric efforts to identify shocks are sometimes problematic (Hannsgen 2012b). Chiarella, Flaschel, and Semmler (2013, chapter 11) contains an effort to calibrate shocks in the context of a Keynes-Metzler-Goodwin model.

WHAT SHOCKS ARE

So I intend to ask the question, “What are shocks?” However, before I do that, I would like to show you some examples, as it were, of “what shocks are.” In other words, what sorts of phenomena appear to be shocks? In this section, I will make use of the examples to try to make the case that there is a real world connection to the ideas discussed in the rest of the paper.

In the eyes of some observers, variables for expectations and confidence seem more likely to be subject to shocks than most other economic variables. It seems reasonable to assert that expectations and attitudes toward the future can change without impetus from any tangible quantity in the model.

In describing his concept of kaleidics, G. L. S. Shackle put this sentiment as follows,

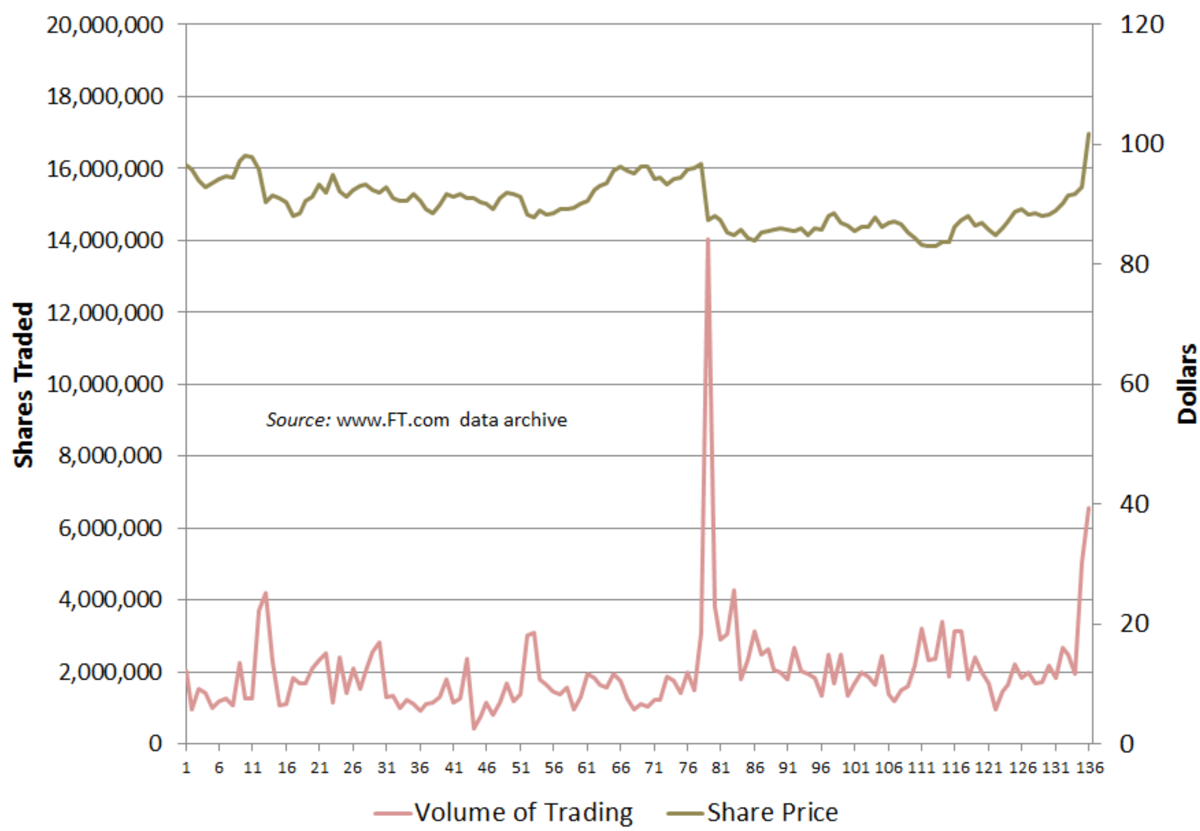
> By the kaleidic theory I mean the view that the expectations, which together with the drive of needs or ambitions make up the ‘spring of actions’, are at all times so insubstantially founded upon data and so mutably suggested by the stream of ‘news’, that is, of counter-expected or totally unthought-of events, that they can undergo complete transformation in an hour or even a moment, as the patterns in the kaleidoscope dissolve at a touch; the view that men are conscious of their essential and irremediable state of un-knowledge and that they usually suppress this awareness in the interest of avoiding a paralysis of action; but that from time to time they succumb to its abiding mockery and menace, and withdraw from the field. (Shackle 1974, 42)

On the other hand, consumption, for example, may be more stable for many reasons, including the existence of basic human needs that remain nearly constant over time, such as a reasonable minimum and maximum caloric intake. Many consumption needs are thought of by Institutionalists, Marxists, etc. in particular as governed largely by habit, custom, cultural norms, social structure, social planning, or availability in a given geographic area, and hence inherently slow to change over time (Todorova 2009). Hence, consumption is less often thought of than investment as subject to abrupt and otherwise inexplicable shifts brought about by such factors as psychology, expectations, etc.

A related view is that, in general, prices set in competitive markets are more subject than other variables to sudden (or, perhaps, discontinuous) jumps. Benoît Mandelbrot held this view: “Continuity should prove a reasonable assumption for diverse ‘exogenous’ quantities and rates that enter economics but are defined in purely physical terms. But prices are different: mechanics involves nothing comparable, and gives no guidance on this account…...and when no institution injects inertia to complicate matters, a price determined on the basis of anticipation can crash to zero, soar out of sight, do anything" (Mandelbrot 1983, 334–335). It is not farfetched to connect Mandelbrot's observation to Shackle's kaleidic theory.

Consider how some real-world shocks appear to us researchers when we look at them in datasets of various kinds. What they have in common is exogeneity and either sudden movement and/or some form of apparent randomness.

Figure 1. Whole Foods Markets, Inc.



Seemingly in keeping with the idea that shocks to financial markets are crucial, one often finds sudden movements in financial price series. Just to provide an example, Figure 1 depicts data on daily closing prices and trading volume for the stock of Whole Foods Markets, Inc., a NASDAQ-listed company headquartered in the United States. Note the large partial-day move, as well as the big jump that happened to be underway on the day the data were downloaded. To come up with a good theory of shocks, we should try to think about the reasons for phenomena we observe in time series, which of course include the day's business news, the fancies of investors, and a variety of other factors.

