Reflexivity, path dependence, and disequilibrium dynamics

Author(s): ANWAR SHAIKH

Source: *Journal of Post Keynesian Economics*, FALL 2010, Vol. 33, No. 1 (FALL 2010), pp. 3-16

Published by: Taylor & Francis, Ltd.

Stable URL: https://www.jstor.org/stable/20798378

ANWAR SHAIKH

Reflexivity, path dependence, and disequilibrium dynamics

Abstract: *George Soros's theory of reflectivity focuses on the interactions between expected, actual, and fundamental values of variables. The fundamental values are affected by the historically contingent paths of the other two variables so that the equilibrating process is turbulent, path dependent (nonergodic), and may give rise to extended disequilibrium boom-bust phases. Such patterns are consistent with classical and Keynesian ideas of equilibration, but they invalidate notions such as rational expectations and the efficient market. The purpose of this paper is to lay out Soros's theory and show that it can be formalized in a simple and general manner with testable propositions.*

Key words: *cycles, disequilibrium, equilibrium, finance, nonlinear dynamics, reflexivity.*

Much of finance theory revolves around the interactions between expected, actual, and equilibrium outcomes.[1] It is important to recognize at the outset that the term *equilibrium* can refer to two very different notions. There is the standard notion of equilibrium-as-a-state-of-rest, in which expected and actual outcomes coincide with, or at least randomly fluctuate around, the equilibrium outcome. And there is the classical notion of equilibration-as-turbulent-regulation, in which expected and actual outcomes endlessly cycle around some moving center of gravity. (Mueller, 1986, p. 8, 1990, pp. 1–3; Shaikh, 1998). In order to distinguish between these two conceptions, I will use the term *equilibrium* for the former and *gravitation* for the latter, more general, conception. Equilibrium is then a special case of gravitation. Despite this difference,

Anwar Shaikh is a professor in the Department of Economics of the Graduate Faculty at the New School for Social Research.

[1] Standard finance theory focuses on expected rates of return on different financial assets. Expected prices of financial assets play a key role, because they determine the capital gains component of the expected rates of return. When actual rates equal expected rates, and when financial arbitrage has made all actual rates equal to one another, the resulting common rate is the equilibrium rate of return (Lutz, 1968, pp. 211–219).

Journal of Post Keynesian Economics/Fall 2010, Vol. 33, No. 1 3

0160–3477 / 2010 $9.50 + 0.00.
DOI 10.2753/PKE0160-3477330101

most representations of these two notions nonetheless have a common attribute: the gravitational value is generally assumed to be independent of expected and actual outcomes. The gravitational value may, of course, vary in response to changes in technology, tastes, and profits. But because these fundamentals are assumed to be immune to variations in expected and actual outcomes, so too is the gravitational point.

George Soros's theory of reflectivity, which emerges from his considerable experience in the world of finance, explicitly rejects the independence of fundamentals from variations in expected and actual outcomes. He advances three general theses: expectations affect actual prices, actual prices can affect fundamentals, and expectations are in turn influenced by the behavior of actual prices and fundamental prices. The end result is a process in which actual prices oscillate turbulently around their gravitational values. Expectations can induce *extended disequilibrium* cycles in which a boom eventually gives way to a bust (Soros, 2009, pp. 50–75, 105–106). Because expectations can affect fundamentals, the gravitational centers are path dependent (Arthur, 1994; David, 2001).[2] Hence, the future is not a stochastic reflection of the past, so that the overall system is nonergodic (Davidson, 1991).[3] The existence of extended disequilibrium processes invalidates the efficient market hypothesis, and the dependence of fundamentals on actual outcomes invalidates the notion of rational expectations (Soros, 2009, pp. 58, 216–222). Last, it is important to recognize that although expectations can influence actual outcomes, they cannot simply create a reality that validates them (ibid., pp. 40–44). On the contrary, gravitational centers continue to act as regulators of actual outcomes, which is precisely why booms eventually give way to busts.