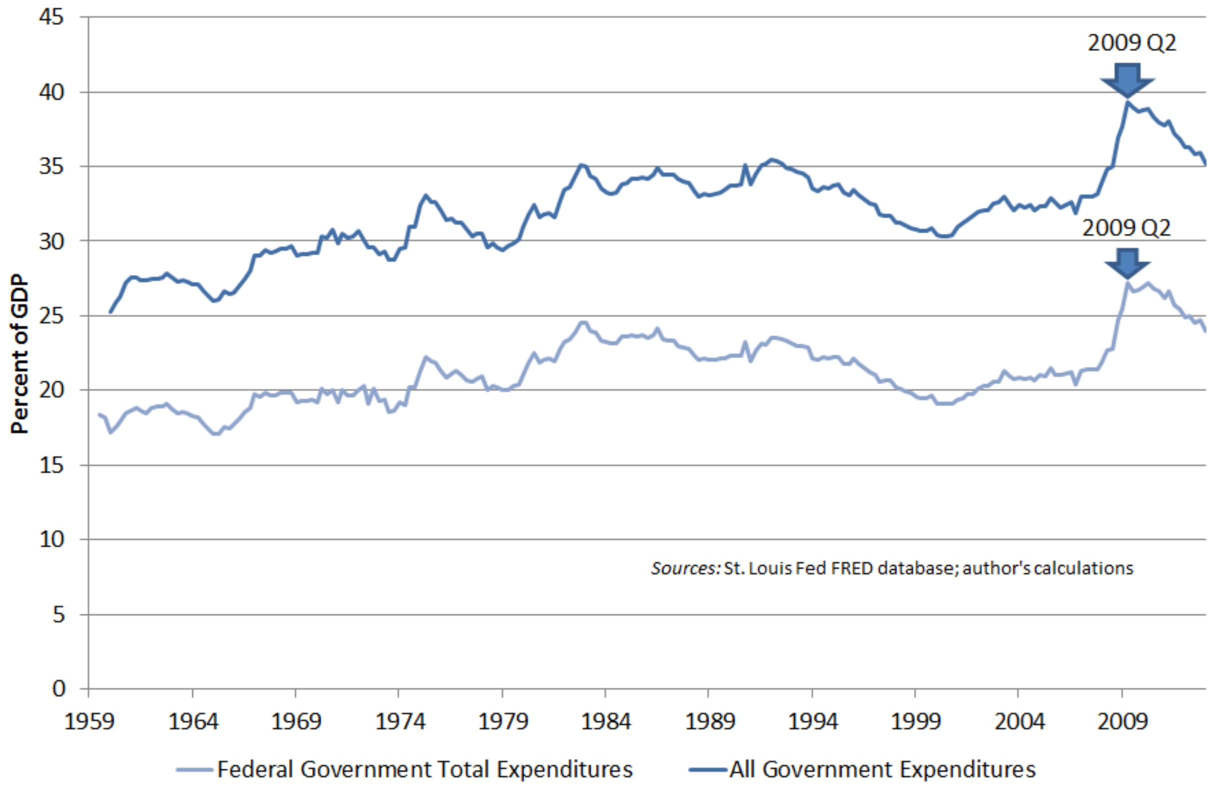
On the other hand, some large jumps in macro variables are by definition related to changes in macro policy. It is common to refer to some changes in policy as “shocks.” The automatic “sequester” spending cuts that went into effect at the start of March 2013 in the US will mark a fairly abrupt change in the rate of government spending per month, though in actuality, not all of the cuts will go into effect during the same quarter. (See the breakdown of the cuts displayed in Table 1.) Moreover, to some extent the shock was anticipated, leading to reduced outlays in the run-up to the sequester. Is this change worthy of the term “shock,” in the sense of a large, exogenous, and sudden change—a typical Type 1 shock?

Table 1 Spending cuts called for under sequester

Category of Spending	Sequester Cuts	Prorated Spending	Cuts as Percentage of Prorated Spending
National Security Operations & Military Costs Other than Military Personnel	43	229	19
Military Personnel	0	65	0
Affected Nonmilitary Discretionary	26	213	12
Unaffected Nonmilitary Discretionary	0	35	0
Medicare	11	233	5
Mandatory other than Social Security and Medicare	5	40	13
Social Security	0	625	0
TOTAL	85	1440	6

In theory, at least, the total amount of spending cuts in the sequester, prorated for a 12-month fiscal year, would amount to perhaps as much as nine-tenths of one percent of annual GDP, which stood at about $16 trillion last year in current dollars. Since entitlement spending is for the most part excluded from the reductions, the impact on affected spending categories will amount to a rather large fraction of expenditures that otherwise would have been made through the end of the 2013 fiscal year, at the end of September. In particular, as shown in Table 1, the cuts amounted to 19 percent of military spending (excluding personnel), 12 percent of affected domestic discretionary program areas, and 13 percent of mandatory spending other than Medicare and Social Security benefit payments. After recent legislation to reverse mass furloughs of air-traffic controllers, along with any future legislation to "fix" the sequester, the coming rounds of spending cuts will probably be concentrated in an even smaller portion of the federal budget.

Figure 2. Government Expenditures in United States, 1959–2013: Signs of a Cliff?



The March 1, 2013 sequester cuts were originally scheduled to go into effect January 1 as part of a major fiscal tightening, known as the "fiscal cliff." Last-minute legislation known as ATRA[4] prevented many of the changes from going into effect as scheduled, but nonetheless the new year brought a round of reductions in cash benefits for the long-term unemployed, a 2-percentage-point increase in payroll taxes on earned income, and an income-tax increase for very wealthy filers. This year's two big tightenings of fiscal policy—one in January and one in

[4] The formal name of the legislation was the American Taxpayer Relief Act of 2012.

March—follow a period of more-gradually falling federal spending that had already led to large reductions in the federal workforce.[5]

Data from the National Income and Product Accounts (NIPA) reveal a modest first quarter 2013 drop in federal government consumption and investment as a percentage of GDP. This is shown in light blue line in Figure 2. No sudden cliff emerged immediately in 2013Q1, as this series had already peaked in 2009Q1. Furthermore, total expenditure at all levels of government, shown in a darker shade of blue, has been falling more abruptly for a longer time. These NIPA series of course do not include transfers. The most recent round of spending cuts will probably be implemented somewhat gradually over time, with some last-minute legislative and other changes to the nature of the cuts.[6] Current official projections call for nominal federal government outlays to fall in this fiscal year by about 0.5 percent of nominal GDP.[7] In actual time series data, the manifestation of this policy "shock" appears to be a bit drawn out, though in other respects it may be a lot like a Type 1 shock.

ARE THEY KEYNESIAN?

For example, Keynes believed that over the short run, stock-market investors could usually count on a relatively stable social convention among investors about the value of securities, based on a widely shared and persistent psychological "state of confidence," rather than on a precise factual basis. By the same token, when this social convention did change, the resulting market move could be sudden and abrupt. In fact, this quality of market expectations, along with the somewhat-less-flighty expectations and emotions of business people, helps to account in the

[5] In addition, the sequester cuts were said to be implemented by administrators on the ground somewhat gradually. In the days leading up to the implementation of the sequester, an expert and former Congressional aide was quoted as saying, "When you wake up on March 1 or 2, the world will not have come to an end." In particular, while the *Financial Times*, commenting on March employment data, reported that "federal workers are likely to bear the brunt" of the sequester cuts, but "there is generally a 30-day notice period for unpaid leave, so those actions are not likely to kick in before April" (Politi 2013). Also, the cuts were anticipated for many moons, since the sequester was originally set up under a 2011 law to go into effect in the event that a deadline for passing alternative deficit-cutting measures was not met. Hence, federal managers had some time to gradually phase in spending cuts. As of May of this year, some federal furloughs were reported to be occurring as a result of the sequester.

[6] Coricelli and Fiorito (2013) argue that a large percentage of government spending is nondiscretionary. They link this lack of discretion to the time series properties of high persistence (as measured by autocorrelations) and low volatility. They test their preferred measure of discretionary spending by using these properties as indicators of continuity or discontinuity in various spending series.

[7] As of May 2013, the CBO projects 2013 GDP to be approximately $16 trillion, with federal outlays falling from $3.577 trillion in 2012 to $3.455 trillion in 2013.

Keynesian world for the relatively high variability of fixed investment, compared to most other components of GDP.

Hence, in Keynes's model in the *General Theory of Employment, Interest and Money* (1936), the marginal efficiency of capital (mec) schedule was one of the factors that he took as given but capable of changing over the long term. Moreover, in practice, Keynes wrote, "…there is not one [factor] which is not liable to change without much warning, and sometimes substantially" (249). This quote suggests an economy that was driven largely by sudden, largely unpredictable, changes. Hence, for most of the book, Keynes deliberately abstracted from changes in the state of long-term expectations and from the feedback loops from economic variables to this psychological variable.[8] Such effects can rather obviously be hard to model and predict.[9]

Keynes's theory of long-term investment was criticized in a sympathetic review by Kalecki (Targetti and Kinda-Hass 1982) for its reliance on the assumption that the marginal efficiency of capital could be regarded as exogenously determined, as well as independent of the profit rate and other economic variables in the short run. Kalecki, along with Hyman P. Minsky and numerous other Keynesian and post-Keynesian economists, dealt with this problem in their work. In general, heterodox interpreters (e.g., Foley 2010) remain at least somewhat sympathetic to Minsky's skepticism about the ability of economists to quantify and endogenize psychological variables in macro models.

ARE THEY REALLY EXOGENOUS?

In heterodox theory, shocks usually represent behavior not explained by the equations that make up the model.[10] For example, if they are of Type 1, they generally affect parameters rather than model variables and hence are usually exogenous by nature, rather than modeled as endogenous

[8] A helpful and interesting general account of the dynamic role of changes in independent variables in Keynes (1936) can be found in Asimakopulos (1991, 120–136). See also, Mirowski (1985, *op cit.*) and Targetti and Kinda-Hass (1982).

[9] Keynesians still argue that changes in confidence are economically important and difficult to explain using any model (Shiller 2013). "There hasn't been much research into the emotional factors and the shifts in worldview that drive major turning points. The much-quoted consumer sentiment and confidence indexes don't yet seem to offer insight into what's behind the changes they quantify."

[10] Rosser (2013) gives an account of business-cycle theories that sees them as falling into exogenous and endogenous categories, with the former traced to Ricardo and the latter attributed to Sismondi and Malthus. I look at this distinction in more detail below in the section on whether the most important shocks are noneconomic in origin.

variables. One concern about them is that if they alone determine the dynamics of the model, then the model's properties wind up being somewhat arbitrary from a theoretical standpoint. Second, a model driven by shocks is often a black box that leaves us in the dark about explanations for the economy's time path. Though they might in principle help us do a simulation that mimics the time-series properties of the data, they often fail to help us understand why economic variables move in the ways that they do. Third, stable, linear, neoclassical models driven by exogenous shocks performed very badly during the recent financial crisis and recession (Rosser 2013). Goodwin (1989) was one of many heterodox modelers to question the use of shocks to model the business cycle, arguing that they were examples of dynamics that could be explained as nonlinear phenomena.[11]

Some observational equivalence results surely exist; given some model properties, it is often possible to obtain a model whose simulated outputs have such characteristics using either stochastic or deterministic techniques. So if the goal is simply to mimic the statistical properties of an actual economy, a shock-driven model might be just as good, and perhaps simpler to construct (Skott 2012).

ARE THEY ECONOMIC?

Often the exogeneity issue comes down to whether the relevant forces are economic or noneconomic in origin. For many neoclassical economists, the latter term applies, with shocks being driven by natural disasters, the emergence of new technologies, changes in consumer tastes, etc. There is no reason that this should necessarily be the case, as I will outline in more detail below.

CAN THESE SUDDEN MOVEMENTS BE EXPLAINED?

Often, heterodox theorists find it reasonable to imagine that parameters move in a sudden or abrupt fashion without an elaborate explanation of how this might occur. For example, Amitava Dutt (2012, 444–445), in discussing the dynamics of distribution in Kaleckian models, points

[11] Mirowski (1985) provides a historical account of the shocks-alone-don't-explain view of shock-driven theories, noting important simulation work by Adelman and Adelman.

out that there might be changes in the capital-intensity of production σ, which appears in an investment equation such as the following

$$g = I/K - \delta = f(\sigma u, \pi), \text{ with } f_1 > 0, f_2 > 0$$

where I = investment, K = the capital stock, δ is depreciation over K, π is profits over K, and f_i symbolizes the derivative of the function f with respect to the specified argument. Similarly, an ad hoc animal-spirits shock is used to start an unstable "Minsky cycle" in Taylor's recent Keynesian treatise (2010, 196).[12] Taylor illustrates the cycle with a figure showing the economy first dropping vertically away from the equilibrium point as the confidence shock hits, then spiraling outward as endogenously unstable dynamics in the debt/capital ratio and the growth rate of the capital stock take over. As a final modern example, Caiani, Godin, and Lucarelli (2012) deal with the dynamic effects of cost-reducing technical innovation shocks that affect more than one sector in a stock-flow consistent model. In turn, the innovation leads to a number of discrete changes over time, including the eventual bankruptcy of the sector that retains the older technology.

However, as I hinted earlier in this paper, applicable theoretical models of sudden movements can often be found in such fields in science such as catastrophe theory or theories of complex systems. To take the former type of theory first, Poston and Stewart (1978) define catastrophes roughly as sudden movements that arise from continuous movements in model variables. They are discontinuous phenomena, in contrast to the smooth behavior generated by, say, systems of continuous differential equations. Rosser (2000) subsumes these fields and a number of others in nonlinear dynamics under the broad rubric "discontinuous behavior."[13]

On the other hand, complex systems are known to collapse occasionally by their very nature. Some financial assets are traded on networks that are complex in that they are made up of many interrelated parts. Some examples of algorithmically generated crashes have been observed in recent years and the threat of such an event exists alongside Minskyan financial fragility as a potentially important trigger for future financial cycles (O'Hara and Easley 2013). Mirowski (2010) mentions some applications along these lines, along with some of the computer science involved, in his analysis of the recent financial crisis.