The purpose of this paper is to show that Soros's theory of reflexivity can be formalized in a simple and general manner that gives rise to the very patterns he describes. The next section lays out Soros's argument in more detail. The section after that translates the argument into three simple behavioral propositions and demonstrates that the resulting system exhibits stable disequilibrium dynamics of the sort described by Soros. The final section proposes a testable version of the theory and offers

[2] Path dependence implies that a variable's gravitational center is dependent on a particular historical path taken by the variable.

[3] An ergodic stochastic process is a process in which "averages calculated from past observations cannot be persistently different from the time average of future outcomes" (Davidson, 1991, p. 132). Samuelson (1969) "made the acceptance of the 'ergodic hypothesis' the *sine qua non* of the scientific method in economics" (Davidson, 1991, p. 133).

some reflections on some of the broader implications of the theory of reflexivity for economic analysis and policy.

Soros's theory of reflexivity

The first proposition of Soros's theory is that expectations affect actual outcomes. In the specific case of financial markets, expectations affect the market prices of financial assets. Thus, a general expectation that a stock's price will rise will create an excess demand for the stock, which will raise its market price (ibid., 2009, pp. 3–5, 8, 10, 66–71, 73). In a practical sense, what you expect affects what you get—the future is contingent.

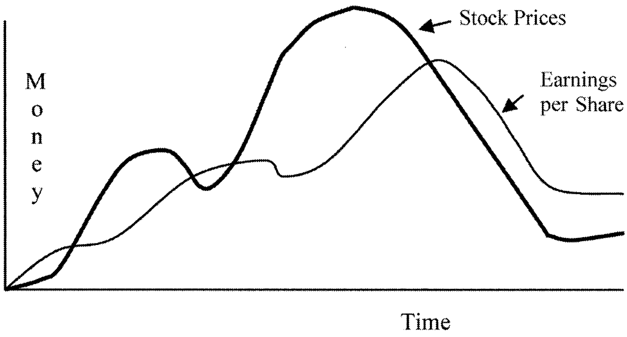
The second proposition, which is "the crux of the theory of reflexivity," is "that market prices can [in turn] influence the fundamentals" (ibid., p. 59). In conjunction with the first proposition, this means that expectations affect both "market prices . . . [and] the fundamentals they are supposed to reflect" (ibid., note p. 73).

The third proposition is that expectations are influenced by actual prices and fundamental prices. This proposition is stated less directly than the first two but is nonetheless implicit in Soros's statements. For instance, he says that the "change in fundamentals may then reinforce the biased expectations in an initially self-reinforcing *but eventually self-defeating process*" (ibid., p. 59, emphasis added). This describes a process in which expectations feed on themselves, while at the same time, any resulting bubble progressively undermines the confidence that the process will continue.

According to Soros, the interactions between the three variables lead to the gravitation of actual prices around the price corresponding to the fundamentals.[4] The gravitational process may involve an extended period where the actual price is above the fundamental price (bubble) followed by another extended period where the former is below the latter (bust). He illustrates his "boom-bust model" with a theoretical diagram and with empirical charts in which both the market price of a stock and the corresponding fundamental variable (earnings per share) are continually moving. Yet the fundamentals move less than the market price, and the overall process is a wave in which the actual price first overshoots, and then undershoots, the fundamentals. This, he says, is an illustration of the

[4] Soros actually compares market prices with earnings per share, but the manner of his exposition and argument makes it clear that the latter is a proxy for a price that corresponds to fundamentals—that is, a fundamental price.

Figure 1 Soros's theoretical boom-bust cycle wave



Source: Soros (2009, p. 67).

kind of bubble that can arise out of reflexive relations (ibid., pp. 66–72). Figure 1 duplicates his theoretical chart (ibid., p. 67).