[12] A slightly different version of Taylor's Minsky cycle is presented in Taylor (2004, 298–302).
[13] See also Rosser (2007) for an assessment of this literature, including a substantial number of heterodox examples.

ARE THEY RANDOM?

A particular shock imposed to start an experiment is regarded by some as ad hoc and hence dubious. When shocks are not experimental constructs, they can of course be an integral part of the model itself. In that case, there may be nonzero realizations of the shock in each time period. These can be used, for example, to model seemingly random empirical behavior like the movements of stock prices. The idea is model series that do not appear to follow some empirical pattern in a rough-and-ready way.

Along these lines, the late Wynne Godley attempted in an until-recently overlooked article to model the effects of randomly varying sales- and income-expectations variables using Type 2 shocks (2012; see also Godley and Lavoie 2012, 107–111). He explains,

> …we put the whole system under severe strain by assuming that expectations of sales by firms and also expectation of disposable income by households are subject to violent random processes. No pretense is made that expectations are really formed in this way; the object of the exercise is to find out how banks deal with such chaotic behavior if they had to (Godley 2012, 111).

It was only a short step for him from his econometric models to such stochastic simulations, though Godley may have been skeptical and tentative about his use of the technique in the posthumously published article.[14] The article illustrated how financial variables would move if the amount of money in circulation was endogenously determined by constantly changing entrepreneurial demands, as in the "horizontalist" theory espoused by Nicholas Kaldor (1985a, b) and others. Of course, this example stands in stark contrast with the Type 1 simulation shocks found more frequently in the work of Godley and his colleagues (e.g., Godley and Cripps 1983; Godley and Lavoie 2012, 232).

It is useful to have exogenous changes in some variable to account for ongoing movements of the money stock in a model in which money is said to be endogenous. One can compare this approach to Tobin's *reductio ad absurdum* (1970) in which investment is assumed to follow an exogenous sine function of time, driving income, which in turn determines the stock of money. Both are simple ways of accounting for observed positive correlations and lags in a model in which money is not an exogenous policy variable driving economic variables at

[14] Godley "did not seem to see much interest" in publication of this paper, according to the editors of the posthumous volume in which the article was recently published. They argue that the article by Godley had been "unfairly neglected" (Lavoie and Zezza 2012, 7).

business cycle frequencies. Tobin's model shows that a somewhat facetiously named "ultra-Keynesian" model with endogenous money can generate paths in which money is correlated with (and leads) income, as in monetarist theory. However, by construction, the model generates unrealistically smooth and uniform cycles (Tobin 1970, 308), in contrast to the irregular or jagged graphs shown in Godley's posthumous article, which are generated by adding random shocks to certain model equations and simulating the resulting model (2012, 112–14). For an empirical model, as opposed to a hypothetical argument, random shocks offer some advantages. In Godley's article, they help to produce realistic time paths in the absence of a detailed theory of the multifarious processes, however they might be generated, that come together to generate total entrepreneurial money demand.

Moreover, a case can be made that many forces in economics truly are stochastic. These would include most types of day-to-day reserves and currency flows. Only more fine-grained, microeconomic models of cash demand would be able to theoretically account for these erratic movements. Such a model might need to include day-of-the-week effects and so on but would probably still have large shocks. Think, for example, of a particularly good retail shopping day during the holiday season. Demands on automatic teller machines and deposits by merchants would be likely to be much greater than on a typical business day.

Minsky's dissertation (2004) featured a short section on multiplier-accelerator models with a randomly changing coefficient β on the accelerator term. In Minsky's experiment with this model, a new coefficient was drawn for each period from a set of three possibilities in order to model the effects of changes in the composition of final goods demand. By making the coefficient move over time, Minsky sought to mimic the effects of changing financial conditions, which played a fundamental role in his financial theory of the business cycle (Papadimitriou 2004). Moreover, the approach would enable him to construct a model in which the last remnants of autonomous investment disappeared, with investment being determined by nothing but the variables and the varying and nonvarying coefficients. (Papadimitriou 2004, xii).

First, Minsky provides an example in which the distribution of the random coefficient is time-invariant. Next, in a more elaborate version, he conditions the mean of the coefficient distribution on two lagged variables: (1) the change in income between the previous two periods, and (2) the difference between last period's income and the peak realization of the income variable up to that point in time.

Chiarella, Flaschel, and Franke (2005) perform a more recent experiment with randomness in the context of a heterodox model. They use the mainstream-like expedient of adding normally distributed Type 2 shocks to both the inflation equation and the demand equation of their "Keynes-Metzler-Goodwin-Taylor [rule]" model. They contrast the resulting simulation with another experiment in which cycles are endogenously generated by a nonlinear system with an unstable equilibrium point.

In a similar vein, Kalecki mentions generating cyclical behavior with random shocks in a footnote of an early article ([1939] 1990, 318). He uses the example of stochastic models constructed by Frisch and Slutsky to make the point that even if the economy were to reach some stable equilibrium, exogenous shocks would probably upset stasis very quickly. His *Theory of Economic Dynamics* contains an effort ([1954] 1990, 316–321) to simulate investment dynamics using normally distributed shocks and lag dynamics, the latter justified by his model. This stochastic investment model was probably one of the earliest heterodox models to incorporate shocks drawn from any form of stable probability distribution, as I will explain below.

Perhaps in a similar vein to Godley's article, a posthumously published article by Steindl (1990) proposes modeling the expectations of market participants using probability measures. For example, F might represent the distribution of market participants' expected price changes on the real line $\mathbb{R}$. He further suggests that there might exist individual-level probability measures F_i representing the distribution of possible price changes for each market participant i: "Again, these expectations of the various 'subpersonalities' may be ordered statistically and combined with the orderings of the other participants. In probabilistic terms this will mean a convolution of the various frequency distributions of the individuals' expectations" (374).

Going further, he notes however that a stable equilibrium of an asset-pricing model of this type probably would not exist, given that price expectations are not independent across market participants. A change of expectation on the part of one individual could lead the rest of the participants to change their views like a "flock of seagulls." He suggests that it might form the basis for a more objective approach to expectations than the one employed by Keynes (1936, 1937). Steindl's somewhat speculative paper does not offer a complete dynamic model, though the ideas therein are obviously related to much more recent work with heterogeneous agents, which is mostly beyond the scope of this paper. In contrast, as mentioned above, Godley was able to implement his random expectational Type 2 shocks by simulating a simple sectoral model (2012, 111–114).