Because the boom-bust cycle is a *disequilibrium* process that affects even the gravitational value, Soros sees it as an indictment of the rational expectations hypothesis and of equilibrium theory in general. The "prevailing paradigm asserts that financial markets tend toward equilibrium. That has led to the notion that prices deviated from theoretical equilibrium in a random manner. . . . [T]he claim that those models apply to the real world is both false and misleading" (ibid., p. 75). But on the issue of equilibrium, his real target is the notion of equilibrium-as-a-state-of-rest, not that of equilibrium-as-turbulent-gravitation: "Economics . . . relies on the concept of equilibrium, similar to the resting place of the pendulum, which is the same irrespective of any temporary perturbation" (Soros, 1997). Indeed, his charts, like the chart in Figure 1, depict mutual gravitation between actual prices and their fundamental values. He also speaks of "equilibrium as a moving target" (2009, p. 73), refers to prices having a "normal relation" to fundamentals,[5] and describes the case of an "overvalued stock" that eventually collapsed because "reality could not sustain expectations" (ibid., p. 61). I would argue that this puts him in the gravitational camp, with the important qualification that in his case, the gravitational center is affected by actual prices. This particular point is the hallmark of his theory of reflexivity.

[5] "Housing prices will have to fall at least 20 percent over the next five years to get back to a *normal* relationship to household income" (Soros, 2009, note p. 129, emphasis added).

Path dependence is a natural consequence of this argument. In the case of social event, their "one-dimensional path . . . emerges out of the reflexive interplay between the participants' views and the actual state of affairs" (ibid., p. 105). Hence, "events in financial markets are best interpreted as a form of history. The past is uniquely determined, the future is uncertain" (ibid., p. 106). Moreover, "financial markets do not reflect prevailing conditions accurately; they provide a picture that is always biased or distorted in one way or another" (Soros, 2008, p. 2). This distortion is exemplified by bubbles:

> Bubbles have two components: a trend that prevails in reality and a misconception relating to that trend. The simplest and most common example is to be found in real estate. The trend consists of an increased willingness to lend and a rise in prices. The misconception is that the value of the real estate is independent of the willingness to lend. That misconception encourages bankers to become more lax in their lending practices as prices rise and defaults on mortgage payments diminish. That is how real estate bubbles, including the recent housing bubble, are born. It is remarkable how the misconception continues to recur in various guises in spite of a long history of real estate bubbles bursting. (ibid., p. 2)

It follows that "financial markets cannot possibly discount the future correctly because they do not merely discount the future; they help to shape it. In certain circumstances, financial markets can affect the so-called fundamentals which they are supposed to reflect" (Soros, 1994). Bubbles are usually self-correcting. But when they are not, reflexivity's "self-reinforcing processes may carry markets into far-from-equilibrium territory" (Soros, 2008, p. 2).

Soros generally supports financial regulations even though he is clear about their limitations. He speaks favorably of the postwar era in which banks and markets were strictly regulated, mortgages required at least 20 percent down and borrowing against stocks required 50 percent, credit cards did not exist, exchange rates were fixed, international financial transactions were highly regulated, and international capital movements were small. But large capital outflows, U.S. trade deficits, and the Vietnam War eroded the foundations of the Bretton Woods system to the point that it had to be abandoned in 1971. Then came successive oil shocks in the 1970s, worldwide inflation, large budget deficits and rising interest rates in the United States, and an international banking crisis that devastated developing countries in the 1980s. International banks began to be bailed out by their governments with the help of the International Monetary Fund (IMF). In the face of all this, banks were actually granted greater freedoms instead of being more strictly regulated. Soros traces this change in attitude to the influence of market fundamentalism, which by then had become the dominant creed in the United States and United Kingdom (Soros, 2009, pp. 108–117). "Ever more sophisticated financial instruments were invented, and new ways to keep assets off balance sheets were found. That was when the super-bubble [of the 1980s] really took off" (ibid., p. 117).

Financial regulation is a complicated Darwinian process. Financial firms are always inventing new instruments not covered by existing regulations and new means to evade restrictions. In this race, authorities are always behind. Moreover, regulators may hold the same distorted information as do market participants. Bureaucracy may make state intervention untimely or even inappropriate under the best of circumstances. Indeed, when the pace of financial mutations is rapid, even private rating agencies may not be able to keep up. And, of course, regulators are hardly immune to the blandishments of financial capital. In the end, these difficulties combined with the pressure to save troubled financial institutions can lead to a climate in which the state actually keeps the bubble growing until it becomes entirely unsustainable (Soros, 2008, p. 3). Despite all of this, Soros argues that regulators must accept the responsibility of trying to limit bubbles as they arise. In addition to monetary policy, he favors limits on margin and capital requirements, the approval and registration of new financial products, and tighter limits on credit and leverage—for in the end a (moderately) regulated market is safer than an unregulated market (ibid., pp. 4–5).

A formalization of reflexivity and its disequilibrium dynamics

Reflexivity theory has to do with the mutual relations among expected, actual, and gravitational values of variables. The paradigmatic case is that of financial markets, where expectations affect the actual price of some asset and the actual price, in turn, may affect the associated fundamentals. In order to formalize these interactions, it is useful to supplement the actual price (p) with two additional variables: the expected price (p^e), which reflects the average expectations in the market, and the fundamental price (p^*), which is the price corresponding to fundamentals. One does not have to tie the theory of reflexivity to any particular specification of the fundamentals. Soros suggests earnings per share as the appropriate fundamental variable (ibid., pp. 67–70), which would presumably be reflected in some corresponding fundamental price. But for present purposes, any other theory of the fundamental price would do as well. I return to this point in the final section of the paper.

We can now define two measures that will play a critical role in formalizing reflexivity theory. First, the difference between the expected price and the actual price ($p^e - p$) is a measure of the *degree of bullishness* in the market. It is also an inverse measure of the degree of underestimation of the path of market price, because the term ($p - p^e$) measures the extent to which actual prices turn out to be higher than expected prices. Second, the difference between the actual price and the fundamental price ($p - p^*$) is a measure of the *degree of overvaluation* in the market:

$$\pi^e \equiv \left(p^e - p\right) = \text{the degree of bullishness} \tag{1}$$

$$\pi \equiv \left(p - p^*\right) = \text{the degree of overvaluation.} \tag{2}$$

With this in hand, we can translate the theses of reflexivity into a series of formal relations between bullishness and overvaluation. The first thesis is that actual prices are affected by expectations. It seems plausible to translate this as saying that the actual price will rise if the expected price is greater than the actual price, which is to say that the actual price changes in response to the degree of bullishness in the market. The second thesis is that fundamentals can be affected by market prices. This could be translated as the proposition that the fundamental price rises if the actual price is above the fundamental price—that is, that the fundamental price is affected by the degree of overvaluation in the market. The third thesis is that expectations are self-reinforcing at first but eventually become undermined by the very conditions they create. One way to interpret this is to say that expected price rises when the actual price is above the expected price because actual outcomes have turned out to be even better than expected (i.e., the degree of underestimation ($p - p^e$) is positive), but that the size of the gap between actual prices and fundamental prices (i.e., the degree of overvaluation, which is the size of the bubble) progressively undermines the ebullience of the market. This would be consistent with Soros's previously quoted statement that the "change in fundamentals may then reinforce the biased expectations in an initially self-reinforcing but eventually self-defeating process." Table 1 summarizes the possible mappings, with the notations $f()$, $h()$, and $j()$ signifying functional relations; $\dot{p}$ signifying the change in p, and so forth; and the sign under particular terms indicating the direction of their linkage. Each of these is, in turn, subject to zero-mean stochastic shocks ε_j.

Table 1
Formalizations of reflexivity theory

Thesis	
Actual prices are affected by expectations	$\dot{p} = f\left(\underset{+}{p^e - p}\right) + \varepsilon_1$
Fundamentals can be affected by actual prices	$\dot{p}^* = h\left(\underset{+}{p - p^*}\right) + \varepsilon_2$
Expectations are self-feeding but undermined as a bubble grows	$\dot{p}^e = j\left(\underset{+}{p - p^e}, \underset{-}{p - p^*}\right) + \varepsilon_3$