ARE THEY STABLE?

Given that Type 2 shocks such as these are usually drawn randomly from a continuous distribution, it would be hard to believe that they were not made up of a convolution of separate draws. Stable distributions often arise when a number of factors, each fairly small in magnitude, are added together to form the total shock at any given time t_0. One example would be shocks that represent various risks to numerous financial entities. Large risks that do not emerge from the separate effects of many small risks are more likely to be modeled in some other way. Given this context, it often makes sense to model the size of such occasional, random shocks with some form of stable distribution. (See Nolan [forthcoming] for a technical review.) These laws arise from sums of constituent shocks, each in the basin of attraction of a stable distribution.[15] One example of a stochastic process that wanders randomly in continuous time and sometimes jumps would be a stable Lévy process, which moves in Lévy- stable increments. Methods exist to test for behavior consistent with stable processes of various kinds.[16] One member of the stable family is the univariate normal distribution, so Kalecki's aforementioned early experiment in the *Theory of Economic Dynamics* ([1954] 1990, 316–321) may have technically represented the first use of stably distributed shocks in a post-Keynesian model of economic fluctuations. In the non-Gaussian case, the shocks or increments in these processes have fat-tailed distributions, meaning that the model can account for a predominance of large and small moves. In this infinite-variance case, the distribution also contains a nontrivial skew parameter, allowing it to be fit to skewed data.

[15] In the context of his work on distributions of wealth and income, Steindl, who was mentioned above in connection with distributions of expectations, sometimes made use of a Pareto (power law) distribution. In the symmetric case, the tails of stable distributions approach a power law in the limit as the variable x approaches positive or negative infinity.

[16] See Embrechts and Maejima (2002, 9–11) for a definition. Chapter 8 of that monograph as well as Rachev and Mittnik (2000) contain ideas on statistical estimation for stable distributions and stable Lévy processes and other processes with stable shocks. See also Nolan (forthcoming). In Hannsgen (2012b), I find some evidence consistent with the hypothesis that some of the error terms in a somewhat representative neoclassical monetary SVAR possess Lévy-stable unconditional distributions. Moreover, in most cases, the fitted stable distributions possessed better fits than fitted t-distributions, and some evidence suggests that the fat tails documented in the article cannot be completely explained by heteroskedasticity alone. Moreover, for each full-sample error term, parametric bootstrap tests reject the hypothesis that $\alpha = 2$ (the Gaussian case), given a time-invariant, Lévy-stable specification, implying that the variances are infinite in each case for this model. See Hannsgen (2012b) for more findings and details.

ARE THEY "NEW INFORMATION" [UNEXPECTED]?

In colloquial English, the term "shock" often implies the arrival of information that the observer did not have before, as in the statement, "It was a shock to see you today." In time-series analysis, shocks are usually new information at time t, in the sense of Bayesian statistics, etc. In Keynesian economics, and presumably in most heterodox modeling, it is not necessarily true that shocks somehow represent new information, in part because expectations need not be "rational" in any way (Keynes 1936, chapter 12).

Numerous financial analysts saw a bubble in US housing markets and related securities markets developing from approximately the early 2000s to 2006, and indicators of overvaluation such as P/E ratios suggested a future collapse of home prices nationally, though the timing or circumstances of this crash could not be foreseen even by the most skeptical observers. Non-rational-expectations models of the market, which are robust to slight errors in measurement, forecasting, etc., at least allow for such possibilities (Christiaans 2013). Usually, various predictors, including lagged price changes, help predict price changes to some extent in many asset markets, including the housing market, which is characterized by momentum. However, the useful fact that some variables have such predictive power does not mean that an adequate theory exists to explain price movements, as opposed to predicting them.

It is not even clear whether the every-time-period shocks from Godley (2012) and other Type 2 shocks are meant to be interpreted as containing new information. Godley's simulation does not rely on such a claim, only that the variables that affect money demand vary from period to period in an erratic way. On the other hand, in the example in Godley and Lavoie (2012), the source of the shocks is unexpected changes in income. Given their adherence to the Keynesian concept of uncertainty (1936, chapters 12 and 15), there is still no reason to equate these unexpected movements with new information in a Bayesian or econometric sense, as might be the case in a ratex model. Similarly, the Minskyan example discussed above does not rely on the notion that shocks reflect new information. Hence, the new-information assumption is far too demanding to adopt as a required characteristic of a heterodox shock.

On the other hand, the novelty of economic shocks may be one way to help establish that the business cycle can persist despite countercyclical government policies. For example, as Skott (2012) mentions, Keynesian business cycle models sometimes lead to the question: given that fiscal policy is potentially effective, why can't the government eventually learn to eliminate a predictable, regular cycle? It might seem implausible to critics that the business cycle could persist if it were so "easy" to tame it. Adding confounding random shocks to the model is one way of making persistent fluctuations and underemployment a more convincing possibility even under a competent Keynesian countercyclical policy regime (Skott 2012).[17] What's more, in the context of a demand-driven Keynesian model, private sector demand shocks arise naturally and easily, as we saw above in the case of kaleidic shocks to expectations.

ARE THEY ONE-TIME OCCURRENCES?

As mentioned above, in Mitchell's business-cycle treatise, the author wrestled openly with fears that movements not fitting the patterns of a "normal cycle," seasonal fluctuations, or other modeled effects could not simply be "written off" in order to proceed with statistical analysis. Sometimes, one can explain such a break by a change in the way the series is collected or calculated or by making reference to some historical event such as outbreak of war or a particular financial crash. Mitchell pointed out that often events such as these would be small and independent in a given series, implying that they would normally cancel each other out, owing to some version of the law of large numbers. Other times, data series failed to possess this property, and significant moves stood out from normal cyclical patterns after statistical analysis had been performed. Mitchell pointed out that these movements had many possible explanations:

> For example, [statisticians] point out that wars or civil insurrections may disturb many economic processes for a considerable period. Less serious disturbances may be caused by such events as earthquakes, conflagrations, floods, droughts, epidemics, insect pests, strikes and lockouts, railway embargoes, inventions, changes in trade routes, discoveries of fresh resources, changes in laws, judicial rulings, and so on, through an interminable list. Nor should we forget the effects of changes in the method of compiling statistics, and of inaccurate reporting. (1927, 249)

Mitchell concludes in part that "while we desire to discriminate as clearly as we can between the irregular and cyclical fluctuations of time series, we cannot discard irregular fluctuations

[17] Kalecki ([1943] 1990) offers some additional possible reasons why full employment is not likely to be attained even in a Keynesian model with fiscal policy. For some further arguments in a more modern context, see Hannsgen (2012a).

offhand as irrelevant to the understanding of business cycles" (255). By the same token, "we cannot take it for granted that irregular fluctuations are to be eliminated from our theorizing, much as we would like to eliminate them from our curves" (255). Business cycles arise from a confluence of forces, some reflecting endogenous dynamics, and others "extraneous" to macroeconomic models. Mitchell expressed hope that one would gain confidence in the validity of statistics impacted by irregular movements as the number of observations grew larger. Of course, depending on the dataset, this kind of analysis may or may not hold true (Chen 2010, 4; Davidson 1982; Mandelbrot and Bernstein 2004).

ARE THEY EXPOSITIONAL?

Many Type-1 heterodox shocks are designed to demonstrate, elucidate, or exposit the dynamic properties of a model. Two examples would be the Minsky cycle in Taylor's volume that I mentioned before, along with the hypothetical shock used in Duménil and Lévy (1999) to help clarify the concepts of short and long-term equilibria that are central to that article.[18] They are not thought of as simulations of actual events or as a means of helping a model fit a specific data set.

Other Type 1 shocks mentioned in various exercises in the literature are intended in part to capture the transitional dynamics of a stable model subjected to a once-and-for-all change in parameter configurations. One case would be the use of change in the saving rate for the South in the course of a simulation run of an open-economy model in Godley and Lavoie (2012, 183–186). In such a case, the simulation is intended merely to help one get a sense of the factors that govern the dynamics of the model variables. A simulation of this type often rather naturally takes the place of an analytical exercise when the model in question possesses large numbers of sectors, equations, etc.

In a different way, the Type 2 shocks in Godley (2012) are also somewhat hypothetical in nature. Recall from the quote above that Godley's intent was to show how model variables

[18] Compare with the more orthodox language used by Tobin (1994, 173): "Suppose that shocks to current real demands for goods and services create, at existing prices and wages, excess supplies of labor and capital services. What are the variables whose changes would avert or eliminate macroeconomic disequilibrium." Tobin goes on to suggest ways in which equilibrium might or might not be restored in Keynesian and more "classical" approaches. In other words, one starts the example from a "normal" situation, in which markets clear except for frictional unemployment, etc., and shows how one returns to equilibrium either slowly or quickly following a shock.

would move if expectations changed each period with a “wildness” that he took to be self-evidently counterfactual.

It’s okay to use such tropes. After all, they are meant only as examples! On the other hand, they are a way of more effectively demonstrating model robustness to a skeptical audience.

ARE THEY HISTORICAL?

What happens ex post? Often it is necessary to account for historical changes in economic variables. One can do so by referring to a major exogenous change as a shock. Modelers often attribute large unexplained movements to one-time exogenous “shocks” in a similar way. Two historical examples would be the oil shocks to the US economy that occurred, respectively, at the time of the announcement of the oil embargo in 1974 and with the revolution that took place in Iran in 1979 (Blinder and Rudd forthcoming). There is no reason to expect a typical model equation to be able to account for the abrupt movements that subsequently occurred in consumer prices, etc., as if these events did not occur. On the other hand, models of labor-market hysteresis are an example in which fairly standard types of aggregate demand shocks can lead to permanent effects.[19]

The historical plausibility of shocks lends some credence to the notion that shocks are also useful for generating realistic simulations.

ARE THEY PRAGMATIC?

As mentioned before, shocks can be ad hoc, compared to the sophisticated models used in such fields as financial engineering or complexity theory. On the other hand, it may be that within the context of a relatively small model, a shock can do wonders, summarizing the possible effects of numerous sorts of catastrophes, minor and major, which cannot possibly be fit into such a model. The result may be a useful model. An analogy might be drawn to “normal accident” theory, which posits that accidents are to be expected and hence that they must be planned for, even if, hypothetically, they are preventable in some way (Perrow 1984). Such a theory often absolves individuals from personal blame. This is sometimes appropriate, given the inherent

[19] Dutt and Ros (2007) provide an account of macroeconomic hysteresis and related dynamic phenomena from a heterodox perspective.

nature of the risks involved in a particular market structure, technology, historical situation, etc. Yet, in addition to justifying the social costs of preparing for a possible disaster, it allows a role for a critique involving the latter kinds of factors.

For reasons that are similar in some ways, regardless of the question of responsibility and the nature of the risk, model-using agents may need a model specific to their own responsibilities and problems. For example, reinsurers need some sense of the overall risk involved in the policies they have underwritten, over which they have no direct control. The reason is that fiduciary responsibilities require them to have an approximate sense of potential losses across a wide variety of policies and risks, assuming that the latter are reasonable. In a similar way, the macroeconomist, modeling an economy with numerous vaguely understood risks to aggregate output, may benefit from a similar way of dealing with risk. This way of justifying the use of shocks contrasts with a related, yet more neoclassical approach, which might emphasize costs or "convenience" per se, avoiding reference to the particular model and modeler's role in society.

On the other hand, of course, one often needs an economic model in which crises, etc., arise endogenously in order to rebut claims that the events being explained are *entirely* natural in origin, rather than economic. Such claims are often used in an attempt to justify policy inaction or stasis. An example would be the specious claim that the business cycle can be completely accounted for using technological shocks, natural disaster shocks, etc. Nonetheless, an explanation of the business cycle that has *some* role for random shocks does not mean one with no role for policy measures to alleviate financial fragility, stabilize aggregate demand, provide for the unemployed, and so on. This is simply a case of the advantages of avoiding false dichotomies claiming that an explanation must be of either one type or another.

Another pragmatic argument in favor of being open to the use of shocks comes in a commentary by Steindl, whom we discussed earlier. He notes that sometimes controversial questions cannot very well be decided "on a general philosophical plane." He advocated exploring the possible role of shocks by simulating nonlinear dynamic models with shocks, a methodology that was becoming increasingly feasible for heterodox macro models at the time he wrote. To keep them out of our minds is perhaps even unrealistic for practicing modelers, with humanity's limited knowledge of the things that matter to their work. Quoting Steindl again, "My personal point of view is that the shocks are there in any case…I think it is most important keep a theory of the cycle flexible so that it will be capable of accommodating all the exogenous influences: the history, the accidents, and that a simple endogenous model cannot possibly take into account” (1989, 312). As we tend necessarily in dealing with everyday problems to proceed on the basis of both theory and preliminary empirical work, so might applied modeling best allow a role for both endogenous and shock-driven dynamics. There is much to be gained from new work of this type, one would hope, but there are ample precedents to make the case that this strategy need not pull us away from heterodox traditions.

ARE THEY JUMPY?

Mandelbrot and Hudson (2004, 86) note that “Clearly, prices do jump, both trivially and significantly.” The price series featured in Figure 1 displays two big moves that stand out from the rest of the series, as noted above. Mandelbrot and Hudson point to the examples of stock prices quoted in numbers ending in 0 or 5 as well as the less trivial case of big changes that happen when institutional market makers fail at some point in a trading day to clear the market for a particular listing. On the other hand, policy shocks are often hard to define and find, though, as we saw in Figure 2, the recent fiscal cliff episode in the United States appears, initially at least, to amount to a smoothed version of a big shock.