The number of possible models that can be constructed depends only on the particular functional forms used to represent these relations. For the first two relations, I use linear forms. For the third, the response of expected price to the degree of underestimation is linear, but its response to the degree of overvaluation (the size of the bubble) is nonlinear in that it gets more intense with the size of this term. This latter response is captured by using the cube of the degree of overvaluation. Then for any positive coefficients α, β, γ_1, γ_2 and zero-mean stochastic shocks ε_1, ε_2, ε_3, the model is

$$\dot{p} = \alpha\left(p^e - p\right) + \varepsilon_1 \tag{3}$$

$$\dot{p}^* = \beta\left(p - p^*\right) + \varepsilon_2 \tag{4}$$

$$\begin{aligned} \dot{p}^e &= \gamma_1\left(p - p^e\right) - \gamma_2\left(p - p^*\right)^3 + \varepsilon_3 \\ &= -\gamma_1\left(p^e - p\right) - \gamma_2\left(p - p^*\right)^3 + \varepsilon_3. \end{aligned} \tag{5}$$

This model can be rewritten as a 2×2 linear differential equation system with shocks $\varepsilon_4 = \varepsilon_3 - \varepsilon_1$ and $\varepsilon_5 = \varepsilon_1 - \varepsilon_2$ by making use of the definitions of the degrees of bullishness and overvaluation in Equations (1) and (2).

$$\dot{\pi}^e \equiv \left(\dot{p}^e - \dot{p}\right) = -\left(\alpha + \gamma_1\right)\pi^e - \gamma_2\pi^3 + \varepsilon_4 \tag{6}$$

$$\dot{\pi} \equiv \left(\dot{p} - \dot{p}^*\right) = \alpha\pi^e - \beta\pi + \varepsilon_5. \tag{7}$$

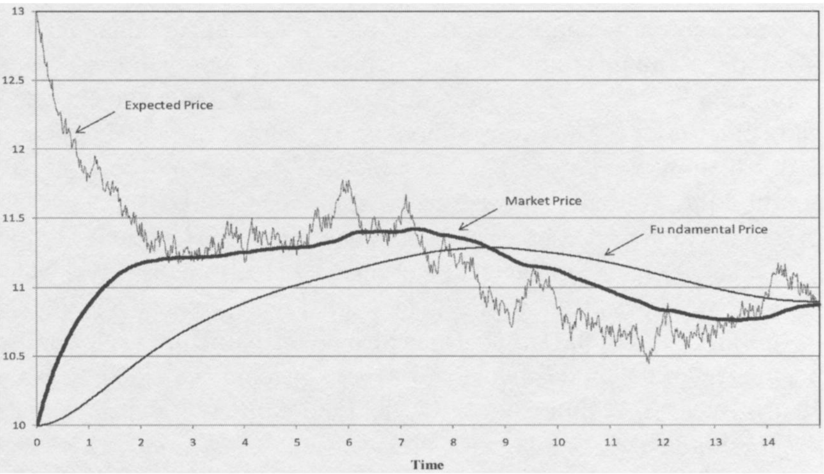
The reduced-form model is globally stable around the values $\pi^e = 0$ and $\pi = 0$—that is, around $p^e = p = p^*$ (see the Appendix). The reformulated system in Equations (6) and (7) has two points of gravitation, $\pi^e \equiv (p^e - p) = 0$ and $\pi \equiv (p - p^*) = 0$, which are independent of the sizes of the reaction coefficients in the original reflexive system in Equations (3), (4), and (5). But it is important to note that *the gravitational center p^* is not a fixed point,* because it, too, responds to the gyrations in expected and actual prices. Moreover, although the degrees of bullishness and overvaluation $\pi^e \equiv (p^e - p)$ and $\pi \equiv (p - p^*) = 0$ are zero on average, equilibrium-as-a-state-of-rest does not hold even for these variables. On the contrary, all the variables and combinations careen endlessly around each other. A characteristic feature of this system is that the actual paths of all the variables, including the gravitational center, depend not only on the initial values of the variables but also on the particular values of the parameters of the model and on any shocks encountered along the way. Hence, successive simulation runs yield quite different paths. *History definitely matters in defining the levels of a system such as this.* This is the central point of Soros's argument. Booms inevitably give way to bubbles, although one can never say precisely when, because the exact paths are historically contingent. This, too, is prefigured in Soros's remarks and illustrations, and according to his statement, is an important factor in his enormous financial success.[6] Figure 2 displays the paths of actual and fundamental prices, which start out equal and rise in response to an initially higher expected price (see the Appendix for further details). The expected price, whose ghostly presence plays such an important role, is also depicted. The parallels between Figures 1 and 2 are striking.