In contrast, jump dynamics in orthodox economics most often comes in the form of heavily critiqued resolutions of problems with saddle-point dynamics in standard models with expectations (Chiarella and Flaschel 2000, 47–56; Christiaans 2013; Taylor 2004, 97–103).

From a mathematical perspective, some self-similar stochastic processes are continuous in the relevant sense, but generate right-continuous sample paths, jumping occasionally along their otherwise continuous pathways. The distribution of the increments may be Lévy-stable. Moreover, these processes sometimes exhibit long dependence, implying something technically akin to hysteresis (Embrechts and Maejima 2002). From a technical point of view, shocks might need to be smoothed in a model by using some form of distributed-lag function, resulting in an expression such as

$$F\left[\int_{-\infty}^{t} G(t-\tau)x(\tau)d\tau\right]$$

which would make behavior depend upon some function F of a weighted average of previous and current values of the variable x (Jarsulic 1994, 147).

In contrast, the jumps themselves are of measure zero in the time dimension, which means that they technically have zero unconditional probability. Simulations may be very easy, leading, however, to well-known issues with calibration. Once again, we are perhaps left with an approach related to the one used by Godley and others to simulate a sequence of events occurring in a series of discrete time periods in historical time—or in a discretized simulation of a continuous model.

CONCLUSION

Summing up, there are at least two types of heterodox shocks. Type 1 was characterized by Keynes as a change in an independent variable (1936) and was developed more formally by Pasinetti ([1960] 1974), among others. Type 2 shocks, which are less characteristically heterodox, resemble an econometric error term in a time series model. These shocks may have arrived on the scene only after their more Keynesian Type 1 counterparts, though Mitchell's books on the business cycle were among the most important of his era in the US (1927), and Kalecki (1954) and Minsky (2004) were also pioneering. The answers to the questions posed in some of the section titles above depend upon which kind of shock is involved.

Along the lines of removing the dichotomy discussed in the previous section of this paper, one could adopt a combination of exogenous shocks and endogenous nonlinear dynamics by using conditional probabilities, as in Hannsgen (2012a). For the case of a Minskyan financial shock, one possibility would be to condition the probability of the shock event on a few measures of fragility, such as leverage ratios.[20] Conditioning the probability of the permanent shock on some relevant variables may render the shock more plausible than one in which, say, the financial crisis was a *completely* random occurrence, again avoiding a fallacious "either/or" dualism. Galbraith points out that some models of stress to markets, which he refers to as bubble detectors, allowed their users to foresee some form of US residential real estate crash in advance of its actual occurrence in 2007–09, also noting the kinship between such analysis and Godley's use of the concept of sustainability of private sector debt (Galbraith 2009, 89–91). Such models indicate when prices may be out of line, but do not offer forecasts of the exact date of a future crash. They allow economists to construct and simulate models of discrete events such as

[20] Another such metric is developed in Tymoigne (2011).

crashes and crises as opposed to what used to be called “credit crunches,” which tend to be modeled using continuous models of credit-market tightness. In a similar way, the flexibility of the stable probability distribution may have enabled Mandelbrot to perceive the imminence of a new and major asset-market crash early on (Mandelbrot and Hudson 2004). In this paper, I’ve provided some of the generalities of heterodox shocks; a discussion of the issues raised in this paper will hopefully contribute to our effort to provide more specifics.

REFERENCES

Asimakopulos, A. 1991. *Keynes's General Theory and Accumulation.* New York: Cambridge University Press.

Blinder, A., and J. Rudd. Forthcoming. "The Supply Shock Explanation of the Great Stagflation Revisited," In M. Bordo and A. Orphanides, eds. *The Great Inflation*, University of Chicago Press for NBER.

Caiani, A., A. Godin, and S. Lucarelli. 2012. "Innovation and Finance: An SFC Analysis of Great Surges of Development." Levy Economics Institute Working Paper No. 733. Annandale-on-Hudson, NY: Levy Economics Institute of Bard College.

Chen, Ping. 2010. "Meso Foundation of Business Cycles and Market Vitality for Macro Policy: A New Trinity of Micro-Meso-Macro Economy." Working Paper. New York: Columbia University Center on Capitalism and Society.

Chiarella, C., and P. Flaschel. 2000. *The Dynamics of Keynesian Monetary Growth: Macro Foundations*. New York: Cambridge.

Chiarella, C., P. Flaschel, and R. Franke. 2005. *Foundations for a Disequilibrium Theory of the Business Cycle.* New York: Cambridge University Press.

Chiarella, C., P. Flaschel, and W. Semmler. 2013. *Reconstructing Keynesian Macroeconomics Volume 2: Integrated Approaches.* New York: Routledge.

Christiaans. T. 2013. "Economic Crises, Housing Price Bubbles and Saddle-Point Economics." *Metroeconomica* 64(1): 197–214.

Congressional Budget Office (CBO). 2013. *An Analysis of the President's 2014 Budget*. Washington, DC: CBO. May.

Coricelli, F., and R. Fiorito. 2013. "Myths and Facts about Fiscal Discretion: A New Measure of Discretionary." Working Paper 33. Paris: Centre d'Economie de la Sorbonne.

Davidson, P. 1982. "Rational Expectations: A Fallacious Foundation for Studying Crucial Decision-Making Processes."*Journal of Post Keynesian Economics* 5(2). Winter.

Duménil, G., and D. Lévy. 1999. "Being Keynesian in the Short Term and Classical in the Long Term: The Traverse to Classical Long-term Equilibrium." *The Manchester School* 67(6): 684–716.

Dutt, A. 2012. "Distributional Dynamics in Post Keynesian Growth Models." *Journal of Post Keynesian Economics* 34(3): 431–451.

Dutt, A., and J. Ros. 2007. "Aggregate Demand Shocks and Economic Growth." *Structural Change and Economic Dynamics* 18(1): 75–99.

Embrechts, P., and M. Maejima. 2002. *Selfsimilar Processes.* Princeton, NJ: Princeton University Press.

Foley, D. 2010. “Hyman Minsky and the Dilemmas of Contemporary Economic Method.” In Dimitri B. Papadimitriou, ed. *The Elgar Companion to Hyman Minsky.* Northampton, Mass.: Edward Elgar.

Galbraith, J. K. 2009. “Who Are These Economists Anyway?” *Thought and Action.* Fall.

Godley, W. 2012. “Macroeconomics without Equilibrium or Disequilibrium.” In Marc Lavoie and Gennaro Zezza, eds. *The Stock-flow Consistent Approach.* New York: Palgrave Macmillan.

Godley, W., and F. Cripps. 1983. *Macroeconomics.* New York: Oxford University Press.