Some general implications of reflexivity theory

Reflexivity theory relies on the classical notion of turbulent gravitation. But unlike most representations of classical adjustments, it also allows for a two-way interaction between the market price and its gravitational center. In order to test this theory, we would have to do three things. First, specify a particular theory of the fundamental price. Second, show that the market price gravitates around the fundamental price. And, third, show that the fundamental price is affected by the market price—that is, that

[6] Soros says that he was able to apply his "theory of reflexivity to establish a disequilibrium scenario or boom-bust pattern for financial markets. The rewarding part came when markets entered what I called far-from-equilibrium territory. . . . I specialized in detecting and playing far-from-equilibrium situations with good results. . . . [Yet] the salient feature of my theory is that it does not yield any firm predictions" (Soros, 2009, pp. 18–19).

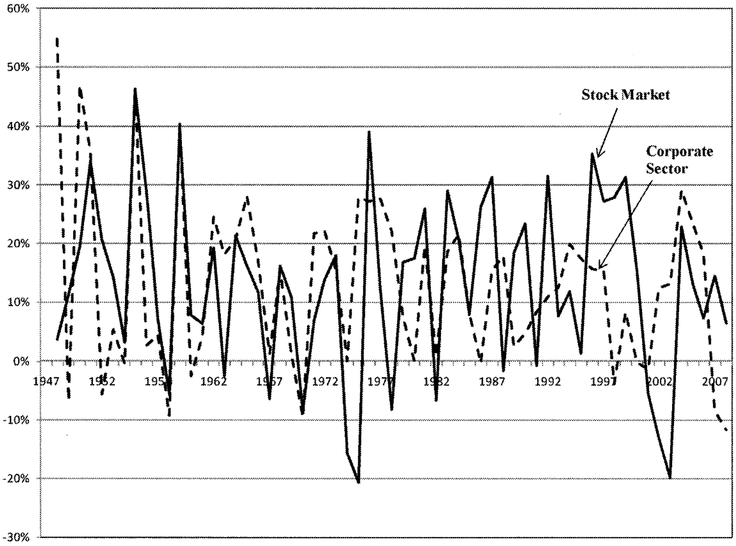
Figure 2 Reflexivity model boom-bust cycle



the gravitation between the two is mutual. Equilibrium-as-a-state-of-rest never exists, and the gravitational center is never a fixed point.

In my work (Shaikh, 1998; 2008), I have argued that for the comparison of rates of return across sectors, the appropriate measure of the rate of return in the real sector is the return on *new* investment, not the rate of return on *average* investment. In the case of the stock market, this distinction does not exist because equities have no "age": stocks issued a long time ago have exactly the same price, dividends, and rates of return as stocks issued just recently. But in industry, the profitability of an old plant and equipment is decidedly different from that of new ones, which is why older ones are always retired at some point. It is the return on new investment that motivates the mobility of capital from one use to another. Hence, the appropriate comparison is between the stock market rate of return and the return on new investment in the real-sector rate. As a proxy for the latter, I used the incremental rate of return (the ratio of the change in gross profits to gross investment). With this, I was able to demonstrate that the rate of return in the U.S. stock market (the financial structure) does indeed gravitate around the rate of return on new investment in the U.S. corporate sector (the real sector). I defined the fundamental (warranted) stock price as the price that would make the stock market rate of return equal to that in the real sector, and showed that the average and fundamental stock prices gravitated around each other in a highly turbulent manner. I argued that this finding contradicted Shiller's (1989,

Figure 3 Annual stock market and corporate-sector rates of return, 1947–2008



pp. 78–82) claim that stock market prices were essentially disconnected from fundamentals (Shaikh, 1998, pp. 396–398).