Godley, W., and M. Lavoie. 2012. *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production, and Wealth.* Second edition. New York: Palgrave Macmillan.

Goodwin, R. M. 1989. “Kalecki’s Economic Dynamics: A Personal View.” In Mario Sebastiani, ed. *Kalecki’s Relevance Today.* New York: St. Martin’s Press.

Hannsgen, G. 2012a. “Fiscal Policy, Unemployment Insurance, and Financial Crises in a Model of Growth and Distribution.” Working Paper No. 723. Annandale-on-Hudson, NY: Levy Economics Institute of Bard College.

———. 2012b. “Infinite-variance, Stable Shocks in Monetary SVAR.” *International Review of Applied Economics* 26(6): 755–786.

Jarsulic, M. 1994. “Continuous Time Dynamical Models with Distributed Lags.” In W. Semmler, ed. *Business Cycles: Theory and Empirical Methods.* Boston: Kluwer Academic.

Kaldor, N. 1985a. *Economics without Equilibrium.* Armonk, NY: M. E. Sharpe.

———. 1985b. *The Scourge of Monetarism.* New York: Oxford University Press.

Kalecki, Michal. (1939) 1990. “The Theory of Economic Fluctuations.” In Jerzy Osiatyński (ed.), *Collected Works of Michal Kalecki, Vol. I.* Translated by Chester Adam Kisiel. New York: Clarendon Press.

———. (1943) 1990. “Political Aspects of Full Employment.” In Jerzy Osiatyński (ed.), *Collected Works of Michal Kalecki, Vol. I.* Translated by Chester Adam Kisiel. New York: Clarendon Press.

———. (1954) 1990. *Theory of Economic Dynamics: An Essay on Cyclical and Long-Run Changes in Capitalist Economy.* In Jerzy Osiatyński (ed.), *Collected Works of Michal Kalecki, Vol. II.* Translated by Chester Adam Kisiel. New York: Clarendon Press.

Keynes, J. M. 1936. *The General Theory of Employment, Interest and Money*. New York: Harcourt, Brace and Company.

———. 1937. “The General Theory of Employment.” *Quarterly Journal of Economics* 51(2): 209–223.

Lavoie, M., and G. Zezza. 2012. Introduction to *The Stock-Flow Consistent Approach: Selected Writings of Wynne Godley*. New York: Palgrave.

Mandelbrot, B.B. 1983. *The Fractal Geometry of Nature.* New York: W. H. Freeman.

Mandelbrot, B. B., and R. L. Hudson. 2004. *The (mis)Behavior of Markets: A Fractal View of Risk, Ruin, and Reward.* New York: Basic Books.

Minsky, H. P. 2004. *Induced Investment and Business Cycles.* Northampton, Mass.: Edward Elgar.

Mirowski, P. 1985. *The Birth of the Business Cycle.* New York: Garland Publishing.

———. 2010. “Inherent Vice: Minsky, Markomata, and the Tendency of Markets to Undermine Themselves.” *Journal of Institutional and Theoretical Economics* 6(4): 415–443.

Mitchell, W. C. 1927. *Business Cycles, Volume I: The Problem and Its Setting.* New York: J. J. Little and Ives.

Nolan, J.P. Forthcoming. *Stable Distributions: Models for Heavy Tailed Data.* Boston: Birkhäuser.

O’Hara, M., and D. Easley. 2013. “The Next Big Crash Could Be Caused by ‘Big Data.’” *Financial Times*, May 21.

Papadimitriou, D. P. 2004. Introduction to *Induced Investment and Business Cycles* by Hyman P. Minsky. Northampton, Mass.: Edward Elgar.

Pasinetti, L.L. [1960] 1974. “Cyclical Fluctuations and Economic Growth.” In *Growth and Income Distribution.* New York: Cambridge University Press.

Perrow, Charles. 1984. *Normal Accidents.* New York: Basic Books.

Politi, J. 2013. “US Cuts Poised to Hit Long-term Unemployed.” *Financial Times,* February 24.

Poston, T., and I. N. Stewart. 1978. *Catastrophe Theory and its Applications.* Marshfield, Mass.: Pitman.

Qin, Duo and Christopher L. Gilbert. 2001. “The Error Term in the History of Time Series Econometrics.” *Econometric Theory* 17(2):424–450.

Rachev, S. and S. Mittnik. 2000. *Stable Paretian Models in Finance.* New York: John Wiley.

Rosser, Jr., J. B. 2000. *From Catastrophe to Chaos: A General Theory of Economic Discontinuities.* Second Edition. Boston: Kluwer Academic.

———. 2007. "The Rise and Fall of Catastrophe Theory Applications in Economics: Was the Baby Thrown Out with the Bathwater?" *Journal of Economic Dynamics and Control* 31(10): 3255–3280.

———. 2013. "A Conceptual History of Economic Dynamics." Working Paper. Harrisonburg, VA: James Madison University.

Shackle, G. L. S. 1968. *Expectations, Investment and Income.* 2nd Edition. London: Oxford University Press.

———. 1974. *Keynesian Kaleidics.* Chicago: Aldine Publishing.

Shiller, Robert J. 2013. "Yes, We're Confident, But Who Knows Why?" *New York Times,* March 10.

Skott, P. 2012. "Business Cycles." In J. E. King, ed. *The Elgar Companion to Post Keynesian Economics.* Second edition. Northampton, Mass.: Edward Elgar.

Steindl, J. 1989. "Reflections on Kalecki's Dynamics." In M. Sebastiani, ed. *Kalecki's Relevance Today.* New York: St. Martin's Press.

———. 1990. "The Dispersion of Expectations in a Speculative Market." In *Economic Papers 1941–88.* New York: St. Martin's Press.

Targetti, F., and B. Kinda-Hass. 1982. "Kalecki's Review of Keynes' *General Theory." Australian Economic Papers.*

Taylor, L. 2004. *Reconstructing Macroeconomics: Structuralist Proposals and Critiques of the Mainstream.* Cambridge, MA: Harvard University Press.

———. 2010. *Maynard's Revenge: The Collapse of Free Market Economics.* Cambridge, Mass.: Harvard University.

Tobin, J. 1970. "Money and Income: Post Hoc Ergo Propter Hoc?" *Quarterly Journal of Economics* 84(2): 301–17.

———. 1994. "Price Flexibility and Output Stability." In W. Semmler, ed. *Business Cycles: Theory and Empirical Methods: Theory and Empirical Methods.* Boston: Kluwer Academic.

Todorova, Z. 2009. *Money and Households in a Capitalist Economy.* Northampton, Mass.: Edward Elgar.

Tymoigne, Eric. 2011. “Measuring Macroprudential Risk through Financial Fragility: A Minskian Approach.” Working Paper No. 654. Annandale-on-Hudson, NY: Levy Economics Institute.