My earlier argument against Shiller's hypothesis continues to hold up. Figure 3 extends my earlier empirical evidence to 2008, using the same methodology as in Shaikh (ibid.).[7] The strong relation between the rate of return in the stock market and that on new investment in the corporate sector is clearly visible. Even their means and volatilities are virtually the same: the stock market rate has a mean of 12.82 percent and a standard deviation of 15.08 percent, whereas the corporate rate has a mean of 13.4 percent and a standard deviation of 14.95 percent. And now one can also clearly see a bubble in the 1990s and an ensuing bust at the beginning of the twenty-first century. As noted previously, the relation between rates

[7] Corporate profits (*P*), fixed capital consumption (*D*), gross profit ($PG = P + D$), and gross investment (*IG*) were calculated from the U.S. National Income and Product Accounts (NIPA) tables 6.16A–D (line 2), 7.5 (line 4), and the sum of 4.7 (line 13) and 5.7 (line 3) (www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N). The S&P500 stock price index (*ps*) and dividends per share (*d*) were taken from Shiller's home page at http://aida.econ.yale.edu/~shiller/data.htm. The corporate-sector rate of return on new investment was then calculated as $\Delta PG_t/IG_{t-1}$, and the stock market rate of return was calculated in the usual manner as $(\Delta ps_t + d_t)/ps_{t-1}$. The fundamental stock price (not shown here) can be calculated by setting the two rates of return equal and solving for ps_t.

of return can be represented as a relation between the actual stock market price and the corresponding fundamental price (the stock price at which the stock market rate of return was equal to the real-sector rate). I would argue that my findings strongly support Soros's notion that market prices and fundamentals are gravitationally linked.

The preceding work is relevant to the first two testing requirements mentioned at the beginning of this section: it specifies a particular measure of fundamental price and it shows that the fundamental price acts as a center of gravity for the market price. It did not address the third requirement, which was to see if the fundamental price was also responsive to the market price. But the latter inquiry is evidently possible. It follows that all of the propositions of reflexivity theory are testable.

Second, the fact that variables affect each other does not imply that they do so to the same degree or at the same speed. Expected prices are likely to be the fastest and most volatile, actual prices both slower and less volatile, and fundamental prices slowest and least volatile. Such distinctions are implicit in standard notions of short, medium, and long runs. But here they are given a different content because the variables, and hence the "runs," are not independent of one another. I would argue that at a macroeconomic level, one can construct a similar typology for effective demand, supply, and capacity (the domain of Keynes and Harrod), and for the financial sector versus the real sector.

Finally, it has been noted (Vienneau, 2008) that there is an affinity between Davidson's (1991, pp. 130–133) argument that social outcomes are subject to true uncertainty and Soros's emphasis that "social events are fundamentally different from natural phenomena" because the future "emerges out of the reflexive interplay between the participants' views and the actual state of affairs" (2009, p. 109; see also 1997). Soros explicitly refers to his rejection of the "ergodic hypothesis" (Vienneau, 2008). Both Davidson and Soros emphasize that history plays a crucial role in defining the time paths of their key variables: aggregate supply and demand in the Keynesian case, and market price and fundamental price in the reflexivity case. Yet both authors also speak of a (turbulent) balance between their key variables. Because the respective pairs gravitate around each other, their difference is zero over some appropriate interval (which may be long). This means that any system that generates turbulent gravitation also possesses a *center point,* which is their average distance—zero. As long as one adheres to some notion of gravitation under structural forces, the existence of such a point is intrinsic. So we can say two things at the same time: key economic variables are historically contingent and path dependent, yet their inner relation to one another is structurally determined and path independent.

REFERENCES

Arthur, W.B. *Increasing Returns and Path Dependence in the Economy.* Ann Arbor: University of Michigan Press, 1994.

David, P.A. "Path Dependence, Its Critics and the Quest for 'Historical Economics.'" In P. Garrouste and S. Ioannides (eds.), *Evolution and Path Dependence in Economic Ideas: Past and Present.* Cheltenham, UK: Edward Elgar, 2001, pp. 15–40.

Davidson, P. "Is Probability Theory Relevant for Uncertainty? A Post Keynesian Perspective." *Journal of Economic Perspectives,* 1991, *5* (1), 129–143.

Hirsch, M.W., and Smale, S. *Differential Equations, Dynamical Systems, and Linear Algebra.* New York: Academic Press, 1974.

Lutz, F.A. *The Theory of Interest.* Chicago: Aldine, 1968.

Mueller, D.C. *Profits in the Long Run.* Cambridge: Cambridge University Press, 1986.

——— (ed.). *The Dynamics of Company Profits: An International Comparison.* Cambridge: Cambridge University Press, 1990.

Samuelson, P.A. "Classical and Neoclassical Theory." In R.W. Clower (ed.), *Monetary Theory.* London: Penguin, 1969, pp. 1–15.

Sanchez, D.A. *Ordinary Differential Equations and Stability Theory: An Introduction.* New York: Dover, 1968.

Shaikh, A. "The Stock Market and the Corporate Sector: A Profit-Based Approach." In M. Sawyer, P. Arestis, and G. Palma (eds.), *Festschrift for Geoffrey Harcourt.* London: Routledge & Kegan Paul, 1998, pp. 389–404.

———. "Competition and Industrial Rates of Return." In P. Arestis and J. Eatwell (eds.), *Issues in Economic Development and Globalisation, Festschrift in Honor of Ajit Singh.* Basingstoke, UK: Palgrave Macmillan, 2008, pp. 167–194.

Shiller, R.J. "Comovements in Stock Prices and Comovements in Dividends." *Journal of Finance,* 1989, *44* (3), 719–729.

Soros, G. "Theory of Reflexivity MIT Speech." MIT Department of Economics, World Economy Laboratory Conference, Washington, DC, April 26, 1994 (available at www.sharpeinvesting.com/2007/08/george-soros-theory-of-reflexivity-mit-speech.html).

———. "Unrepentant." *Economist,* March 15–22, 1997.

———. "The Crisis & What to Do About It." *New York Review of Books,* December 4, 2008, 1–6 (available at www.nybooks.com/articles/archives/2008/dec/04/the-crisis-what-to-do-about-it/).

———. *The Crash of 2008 and What It Means.* New York: PublicAffairs, 2009.

Vienneau, R. "Letters from Soros." *Thoughts on Economics,* 2008 (available at http://robertvienneau.blogspot.com/2008/05/letters-from-soros.html).

Appendix

The differential equation system in the text is

$$\dot{\pi}^e \equiv \left(\dot{p}^e - \dot{p}\right) = \dot{p}^e = -\left(\alpha + \gamma_1\right)\pi^e - \gamma_2\pi^3 \qquad \text{(A1)}$$

$$\dot{\pi} \equiv \left(\dot{p} - \dot{p}^e\right) = \alpha\pi^e - \beta\pi. \tag{A2}$$

Equilibrium values are obtained by setting $\dot{\pi}^e = 0$, which yields

$$\pi^e = \left(\frac{\gamma_2}{\alpha + \gamma_1}\right)\pi^3,$$

and $\dot{\pi} = 0$, which yields

$$\pi^e = \left(\frac{\alpha}{\beta}\right)\pi,$$

so that $\pi^e = \pi = 0$ is the only solution. Hence, the equilibrium point is given the equality of expected, actual, and fundamental prices ($p^e = p = p^*$) *even though the fundamental price is affected by the other two.* The system has the Jacobian

$$J = \begin{pmatrix} -(\alpha + \gamma_1) & -2\gamma_2\pi^2 \\ \alpha & -\beta \end{pmatrix},$$

which at the equilibrium point is

$$J_0 = \begin{pmatrix} -(\alpha + \gamma_1) & 0 \\ \alpha & -\beta \end{pmatrix}.$$

The latter has trace $TR = -(\alpha + \gamma_1) - \beta < 0$ and determinant $DET = (\alpha + \gamma_1)\beta > 0$, so the system is stable around its unique equilibrium point (Hirsch and Smale, 1974, p. 96; Sanchez, 1968, pp. 84–87).